4-2003

Evaluation of the Pediatric Test of Brain Injury

Heather K. Koole

EVALUATION OF THE PEDIATRIC TEST OF BRAIN INJURY

by

Heather K. Koole

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Speech Pathology and Audiology

Western Michigan University
Kalamazoo, Michigan
April 2003

ACKNOWLEDGMENTS

I would like to thank the members of my committee, Dr. Nickola Nelson, Mrs. Adelia Van Meter, and Dr. Diane Dirette, for their time, suggestions, and for making it obvious that intelligence and compassion can go hand in hand. And thank you especially, Dr. Nelson, for your guidance, precious time, and confidence in my abilities.

I owe many thanks to my subjects with traumatic brain injury, who made this project real. I also thank their parents for their willingness to take part in this study and for helping me realize the tremendous impact of traumatic brain injury. Thank you to Dr. Carol Presant without whom I would not have had subjects for this study. Thanks are also due to Jean Silbar who facilitated the connection with Dr. Presant at a time when all hope of finding subjects was lost. And thanks to my three friends without TBI who eagerly contributed as control subjects. Thank you all!

Laura Workman offered needed advice and sharing of ideas through this crazy process. Thank you! Thanks to my classmates who, simply by being in this field, will add much compassion and service for students with TBI and many others. You are all amazing. I appreciate my dear friends so much who, by not being involved in the field, kept me sane. Also incredibly encouraging and supportive were my parents, Marinus and Elizabeth Koole, who showed me from day one that when we stand up, we must know that we are standing up for everybody. Finally, thank you John, for being a husband of endless patience, for believing in me, and for keeping things in perspective just by being you.

Heather K. Koole

EVALUATION OF THE PEDIATRIC TEST OF BRAIN INJURY

Heather K. Koole, M.A.

Western Michigan University, 2003

This study was designed to evaluate the Pediatric Test of Brain Injury (PTBI), as well as to examine information obtained from informal measures in assessing children and adolescents with traumatic brain injury (TBI). Three students with TBI and three grade- and gender- matched subjects participated in this study. All six students were administered the PTBI, and their performances were given raw scores, rated for level of difficulty in performing the tasks, and compared among and across the two groups. The students with TBI were interviewed by the graduate student researcher regarding self-perceptions of their strengths and weaknesses. In addition, their teachers were asked to complete a questionnaire regarding academic function and classroom behavior. The results of the interviews and surveys were compared with the results of the participants' performances on the PTBI.

The students with TBI had great difficulty with spoken and written discourse tasks involving retelling a story and combining sentences, pragmatic skills for telling how someone would respond given a brief scenario, and digit span memory. The groups performed similarly on tasks involving visual memory, vocabulary skills, and reading fluency. Participant interviews, teacher surveys, and the PTBI results for the participants with TBI were generally consistent with one another. The interviews and surveys, however, focused on cognitive-behavioral issues, whereas the PTBI specified cognitive-linguistic strengths and needs.

TABLE OF CONTENTS

Table of Contents—continued

Table of Contents—continued

Table of Contents—continued

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Statement of the Problem

The National Center for Health Statistics reported that traumatic brain injury (TBI) is the "leading cause of death and disability in children between the ages of 1 to 14" (Blosser & DePompei, 1994, p. 10). There is a reason this cause is identified as "traumatic." Literally, the term refers to the assault on the brain when the forces of acceleration and deceleration are applied to it, resulting in the bruising of brain tissue and the shearing of fibers as the brain moves rapidly within the skull. "Traumatic" also appropriately describes the experience of individuals and their families once they survive the physical trauma that affects their abilities to use the precious matter in their skulls to view the world and to think, learn, and communicate in their environment.

The consequences of pediatric TBI are great. Lives affected are never the same. The children and adolescents themselves must adjust to new ways of thinking – their brains are forever altered. Their parents must adapt to new ways of parenting – their children are forever changed. Rehabilitation specialists and educators must familiarize themselves with the population affected by brain injury – these clients and their families need assistance to find effective rehabilitation services, answers to their many questions, and methods to compensate for new limitations. Clinicians play a role in empowering families to deal with new challenges. This empowering begins with a strong knowledge base and the tools for a comprehensive and appropriate

assessment.

Overview of Cognitive and Linguistic Deficits in Pediatric TBI

Many authors agree that the effects of TBI on the young brain are devastating and far-reaching, especially in the case of severe levels of injury. Severity levels in TBI are defined on the basis of initial Glasgow Coma Scale (GCS) score and the results of Magnetic Resonance Imaging (MRI) or Computerized Tomography (CT). The GCS is used in acute care facilities to determine level of consciousness following TBI. Possible scores range from 3 to 15 based on eye opening, motor responses, and verbal responses. Severity levels typically follow these criteria (J. Donders, personal communication, December 12, 2001; Turkstra, 1999):

- Mild = GCS > 12; no MRI or CT evidence of intracranial pathology
- Moderate = GCS 9 to 12 or GCS > 12 with CT or MRI evidence of intracranial pathology
- Severe = GCS < 9

Deficits in the cognitive processes of attention, memory, and executive functioning are among the most obvious sequelae of TBI in children and adolescents. Emotional and behavioral issues such as anger management, impulsivity, judgment, and social skills are also often observed as problem areas (Blosser & DePompei, 1994; and Farmer, Clippard, & Luehr-Wiemann, 1996).

Language deficits are less obvious. In fact, linguistic deficits in children and adolescents with TBI may not be detected by traditional language assessment tools designed for children and adolescents with developmental disorders. The result is that it is difficult to determine accurate profiles of linguistic ability in the pediatric TBI

population, and impairments may be overestimated or undetected (Sohlberg & Mateer, 1989; Turkstra, 1999; Ylvisaker, 1998; Ylvisaker, Koplan, & Rosenthal, 1994).

Several studies have examined the language deficits specific to children and adolescents with TBI using informal tools. The most revealing of these language tasks have involved spoken and written discourse, which are areas generally not measured by traditional standardized language tests (Chapman, McKinnon, Levin, Song, Meier, & Chiu, 2001; Chapman, Levin, Wanek, Weyrauch, & Kufera, 1998; and Yorkston, Jaffe, Liao, & Polissar, 1999).

In addition to the major categories of deficits associated with pediatric TBI, Blosser and DePompei (1994) listed other communication characteristics that can occur in children and adolescents with brain injury. These characteristics include tangential speech, hyperverbal speech, confabulations, and anomia (p. 28). Blosser and DePompei pointed out that the "behaviors and impairments associated with pediatric traumatic brain injury, while not all specifically speech and language deficits, definitely impact communication" (p. 26).

Overview of Assessment in Pediatric TBI

Formal assessment tools currently used with children and adolescents with TBI are not altogether appropriate for this population with regard to identifying cognitive-linguistic deficits and establishing accurate profiles of abilities. (Chapman et al., 2001; Chapman et al., 1998; Hotz, Helm-Estabrooks, & Nelson, 2001; Turkstra, 1999; Ylvisaker, 1998; Yorkston et al., 1999). Reasons cited for limitations of current formal tools are that: (a) none has been specifically designed for the pediatric TBI population, (b) they may not reveal subtle and functional impairments,

and (c) the nature of the deficits associated with this population provide unique challenges in formal evaluation. These reasons are discussed in greater detail in Chapter Two.

The problems with using the current formal assessment tools leave speech language pathologists with a paucity of appropriate tests from which to choose (Turkstra, 1999). Options in dealing with this challenge include utilizing a battery of tests or administering certain subtests from a variety of cognitive and linguistic tools. Beyond psychometric concerns, an issue that arises is the amount of testing a student with TBI must go through in the "battery" assessment process. Another issue is that traditional language tests do not tap into the unique linguistic deficits of this population, particularly involving connected spoken and written discourse. An ideal situation would be to have a tool available that was designed and standardized specifically for children and adolescents with brain injury, which includes all relevant areas to be evaluated by the speech-language pathologist or other rehabilitation professional.

In addition, it is doubtful that any formal test can adequately tap into how TBI is affecting an individual's functioning in real life contexts (Ylvisaker & Gioia, 1998). The context of test administration is considerably different from real-world situations in which stress, anxiety, distractions, and multiple tasks contribute to an individual's functioning. Informal measures are needed to capture the perspectives of all the key participants in a child's life, including the child himself. Such valuable information can be obtained through interviews with and observation of the child with TBI, members of the rehabilitation team, teachers, family members, and friends.

The Pediatric Test of Brain Injury

Hotz, Helm-Estabrooks, and Nelson (2001) have attempted to tackle this challenge by developing a new assessment tool. Called the Pediatric Test of Brain Injury (PTBI), it was designed specifically for the pediatric TBI population based on the authors' observations that " cognitive and communication problems of children who return to school after TBI tend to be underestimated, probably because of the lack of age-appropriate, specifically designed assessment tools" (p. 427).

The PTBI (Hotz, Helm-Estabrooks, & Nelson, 2001) was developed in light of the fact that no standardized tests have been available to date to assess the full range of cognitive-linguistic impairments associated with pediatric TBI. This test was designed to measure the attention, memory, language, reading, writing, metalinguistic, and metacognitive skills that are particularly at risk in pediatric TBI and that are relevant to the general education curriculum.

The Current Study

The needs of the pediatric TBI population are complex. Such needs challenge the skills of many professionals, including those involved with the assessment and intervention of cognitive-linguistic deficits. As mentioned above, a lack of appropriate tools makes it difficult to provide relevant information regarding the cognitive-linguistic strengths and needs of this population (Hotz, Helm-Estabrooks, Nelson, 2001; Sohlberg & Mateer, 1989; Turkstra, 1999; Ylvisaker, 1998). Without accurate assessments, appropriate and effective intervention is hindered.

The nature of pediatric TBI leads to disconnections within and among developing cognitive-linguistic and social-emotional processes within the child or adolescent who has sustained injury. Similarly, many gaps are apparent within the

medical-educational systems that seek to provide assessment and rehabilitative services. Although better assessment tools and methods will not solve all of the problems, they can contribute better information for addressing the issues. The goal of this study, therefore, was to offer some insights into the nature of this population, provide ideas for closing several of the gaps in assessment, and present some thoughts on best practices with the pediatric TBI population.

Experimental Questions

In addressing the gaps and disconnections within the system providing assessment and intervention to the pediatric TBI population, this study attempts to answer the following questions related to the development of the PTBI and other assessment techniques:

1) Does the PTBI tap into areas of deficit (especially connected discourse) identified by others as lacking from traditional language assessment tools?
2) What difficulties does the PTBI reveal for students with moderate to severe TBI who are several years post onset compared with a control group matched for age and gender, but without disability?
3) Are PTBI results consistent with information regarding functional status in education gathered from teachers?
4) Does the PTBI reveal any information not obtained through the informal measures (i.e., participant interview and/or educational survey) and do informal measures provide any information not obtained with the PTBI?

CHAPTER II

REVIEW OF THE LITERATURE

The Nature of Pediatric Traumatic Brain Injury

Cognitive and Linguistic Sequelae of Pediatric Traumatic Brain Injury

Many authors agree that the effects of traumatic brain injury on the young brain are devastating and far-reaching, especially in the case of severe levels of injury. Mild and moderate TBI also may have a significant effect on the lives of individuals who sustain them, even though the effects may not be as obvious or severe (Jordan, Murdoch, & Buttsworth, 1991; Yorkston et al., 1999).

Cognitive Sequelae

Deficits in the cognitive processes of attention, memory, and executive functioning are among the most obvious sequelae of TBI in children and adolescents. Emotional and behavioral issues such as anger management, impulsivity, judgment, and social skills also are often observed as problem areas.

Blosser and DePompei (1994) discussed several of these sequelae. They stated that attention often seems to be affected in the specific areas of maintenance (sustained attention) and dividing (divided attention). Ewing-Cobbs, Levin, and Fletcher (1998) mentioned that vigilance is also affected by TBI, with more significant deficits noted in severe TBI, as compared with mild or moderate damage.

According to Blosser and DePompei (1994), both long-term and short-term

memory are affected. As a result of impaired semantic and episodic memory, children and adolescents with TBI may experience difficulty recording, storing, and recalling events, facts, and feelings. Problems with short-term memory (or working memory) lead to difficulty in processing stimuli and using information. Such difficulties are often revealed in the inability to follow directions, which places major functional limitations on the lives of individuals with TBI.

Kinsella et al. (1996) found that adults with severe head injuries demonstrated deficits in new learning, delayed recall, and working memory. On the other hand, Kinsella and her colleagues did not find a difference in performance between the TBI and control subjects on tasks involving recognition memory or immediate memory span. This highlights the importance of realizing that memory is not "just memory." Rather, it is more than a simple or single attribute of an individual's cognition. The idea that there are many types and functions of memory becomes increasingly relevant when assessing children with TBI. Many tasks used in assessment tap different areas of cognition, including one or more types of memory. It is critical, therefore, to understand how different types of memory play different roles in the cognitive-linguistic abilities of children and adolescents with TBI.

Attention and memory impairments are major contributors to almost all of the behaviors and deficits seen in students with TBI. In looking at formal testing situations or school work, the longer a student is working at a task, the more likely he or she is to lose attention, forget the task instructions, and become fatigued. These variables then contribute to the student's performance on all tasks of an assessment tool and school work, not only those specifically designed to address attention and memory. The result, of course, is variability in scores on formal tests or performance on everyday school work.

Montgomery (2002) discussed several models of verbal working memory (VWM) and how they relate to language difficulties in children with specific language impairments (SLI). Although he applied VWM models to the difficulties of children with SLI, rather than those with TBI, the models Montgomery discussed may be of significance to the language processing of children and adolescents with TBI. One model appears to have particular relevance.

The model Montgomery (2002) referred to as "Functional Working Memory" (FWM) was taken from Carpenter and Just's (1992) research on VWM. This model "characterizes VWM for language as a resource-limited system that includes both storage and processing functions" (Montgomery, p. 78). Storage in this case is defined as "the ability to temporarily retain verbal information that has already been processed" and processing refers to "language operations/computations that generate various types of [linguistic] representation" (Montgomery, p. 78). The FWM model suggests that both storage and processing occur simultaneously and that these functions share resources or "mental energy" while comprehension takes place.

Montgomery (2002) discussed that according to the FWM model, a "trade-off" takes place between storage and processing when the load of a task exceeds the available resources. Either storage is compromised, leading an individual to "forget" previously processed information, or processing is compromised, causing slower processing (or computing) of linguistic representations.

Montgomery (2002) reported that Carpenter and coworkers found comprehension differences among non-language impaired persons to be reflective of "individual differences in the ability to coordinate simultaneous functions of processing *and* storage" (p. 78). The researchers hypothesized that those with poor comprehension skills assign more mental energy (or resources) to processing than to

storage, resulting in a situation where the linguistic representations already constructed (after processing) are forgotten too soon, hindering their integration with "new, incoming information" (p. 78).

The FWM model (Montgomery, 2002) may well have implications for interpreting the auditory-language processing of children and adolescents with TBI. Because memory deficits are well-known sequelae of pediatric TBI, the possibility exists that compromised storage function (memory) may be "traded-off," resulting in impaired comprehension.

Impaired executive functioning is another frequent aspect of cognitive sequelae of pediatric TBI with far reaching effects. Blosser and DePompei (1994) pointed out that self-analysis and monitoring, goal setting, and evaluation all are areas with which TBI interferes. Ewing-Cobbs, et al. (1998) discussed executive functioning impairment as having a negative effect on inhibition, planning, working memory, resource allocation, and problem solving. All of these affected areas are vital to academic and social success.

Behavioral changes can be among the most disturbing effects of TBI for both the children with TBI and the people in their lives. Ewing-Cobbs, et al. (1998) related several studies that looked at different aspects of behavior in children and adolescents with TBI. Two of these studies, both conducted by Fletcher (1990; 1996), indicated that children with severe TBI acquired negative behaviors in the first six months post-injury and that these were still present one year later. The work of Perrott (as cited in Ewing-Cobbs, et al.) revealed significant problems with behavior and function in children with TBI at 40 months after the onset of injury. Perrott's research showed that the children with severe TBI had more problems "adapting to the demands of daily living and placed greater stress on the parent-child relationship

in comparison to their siblings" (as cited in Ewing-Cobbs, et al., p. 21). Blosser and DePompei (1994) also discussed the effects that TBI can have on the behavior of children and adolescents. They mentioned anger outbursts, emotional lability, apathy, withdrawal, and misperception of social actions and events as several of the indicators of impaired behavioral and social abilities (p. 28).

Linguistic Sequelae

Traditional language assessment tools are not designed to illuminate profiles of linguistic ability and disability in the pediatric TBI population. In fact, they often are criticized for overestimating or hiding impairments (Sohlberg & Mateer, 1989; Turkstra, 1999; Ylvisaker, 1998; Ylvisaker, Koplan, & Rosenthal, 1994). In her study evaluating the Clinical Evaluation of Language Fundamentals – Third Edition (CELF-3), Turkstra (1999) found that her participants with TBI had difficulty with the cognitive-linguistic skills of listening, reading, writing, and speaking in school and required special accommodations for these difficulties, yet these same students performed within the normal range on the CELF-3.

Several interesting studies have been conducted that examine the language abilities of children and adolescents with TBI that are generally not measured by traditional standardized language tests. The most revealing of these language abilities emerged in contexts requiring spoken and written discourse.

Chapman, Levin, Wanek, Weyrauch, and Kufera (1998) conducted a study with 23 children aged six to eight years who had sustained severe closed head injury (CHI) at least one year prior to testing. The control group consisted of 26 age-matched subjects. Two verbal narratives were elicited from all the subjects in the context of two tasks--an auditory story retelling task and a story generation task based

on five picture sequence cards. Both stories were organized into distinct episodes, and they were "similar in global semantic meaning in that the gist of both stories was realized through a role-reversal situation" (p. 425).

The narratives were analyzed on the basis of language structure, information structure, and flow of information. Language structure assessment involved the lexical and sentential aspects of the stories. Information structure assessment addressed the "ability to use the language system to select, organize, and integrate information" (Chapman et al., 1998, p. 426). This was described as going beyond certain isolated language skills to address the multifaceted relationships that language and cognition share. Flow of information analysis looked at the efficiency of discourse through the interplay of linguistic and information structures. The authors also took into consideration the cohesive ties the subjects used in the production of their narratives.

In addition to the discourse tasks, Chapman et al. (1998) administered two standardized tests to assess vocabulary and verbal memory. Their purpose was to acknowledge the possible effects of these abilities on the subjects' narrative productions. These tests were the Vocabulary subtest of the Wechsler Intelligence Scale for Children – Revised (WISC-R) and the California Verbal Learning Test (CVLT).

Regarding language structure, Chapman et al. (1998) found that the children with severe CHI demonstrated a tendency to use fewer t-units (a sentence-like unit) than the control group; however, the differences were not statistically significant. On the other hand, the differences in information structure were found to be highly significant between the children with CHI and the control subjects. The children with CHI formed fewer core propositions and tended to leave out fundamental parts of the

story "resulting in incomplete episodic structure" (p. 428). In the areas of flow of information and cohesion measures, the authors did not find significant differences between the two subject groups. The vocabulary and verbal memory measures revealed that the information structure in the production of narratives was significantly affected by brain injury.

In another study, Chapman and colleagues (2001) looked at the verbal discourse of 43 children who were five to ten years of age and had sustained head injuries. The children were separated into two severity groups based on lowest GCS score and CT or MRI results: mild/moderate and severe

All subjects were assessed at 3 months, 12 months, 21 months, and 36 months post-injury. A series of eight pictures were shown to each participant in order to elicit a verbal narrative. They were asked to "tell as complete a story as possible" based on the picture sequence cards, but they were not allowed to look at the pictures while telling the story. Following the generation of the narrative, participants were asked to tell a life-lesson that that story suggested. This particular discourse task was chosen by the authors in light of previous work that showed it was very sensitive to the cognitive-linguistic deficits following severe TBI.

In this narrative production task, the participants were required to demonstrate three main skills that the researchers considered a challenge for both working memory and planning. That is, they were required to "retrieve depicted information from memory…encode the information in their own words…organize the information in a coherent and sequential manner" (Chapman et al., 2001, p. 445). Four variables were defined to measure the children's performances in these skills areas: (a) amount of language, (b) amount of information, (c) organization of information, and (d) global semantic interpretation. The results showed that the

children in the mild/moderate brain injury group produced significantly greater amounts of language and information that the children with severe brain injuries. They also demonstrated significantly better organization of information.

Yorkston, Jaffe, Liao, and Polissar (1999) also studied the effects of head injury on narrative discourse, but in the area of written rather than spoken discourse. Their study included 71 children and adolescents with TBI between the ages of 8 and 15 years. They also added 71 age-matched control subjects. All participants were given the Test of Written Language (TOWL), which required them to produce a written story based on picture stimuli. This task was given at one month following the end of post-traumatic amnesia and then one year later. The researchers examined the following variables in the writing samples: efficiency, completeness, general readability, errors, vocabulary, and overall written language. Yorkston and her colleagues found the highest correlation between written language and severity of TBI in the areas of efficiency and completeness. The correlation was weakest in the area of vocabulary.

In addition to the major categories of deficits associated with pediatric TBI, Blosser and DePompei (1994) listed other specific communication characteristics that can occur in children and adolescents with brain injury. These characteristics include tangential speech, hyper-verbal speech, confabulations, and anomia (p. 28). They pointed out that the "behaviors and impairments associated with pediatric traumatic brain injury, while not all specifically speech and language deficits, definitely impact communication" (p. 26).

To summarize, previous research has documented that there are significant and persistent deficits for students with severe TBI in the areas of verbal and written discourse, both aspects of language that are critical for academic success (Chapman,

et al., 1998; Chapman, et al., 2001; Yorkston, et al., 1999). Traditional language assessment tools measure areas such as vocabulary and syntax as discrete skills. These were both shown by the Chapman and Yorkston studies not to differentiate students with TBI from those in control groups. Therefore, it would seem logical that a new tool is needed that will assess the intricate aspects of discourse among these students that will identify linguistic deficits that have the potential to deter academic success and further learning.

It also becomes clear from previous studies and from the reports of parents, teachers, and students themselves, that while traditional language testing may not identify language needs, students with severe TBI do in fact have significant cognitive-linguistic struggles that affect their academic success. It becomes less clear exactly how these effects reveal themselves in formal testing.

Heterogeneity of the Population

In this review of the literature, I have attempted to outline the deficits associated with pediatric TBI, however, it is important to state a caveat. That is, that all children and adolescents with TBI are unique. Many variables affect outcome following a brain injury. Chapman (1997) stated that the factors contributing to the heterogeneity of this population include level of injury severity, nature of the injury, lesion site, extent of damage, and "premorbid characteristics and the social milieu in which the child functions" (p. 51). Age at onset of injury also plays a critical role in the outcome following brain injury (Chapman, et al., 1998; Clark, Russman, & Orme, 1999).

Persistent Deficits

Whereas physical deficits often resolve after TBI as times goes on, cognitive-linguistic problems do not necessarily resolve with time post-injury. In fact, the gap may even widen between students with TBI and their uninjured peers in the academic arena. The two reasons often cited for this observation are that (a) deficits persist and (b) students fail to achieve later stages or rates of cognitive-linguistic development.

In two separate studies, Chapman and her colleagues (Chapman, et al., 1998 & Chapman, et al., 2001) looked at the discourse abilities of children with CHI aged six to ten years of age. In their 1998 study, they found that significant deficits were evident in the children with CHI in the production of verbal narratives more than one year post injury. Even more telling was the study by Chapman and her coworkers (2001) that demonstrated that children with severe brain injury still experienced significant difficulties in organizing ideas through verbal discourse three years post-injury. In discussing this finding, the authors pointed out that the "ability to learn new information in a school setting is associated with the ability to comprehend and coherently organize ideas through discourse, either verbal or written" (p. 442).

Yorkston and her research partners (1999) also found enduring deficits in the discourse abilities of children and adolescents with TBI. The authors of this study had a goal to establish whether or not the deficits in written language seen in children with TBI persist one year beyond resolution of post-traumatic amnesia. The results of their work with 71 children between the ages of 8 and 15 with TBI showed that these children experienced significant difficulties with written narratives (compared with age-matched control subjects) beyond one year post-injury.

All three of these studies (Chapman, et al., 1998; Chapman, et al., 2001; & Yorkston, et al., 1999) appeared to support the idea that while many children with

TBI "regain lower level language abilities (as measured by traditional language tests) within three months after the brain injury…they are by no means out of the woods because many are at continued risk for later emerging academic failure and increasing difficulty on tasks requiring higher-order cognitive abilities" (Chapman et al., 2001, p. 441). In addition, it is especially difficult for traditional and structured assessment tools to identify the broad extent of lingering impairments more than one year post injury.

Growing into a Deficit

"Growing into a deficit" has become a term commonly used to describe the course of sequelae following pediatric TBI. Children and adolescents with TBI often appear to have recovered until they return to school or face increased pressures in school or job settings (Chapman, 2000b; Mateer, Kerns, & Eso, 1996; Szekeres & Meserve, 1994; Ylvisaker, 1998). Deficits that were not apparent earlier seem to appear in such contexts. Many researchers attribute this to the age at the time of injury along with increasing academic and social demands.

Age at onset of injury has been the subject of much research. At one time, the general school of thought was that the younger the age at onset, the better. The theory of plasticity of the young brain was the foundation of this position. Plasticity refers to the ability of the child's brain to adapt to injury or the "dings, dents, and major insults that alter it" (Chapman & McKinnon, 2000, p. 333). Because of the ability of the child's brain to handle the sort of insult associated with TBI, it was thought that the prognosis for recovery would be much more favorable for younger children than for the fully developed adult brain.

In contrast, however, much of the current literature suggests that this

"youthful advantage" may not be entirely accurate. Chapman (2000b) states that while young students with TBI may recover premorbid skills, they often do not "achieve later stages or rates of development" (p. 1). Because the young brain is still maturing at the time of onset in pediatric TBI, it may not be able to "finish" developing the critical abilities that are necessary for further learning and functioning (Mateer, Kerns, & Eso, 1996). As mentioned earlier, previous skills may be recovered and the students may seem to have no residual deficits until they find themselves in situations requiring the skills that have not yet been developed. Szekeres & Meserve (1994) state this happens when "academic and social demands outpace development of their [the students'] cognitive-communicative and social skills" (p. 26).

Rate of Change

Another important point to consider when discussing the nature of deficits associated with pediatric TBI is the rate at which these children experience spontaneous recovery and change. In this population, changes can be seen from week to week, day to day, even from morning to night (Rosen & Gerring, 1986; Ylvisaker, 1998). This information suggests that a test given on Monday may produce very different scores than the same test administered on Wednesday. Variability might also be seen within a test that was started in a morning therapy session and completed during an afternoon session. From his extensive experience with the pediatric TBI population, Ylvisaker (1998) added that neurological improvement is in many ways unpredictable until years after the injury. This means that assessment information loses its accuracy. In other words, nature of recovery in this population must be kept in mind in the interpretation of scores from whatever formal measures are used.

Distinguishing Features

Blosser and DePompei (1994) discussed how children and adolescents with TBI are different from their age peers who have other language and/or learning disabilities. Many of the cognitive-communicative characteristics associated with pediatric TBI are seen in other pediatric populations with disabilities and these common traits are important to understand when it comes to providing intervention services. However, the authors stated that it is also important to recognize the distinctions of the pediatric TBI population. They identified unique characteristics that set these students apart from students with typical language and learning disabilities. Some of these distinct features include "a premorbid self-concept of being normal; a previously learned base of learning; discrepancies in ability level; more extreme problems with generalizing, integrating, or structuring information; poor judgment and loss of emotional control; and combinations of conditions resulting from TBI that do not fall into normal categories of disabilities" (p. 30).

Relevance of Study

Problems with Current Formal Assessment Procedures

As mentioned previously, the current formal assessment tools used with children and adolescents with TBI are not altogether appropriate for this population in regard to identifying cognitive-communication deficits and establishing accurate profiles of abilities (Chapman et al., 2001; Chapman et al., 1998; Hotz, Helm-Estabrooks, & Nelson, 2001; Turkstra, 1999; Ylvisaker, 1998; Yorkston et al., 1999). Chapman et al. and Yorkston et al. (1999) found that spoken and written discourse abilities set children with severe TBI apart from mildly and non-injured groups. The

way these children used language differed more significantly from control groups than the amount of language they used. These are important distinctions that are not revealed on traditional language assessment tools. Traditional language tests tap into vocabulary skills, but most fail to analyze in any depth the areas that Chapman et al., and Yorkston et al. found to be most troublesome for the adolescents in their study.

There appear to be four major reasons underlying the problem with the current formal assessment procedures used with the pediatric TBI population: (a) tests have been developed for other populations, (b) high variability exists within this population, (c) formal tests may not reveal subtle and functional impairments in this population, and (d) many deficits seen in this population have a delayed onset.

Tests Developed for Other Populations

First, and most relevant to this study, is the fact that none of the tests commonly used with children and adolescents with TBI have been developed specifically for this population and its unique deficit patterns (Chapman et al., 1997; Turkstra, 1999). As mentioned in chapter one, to date, no single test has been available that is specifically designed to assess the full-range of cognitive-linguistic impairments associated with pediatric TBI (Hotz, Helm-Estabrooks, & Nelson, 2001).

The specific deficits associated with the pediatric and adolescent TBI population often are subtle and difficult to detect using formal assessment tools (Green, Stevens, & Wolfe, 1997; Sohlberg & Mateer; Yorkston, Jaffe, Liao, & Pollissar, 1999). The standardization samples for the majority of these tools have included typically developing children and adolescents and those with developmental disorders, while overlooking those with TBI as a unique group (Chapman, 1999;

Turkstra, 1999; Ylvisaker, 1998). As a result, many of the formal tools used in hospitals, clinics, and schools are not sensitive to the deficits associated with pediatric TBI, and thus fail to detect them (Green, Stevens, & Wolfe, 1997; Jordan, Murdoch, & Buttsworth, 1991). This often means that individuals are sent back into their previous educational and social environments without any extra supports, only to experience difficulties that are unanticipated and unexplained.

In one of her studies, Turkstra (1999) examined the validity of one such language test in terms of its use with adolescents with TBI. She asked three specific questions regarding the Clinical Fundamentals of Language-Third Edition (CELF-3) relative to its stated purposes: (1) "Did the test identify language impairment in a group of adolescents with TBI" (p. 134); (2) "Did the test permit the identification of strengths and weaknesses and suggest areas for extension testing?" (p. 134); and (3) "If the test was measuring one single factor in adolescents with TBI, was working memory that factor?" (p. 134).

Turkstra (1999) included eleven adolescents (five females, six males) in her subject group. These adolescents had sustained TBI's within the past three years and had initial Glasgow Coma Scale (GCS) scores ranging from four to fourteen. All subjects, except for two, qualified for and received special education services after returning to school. No history of premorbid learning disabilities existed for any of the subjects. Upon discharge from acute care, four subjects received services from a speech-language pathologist targeting cognitive-communication impairments. Six other subjects were identified as having verbal information processing impairments that would likely impact communication skills and classroom performance. Despite these noted impairments, which included difficulties with verbal memory, learning, and fluency, none of the six students was referred for speech and language services

following their time in acute care.

In addressing the question whether the CELF-3 identified language impairment in a group of adolescents with TBI, Turkstra (1999) found that the six subjects who were identified with other methods as having impairments in verbal information processing expected to affect communication, were not recognized by the CELF-3 as having a language impairment. While the CELF-3 does not claim to measure these components of communication, this finding is noteworthy. These six subjects "experienced difficulty with the listening, reading, writing, and speaking demands of school, and required academic modifications and assistance" (Turkstra, p. 136). This means, then, that obtaining scores within normal limits on the CELF-3 does not necessarily indicate that a student is without significant communication needs.

Regarding her second question as to whether the test permitted the identification of strengths and weaknesses and suggested areas for extension testing, Turkstra's (1999) data suggested that the scores from individual subtests on the CELF-3 should not be interpreted as evidence of strengths and/or weaknesses in specific areas of language. Even though the subjects' scores on individual subtests were noticeably variable, these variations did not denote a meaningful difference when compared with the standardization sample. This cautionary finding is attributed to the "statistical properties and structure of the test, together with the results from individuals with TBI" (Turkstra, p. 137).

Turkstra's (1999) third question addressed the possibility that the CELF-3 measured only a single factor in adolescents with TBI. She did find that her subjects' performances on the test were being influenced by one element, although she could not be sure that the single factor was memory. Turkstra stated that memory's role in

students' performances on the individual subtests is an area being addressed by further research.

Montgomery's (2002) discussion of FWM may add insight to Turkstra's (1999) question of the role of memory on her subjects' language performance. The FWM model "characterizes VWM for language as a resource-limited system that includes both storage and processing functions" (p. 78). It suggests that both storage and processing occur simultaneously and that these functions share resources or "mental energy" while comprehension takes place. Montgomery discussed that according to the FWM model, a "trade-off" takes place between storage and processing when the load of a task exceeds the available resources. Either storage is compromised, leading an individual to "forget" previously processed information, or processing is compromised, causing slower processing (or computing) of linguistic representations.

In this light, the FWM model (Montgomery, 2002) may well have implications for interpreting the linguistic processing of children and adolescents with TBI. Because memory deficits are well-known sequelae of pediatric TBI, the possibility exists then that compromised storage function (memory) may be "traded-off," resulting in impaired linguistic comprehension and performance. In addition, this model suggests a need in assessment procedures for complex discourse tasks that require integrated use of language skills at the word, sentence, and discourse levels, rather than merely looking at discrete memory skills or isolated language abilities.

High Variability within the Pediatric TBI Population

The second reason for questioning the use of current formal assessment tools to identify cognitive-communication deficits in children and adolescents with TBI is

directly tied in to the first. That is, these students often show variable performance, both within tests and from test to test (Rosen & Gerring, 1986; Turkstra, 1999). Rosen & Gerring cited a 1963 study by Richardson in which all ten patients with pediatric TBI showed considerable variation in formal testing scores from the performance typically found in the normal population. This variation was evident both on subtests of the same test and from test to test.

The reason for this variability seems to be related to two aspects of pediatric TBI. One is the nature of the deficits themselves. Attention and memory impairments are major contributors to almost all of the behaviors and deficits seen in students with TBI. In simply looking at formal testing situations, the longer a student is being tested, the more likely he or she is to lose attention, forget the task instructions, and become fatigued. These variables then contribute to the student's performance on all tasks of the assessment tool, not only the tasks specifically designed to measure attention and memory. The result, of course, is variability in scores, either within one test or from test to test, depending on the testing situation. In addition to neurological factors, inconsistent performance on formal tests is often influenced by emotions and context (Ylvisaker, 1998).

The other explanation for variation in test-retest reliability and in the performance among subtests of a single test is the rate at which children with TBI experience spontaneous recovery and change. In this population, changes can be seen from week to week, day to day, even from morning to night (Ylvisaker, 1998; Rosen & Gerring, 1986). This information suggests that, in the early stages of recovery particularly, a test given on Monday may produce very different scores from the same test administered on Wednesday. Variability also might be seen within a test that was started in a morning therapy session and completed during an afternoon session.

While this aspect is included in this discussion of problems with current formal assessment tools, it is not one that would be easily addressed by a more "appropriate" tool. Rather, the nature of recovery in this population must be kept in mind in the interpretation of scores from whatever formal measures are used, and they may need to be supplemented by informal measures.

Formal Tests May Not Reveal Subtle and Functional Impairments

The third reason underlying the problem with current formal assessment tools is that functional impairments in students with TBI may not show up on formal tests in general, no matter how well they might be designed (Farmer, Clippard, & Luehr-Wiemann, 1996; Sohlberg & Mateer, 1989; Turkstra, 1999; Ylvisaker 1998; Ylvisaker, Kolpan, & Rosenthal, 1994). That is, the nature of formal testing likely plays a role, along with the "non-traditional" deficits associated with pediatric TBI.

The literature reports that some students with TBI score in the average or above-average range on standardized tests, yet function very poorly in school and activities of daily living (Turkstra, 1999; Ylvisaker, 1998). Ylvisaker, Kolpan, & Rosenthal (1994) discussed the contribution that standardized test conditions make to the scores of students with TBI. They stated that variables such as a quiet environment with minimal distractions, clear task explanations and directions, initiation of tasks by examiner, and lack of "real world" context all act to "veil" deficits that may be obvious in a classroom or other real-life situations. Also noteworthy is the observation by Sohlberg & Mateer (1989) of the reverse situation, in which individuals with TBI obtain formal test scores that reflect severe impairment, but are able to function adequately in their natural environments.

The Chapman studies (Chapman et al., 1998; Chapman et al. 2001) and

Yorkston's research (Yorkston et al., 1999) also pointed to significant linguistic deficits in children and adolescents with TBI. These deficits in discourse processing were in areas important for academic success, yet they were not those traditionally addressed in formal language testing.

Delayed Onset of Deficits in Pediatric TBI

Finally, children and adolescents with TBI often appear to have recovered until they return to school or face increased pressures in school or job settings (Chapman, 2000; Mateer, Kerns, & Eso, 1996; Szekeres & Meserve, 1994; Ylvisaker, 1998). Deficits that were not apparent earlier, then seem to appear in these more challenging contexts. Many researchers attribute this to the age at the time of injury, along with increasing academic and social demands.

As mentioned earlier, age at onset of injury has been the subject of much research. Based on the theory of plasticity, it was once thought that the prognosis for recovery would be much more favorable for the young brain than for the fully developed adult brain. In contrast, much of the current literature points out that the young brain still maturing at the time of onset in pediatric TBI, may not be able to "finish" developing the critical abilities that are necessary for further learning and functioning (Mateer, Kerns, & Eso, 1996). Previous skills may be recovered and the students may seem to have no residual deficits until they find themselves in situations requiring the skills that have not yet been developed.

The "growing into a deficit" phenomenon has significant implications for assessment within the pediatric TBI population. Because the profiles of these students have the potential to change as they "grow into" new deficit areas, the need for continued assessment can be appreciated. Lezak (1974) supported on-going

assessment in saying that patients should be examined multiple times because cognitive changes are expected during an individual's life following TBI.

The Need for a New Formal Assessment Tool

The problems with using the current formal assessment tools leave speech language pathologists with a paucity of appropriate tests from which to choose (Turkstra, 1999). Many options in dealing with this challenge include utilizing a battery of tests or administering certain subtests from a variety of cognitive and linguistic tools. One issue that arises here is the amount of testing a student with TBI must go through in the assessment process. Another issue is that most tests do not tap into the unique cognitive-linguistic deficits of this population such as verbal and written discourse. An ideal situation would be to have a tool available that was designed and standardized specifically for children and adolescents with brain injury that also included all the areas to be evaluated by the speech language pathologist or other rehabilitation professional. The PTBI is an attempt to tackle this challenge by examining integrated cognitive-linguistic abilities rather than only looking at discrete, isolated skills and by testing these areas in children and adolescents who have TBI.

Caveats for Using Formal Assessment Tools

Need for Multifaceted Approach, Collaboration, and Ongoing Assessment

Ylvisaker and Gioia (1998) warned against using only formal assessment tools with the pediatric TBI population. In fact, they suggested that rehabilitation professionals " focus less on tests and more on ongoing assessment activities that are collaborative, contextualized, and structured around the testing of hypotheses that

relate directly to decisions about how to teach, interact with, and otherwise support the child" (p. 159). Because children and adolescents do not live in a world void of context, using formal test scores as the only indicators of strengths and needs does not provide accurate profiles of real-life functioning.

Ylvisaker and Gioia (1998) said that collaboration is important in this process because it provides input from many people who interact with and observe the child in different situations and contexts. In addition, the authors pointed out that collaboration offers a team approach to hypothesis testing, encourages unity within the rehabilitation team, and promotes respect among everyone involved.

Ongoing assessment is essential to keeping assessment data relevant. Because recovery and change in the pediatric TBI population is rapid and long lasting, and delayed onset of deficits is common, Ylvisaker and Giaio (1998) stressed that "ongoing dynamic assessment is preferable to (or at least supplements) an assessment that captures only one or a small number of discrete points in the student's life after the injury" (p. 163).

Summary

The nature of pediatric TBI is complex. Cognitive and linguistic sequelae are persistent and often appear after a child has seemingly recovered and returned to school. In addition, there appear to be specific cognitive-linguistic impairments that distinguish this population from children with other language and learning disabilities, but that are typically overlooked on traditional assessment tools. The heterogeneity of this population adds to the complexity. Although children and adolescents with TBI share common traits, each individual also presents with a unique profile of abilities.

The complexity of this population has lead to gaps in the assessment procedures used to evaluate abilities and needs following injury. Many of the formal assessment tools used to examine the cognitive-linguistic abilities of children and adolescents with TBI have been designed for other populations. The high variability within the TBI population and the delayed onset of deficits, along with the nature of formal testing itself, contribute to the need for a new formal assessment tool.

Further research into the specific cognitive-linguistic abilities of children and adolescents with TBI will be important in order to highlight areas of deficit to be identified on formal assessment tools. Insights from formal assessment, children, parents, and teachers into the lasting consequences of these deficits and how they affect functional status in education could serve to close the gap between formal assessment results and real-life functioning.

CHAPTER III

METHOD

This study used a case study methodology (Creswell, 1994) to focus on the performance of three boys with TBI, one 11 years old and the other two 16 years old on a set of formal and informal assessment tools. These three boys were matched for grade, gender, and race with three students who had not sustained TBI. Two of the students (one participant with TBI and one control subject) were in the fifth grade and four (two participants with TBI and two control subjects) were in the tenth grade. All six of the participants completed the formal subtests of the Pediatric Test of Brain Injury (PTBI). In addition, several informal methods were used to gather data for the case studies for the participants with TBI.

For the purpose of this study, formal assessment tools are defined as those that require an individual to perform pre-established tasks specifically designed to measure certain skills in a context outside of their natural environment (i.e., structured and controlled setting). Also in this study, formal testing refers to those tests that are standardized or were designed with the intention of becoming a standardized tool. Informal measures refer to assessment procedures that examine an individual in his or her natural environment with the purpose of obtaining information regarding real-life functioning. Data from sources other than the individual being assessed are included in the category of informal measures.

Subjects

Participants with TBI

To participate in this study, a priori inclusionary criteria were set for the students to have sustained a moderate or severe TBI, and to be 6 to 16 years of age, functioning at a minimum of Level VI according to the Rancho Los Amigos Levels of Cognitive Functioning, able to tolerate 20-30 minute formal testing sessions, past the stage of post-traumatic amnesia (PTA) as measured by the Children's Orientation and Amnesia Test (COAT) (or a comparable measure used in the participant's rehabilitation setting if PTA was previously a factor for an individual), past the stage of muteness associated with traumatic brain injury if this was previously a factor for an individual, able to breathe without the assistance of mechanical ventilation, and able to compensate for any visual field deficits. Exclusionary criteria included being on medications that contribute to attention and memory loss and substantiated premorbid child abuse, neurological, or psychiatric history. Children and adolescents with prior histories of learning disability or other disability were not excluded because I wanted the findings to relate to the broad group of students with TBI.

The research protocol was approved by the Western Michigan University Human Subjects Institutional Review Board (HSIRB) on August 21, 2001 (See Appendix A for HSIRB approval). Simultaneously, a number of programs were contacted to attempt to gain access to students with TBI who met the established criteria. In the case of several hospital or rehabilitation programs, barriers arose in meeting the HSIRB requirement that the primary investigator must be a member of the agency staff. In the case of Mary Free Bed Hospital and Rehabilitation Center, this was not a problem, and their institutional process was followed, but changes

within the program's IRB system resulted in approval coming too late for the timeline of the study. In the case of attempts to contact local school districts, representatives responded positively, but indicated that students with TBI were not identified or tracked. Finally, contact was made with a psychologist in the Grand Rapids area who agreed to make the initial contacts with her clients and their families, as originally approved by the WMU HSIRB.

The three participants with TBI whose families agreed to participate were white males aged 11 years 7 months, 16 years one month, and 16 years 6 months. Each had sustained TBI and had received special education services following his brain injury. The 11 year old was five years post onset; the 16 year 1 month old was four years post injury; and the 16 year 6 month was eight years post onset. Prior to their injuries, the 11 year old had been enrolled in an aural-oral deaf program. One of the 16 year olds had always been in special education. The other 16 year old had never been in special education.

Participants without TBI

The control group was made up of three white male students, one fifth-grader and two tenth-graders. All three attended regular education classes and had never received special education services for cognitive-linguistic problems or learning difficulties. The fifth grader was receiving articulation therapy for the phoneme /r/ at the time of this study, but was not disqualified in light of the non-linguistic nature of the intervention.

Recruitment Procedures

I contacted a psychologist who specializes in work with children and

adolescents with TBI for permission to approach her clients meeting the criteria for inclusion with the intention of asking their interest in participating in this study. Letters with a non-coercive information flyer (see Appendix B) from myself and a cover letter and release-of-information form from the psychologist were mailed to the parents of eleven clients. Three parents responded and I contacted them to set up appointments with their children for the testing.

Consent and Assent

Each parent read and signed a consent form approved by the Western Michigan University HSIRB (see Appendix C) stating that he or she agreed for his or her son to participate in this study. Each student participant also signed a form of assent indicating that he was willing to participate in this study. Both letters provided a brief description of the project and informed the parents and children that testing would include two brief tests and an interview. Parents and children were notified that the participants could withdraw from the project at any time with no adverse affects to their therapy or education and that all data collected would be kept confidential. In addition, the forms requested permission for the teachers to complete an educational survey and for me to review the children's medical charts for relevant injury information.

Follow-up Procedures

For each of the participants with TBI, I provided a profile of the testing results (see Appendix D for example of profile) explaining each subtest of the PTBI and an analysis of the students' performances. Additional follow-up was provided based on the participants' individual needs and requests. Graham's father indicated that they

were attempting to determine "what's going on" with Graham and was satisfied with the profile information. Multiple attempts were made to provide consultation, but Graham's father did not have specific questions or requests. Scott and his father expressed interest in participating in this study in order to help advance testing and service provision in the field of pediatric TBI. They had no questions or requests for information regarding Scott's abilities or educational situation. Jonathan's mother had many questions about service provision so I provided her with information and contacts for intervention services, education programs, and support groups, as well as web sites where she could obtain further information. She also shared concerns regarding Jonathan's academic and social situations. In light of these concerns, I provided her with strategies for teacher-to-student and student-to-student interactions, as well as suggestions for classroom adaptation and student learning techniques.

Procedures and Instrumentation

Testing and interview sessions were arranged to take place in the homes of the participants at the convenience of the participants and parents. Testing was not scheduled in place of therapy sessions or school and was scheduled with as little intrusiveness as possible. I established conditions for testing, which included needing a quiet space, no interruptions from other children, and no distractions from television or music. Sessions with all the participants were quiet and free from distractions, with the exception of those with Jonathan (participant with TBI) and Jordan (control subject). Jonathan's brothers often ran through the testing area and at one point, the television was turned on. Jonathan turned off the television after I asked him to so that we could continue testing in a quiet environment. Jordan's testing was interrupted by a family visitor, so testing was continued in another room.

Because "Acting a Scene" was added to the study after the testing was already underway, follow-up appointments were necessary in the case of two of the participants with TBI (Graham and Scott). I was able to set up an appointment with Scott and completed the additional testing in a 20-minute session. Due to distance and time constraints, I was unable to conduct a second visit with Graham to complete "Acting a Scene" so this test was administered to him over the telephone. In the case of the youngest participant with TBI and co-morbid hearing loss, the initial testing session was discontinued due to fatigue, and a second session was scheduled for the following week to accommodate his needs. The "Acting a Scene" task was administered in the second session.

Participants were given the PTBI (see Appendix E) and the Rapid Automatized Naming Task – RAN (Catts, 1993) as experimental measures in one session, totaling approximately 45 minutes. The performances on these tests were given a raw score and then rated for level of difficulty each participant had in completing each subtest (no difficulty, little difficulty, some difficulty, and great difficulty). Since the PTBI is in its research edition and no normative data were available, these ratings were based on raw scores, as well as behaviors exhibited during testing. Test administration was limited to myself who was trained in the administration of standardized test protocols.

I interviewed the participants regarding their perceived strengths and weaknesses in the areas of cognitive-linguistic ability, memory, and cognitive-behavioral issues. The interview guidelines I used are discussed at a later point in this chapter. All sessions were audio and video recorded for the purposes of scoring accuracy and reviewing reliability of scoring. In addition, the teachers of the participants with TBI were asked to complete a survey regarding the educational

status of the participants in order provide educational outcome measures for comparison with the PTBI and interview results.

The Pediatric Test of Brain Injury – Research Edition

The PTBI (Hotz, Helm-Estabrooks, & Nelson, 2001) is a tool, which is currently in its research edition, for assessing the cognitive-linguistic skills of school-aged children and adolescents following traumatic brain injury. It was developed in light of the fact that no standardized tests currently are available to assess the full-range of cognitive-linguistic impairments associated with pediatric brain injury. It was designed to measure the attention, memory, language, reading, writing, metalinguistic, and metacognitive skills that are particularly at risk in pediatric brain injury and that are relevant to the general education curriculum.

The PTBI was administered in this pilot study in order to obtain data that will contribute information about the methodology of the PTBI and its correspondence to self-perceptions and education functioning. In addition, the administration of the PTBI in this pilot study was conducted to obtain preliminary information applicable to further definitive validation studies of the PTBI so that it can be used to establish baseline behaviors and track recovery functions of children and adolescents with TBI. The PTBI consists of ten subtests, which are described below, essentially as the authors described them previously (Hotz, Helm-Estabrooks, & Nelson, 2001, pp. 437-440).

Task 1: Orientation

Description. This task consists of 14 questions relating to previously learned personal information and orientation to current place and date, e.g., "What school do

you go to? What month is this?"

Rationale. It is important to assess status of orientation early in the recovery process. Good response to a test of orientation depends on memory for old and new information, and language skills for understanding and answering questions. Thus, deficient performance on this PTBI task may be secondary to orientation, memory, or language problems, or any combination of the three.

Task 2. What Goes Together

Description. The PTBI task, What Goes Together, has 10 word-triads ordered according to age/grade difficulty (6 use single-meaning words and 4 use double meaning words). Students are shown word-triads in print to reduce memory demand, which are also read aloud by the examiner. Students must provide sound rationale for their pairings (e.g., "bark, growl, tree" – bark is found on trees; dogs both bark and growl), thus demonstrating good semantic/conceptual knowledge, vocabulary skills, verbal expression, and cognitive flexibility.

Rationale. Semantic/conceptual knowledge forms the basis of language acquisition and use. Vocabulary is used to communicate that knowledge. Impairment of previously acquired language skills after brain damage (aphasia) can result from traumatic brain injury. Furthermore, such deficits in children may interrupt maturation of semantic/ conceptual knowledge and negatively affect academic performance. One way to test this knowledge is to pair words according to a common semantic/conceptual relationship. For example, given the words "dog, cat, knife," one would pair "dog" and "cat" because they are both animals. If the third word is related to one of the other two (e.g., "bone"), then a different pairing can be made

based on other semantic knowledge (i.e., "dog" and "bone" because dogs eat bones). To make both these pairings requires not only expanded semantic knowledge but cognitive flexibility. When one of the words has a double meaning (e.g., "bark"), the task makes even greater demands on semantic knowledge and cognitive flexibility. The latter skill is often affected by traumatic brain injury, with serious implications for productive, independent living.

Task 3: Digit Span

Description. The classic format for testing digit span is used in the PTBI. Numbers are presented orally by the examiner and immediately repeated by students, beginning with two digits and progressing to seven. For each number series, two sets are presented. The subtest is terminated at the level where both sets are failed.

Rationale. Immediate verbal recall of numbers presented auditorally is a test of attention as well as short-term memory capacity. Individuals with traumatic brain damage may show digit-span deficits, particularly in the first months following injury when attention and memory skills are most likely to be affected. In addition, processing and verbalizing numbers depends on an intact language system, so aphasia may lead to poor performance. Interpretation of the scores earned on Digit Span, therefore, must be done in the context of performance on other PTBI tasks such as Orientation, Confrontation Naming and Story Reconstruction.

Task 4: Yes/No/Maybe

Description. Students are presented with printed "stories" of increasing length and syntactic complexity that are read aloud by the examiner. To reduce memory as a

reason for poor performance, the print form of the "stories" remains in view while students are asked three questions for each story. The correct answer can be "yes," "no," or "maybe. An example follows.

The kids ran after an ice cream truck. It turned the corner before they could catch it.

a. Did the kids chase an ice cream truck? (Y)

b. Did the kids catch the truck before it turned the corner? (N)

c. Did the kids get any ice cream? (M)

Rationale. The ability to listen and understand language across sentence boundaries requires language skills, semantic and syntactic decoding, inference, and metacognitive judgment. Impairment of these skills as a result of brain trauma can negatively affect knowledge acquisition, academic performance, and daily communicative interactions.

Task 5: Confrontation Naming

Description. Students are shown a line-drawing picture of a boy with a skateboard wearing a distinctive shirt and shorts and a "Band-Aid" on his knee. Students are asked to name three body parts and three other items in the picture. In pointing to these, the examiner draws attention to all parts of the picture because (unknown to students) Task 9 requires that the picture be recalled and drawn.

Rationale. The ability to name pictured objects is referred to as "confrontation" naming. This form of word retrieval is especially vulnerable to the acquired language disorder of aphasia. In fact, word retrieval problems (anomia) are a cardinal symptom of aphasia. Depending on the site and size of the damage,

children with traumatic brain injury may manifest aphasia with serious consequences for learning, self-expression, and social interactions. In the PTBI, confrontation-naming skills are assessed briefly. Less than fully correct performance on this task should be explored briefly and, thus, a comprehensive naming test may be required.

Task 6: Story Reconstruction

Description. Students are alerted to the fact that they will hear a story only once and must immediately repeat it back just like they heard it. The examiner then reads aloud the "Tommy the Trickster" story comprising 24 information units. A list of these units is provided so examiners can check-off and number each in the order given. Exact repetition is not required. Paraphrases of the information units also are credited.

Rationale. The ability to listen to a story and repeat that story accurately requires verbal memory as well as language skills including auditory comprehension and verbal expression, syntax and story grammar skills and sequencing of factual events. The importance of these skills to academic performance and social interactions cannot be overstated, and they are often impaired following pediatric brain injury. For that reason, a story reconstruction task is included in the PTBI.

Task 7: Reporting the News (Reading)

Description. For both the reading and writing tasks of Reporting the News, students are shown a list of kernel sentences that, together, tell the story "When Our School Closed." For the reading task, the student reads the kernel sentences aloud

("Our school was closed. It was last Wednesday." etc.).

Rationale. The ability to read words aloud accurately and quickly is an indicator of reading fluency and a predictor of reading comprehension. Children with TBI, especially those in earlier grades, may read slowly and with errors similar to those with developmental reading disorders. These reading problems can affect development of higher-order reading skills.

Task 8: Reporting the News (Writing)

Description. To establish the correct cognitive "set" for this task, students are shown the following core sentences: "There was a dog. He was little. He was brown. He was white. A car hit him. He was scared. He was okay." They are then shown how this information can be combined to tell a story someone would want to read (e.g., "A little brown and white dog got hit by a car. He was scared but he was okay.") Students then are given 5 minutes to write a cohesive story using the kernel sentences presented for reading in Task 5.

Rationale. The task of combining kernel sentences to write a cohesive story requires reading comprehension, grapho-motor, syntactic, metacognitive, and narrative discourse skills that include the abilities to combine and sequence events leading to a logical conclusion. Problems in any of these areas can affect performance and only qualitative analyses of products, along with more in-depth testing, can begin to determine the underlying causes of poor performance. Because writing problems are possible sequelae of childhood brain injury, we included a narrative writing task in the PTBI.

Task 9: Picture Recall

Description. Students are asked to recall the picture of the boy they looked at when naming body parts and objects. Then they are asked to draw that picture on the back of the record form. After completing the picture, they are asked to sign their name at the bottom of the picture. The product is analyzed for resemblance to a boy, recall of stimulus picture details, and the ability to write one's name.

Rationale. Memory problems are common and may be long lasting or even permanent following traumatic brain injury. Perhaps no impairment is more devastating to achievement of productive, independent living. Both verbal and visual memory problems have been reported in children with TBI, and these problems have important implications for classroom performance as well as other spheres of children's lives. In the classroom, there is the general expectation of remembering material presented. In other situations, elements must be remembered incidentally during the course of activities. For the PTBI, Task 3 (Digit Span), students are fully aware of their need to remember the stimuli. In contrast, Task 9 (Picture Recall) calls upon incidental memory for the picture used for Confrontation Naming (Task 5). To demonstrate their recall of this picture, they are asked to draw it as they remember it and, when finished, to sign their drawing. Thus, this task calls upon grapho-motor and visuo-spatial skills, as well as delayed, incidental memory.

Task 10: Story Recall

Description. Students are asked to remember the story of "Tommy the Trickster" which they heard and repeated earlier, during subtest 6. As in Task 6,

information units recalled are checked off and numbered in the order given.

Rationale. As described for Subtest 9, memory problems are common (if not the most common) sequelae of traumatic brain injury. Verbal memory skills are particularly vulnerable in pediatric brain damage with important repercussions for maturation of the knowledge base, academic progress, and activities of daily living. The PTBI is designed to test incidental, delayed recall of the story presented in Task 6 (Story Reconstruction). Students are not told during Task 6 that the story must be remembered. Thus, the request to recall this story at the end of the test is unexpected and constitutes a test of delayed, incidental verbal memory as well as those language and metacognitive skills required for narrative discourse.

Acting a Scene

This is a subtest from the Test of Integrated Curriculum-Related Skills (Nelson, Helm-Estabrooks, Hotz, 2002) which was not initially included in this study; however, following comments from participants, parents, and teachers regarding social skills, it was added in order to evaluate aspects of pragmatic expression. "Acting a Scene" examined each participant's ability to understand the language used to describe the scene, grasp the social-emotional problem, and formulate an appropriate linguistic, paralinguistic, and nonlinguistic response to communicate intent from another's perspective.

In this task, the examiner presented the participants with 11 short "scenes," which she read aloud to them while they followed along with the printed material in front of them. The participants were then asked to tell the examiner what a specific character might say and how he/she might say it. Following is a sample item from the subtest:

"Joe always blames other people for his mistakes. One morning Joe runs over his neighbor's bushes with his pick up truck. What do you think Joe would say to his neighbor?"

The Rapid Automatized Naming Task

The Rapid Automatized Naming (RAN) task was administered as described by Catts (1993) and reported by Catts, Fey, Zhang, & Tomblin (2001). It is another task that was not originally part of the PTBI. At the time of this study, however, the authors were contemplating adding the RAN or a similar task as another method of tapping into word-finding difficulties. Word retrieval problems are often mentioned as sequelae of TBI, but they are not easily identified through formal testing.

The RAN task is thought to be sensitive to word finding difficulties and it has been shown to predict difficulties in learning to read (Catts, et al., 2001). The participants in my study were asked to rapidly name the color and type of animal for a series of 24 pictures which showed different combinations of colors (red, blue, and black) and animals (cow, horse, and pig). In this task, participants were required to retrieve words selectively while suppressing competing words, as well as to exert executive control to manage the task and sustain attention.

Participant Interview

Prior to testing, I spent time interviewing the participants about their strengths and weaknesses. I then transcribed each interview verbatim from the audiotapes. The following questions were used as a general outline for the interviews:

- I understand you have a brain injury. Can you tell me anything about it, like how and when it happened?

- How are things going for you? (re: school, friends, work, communication)
- What things are you good at? Is this the same as before your accident, or different? Can you tell me a story about a time when you were good at something?
- What things are hard for you? Is this the same as before your accident, or different? Can you tell me a story about a time when something was hard for you?
- If you could change just one thing right now, what would that be? (re: school, friends, work, communication)
- Before we move on, is there anything else you that you want me to know about you or your accident?

The transcripts of the interviews were coded according to self-perceptions of cognitive-linguistic ability, memory, and cognitive-behavioral issues based on Spradley's (1979) method of domain analysis. Spradley described domain analysis as a method of identifying categories respondents may talk about during an interview. After reviewing the transcripts for topics the participants discussed, I developed four major categories: cognitive-linguistic, cognitive, cognitive-behavioral, and other. The cognitive-linguistic category included verbal expression, auditory processing, naming/word-finding, reading, and writing. Memory was the only aspect of cognition coded. Cognitive-behavioral codes included anger/emotion, impulsivity, social issues, and others' perceptions of self. The category of "other" included perceptions regarding self, general academics, athletics, and art/creativity. All codes were marked as either positive (+) or negative (-) where (+) indicated a perceived strength or area of no difficulty and (-) indicated a perceived weakness or area of difficulty.

Perceptions could be coded as more than one theme. (See Appendix F for table of specific code descriptions.)

All coding of the interview was in reference only to the participants' perceptions of themselves. In other words, behaviors exhibited during the interview were not coded, whereas perceptions of behaviors were. For example, if a participant demonstrated impulsivity during the interview, this was not coded; however, it was coded if the participant commented on or eluded to his impulsivity.

Informal Survey: School-Related Functional Status of Students with TBI

Teachers of the participants with TBI were asked to complete a survey that consisted of questions regarding the daily behaviors and activities of the participants in light of school-related functional status. Five areas were included: academics, attention, oral communication, class participation, and social behavior. Based on their observations and knowledge as teachers, those completing the survey were asked to describe the participant as he was currently functioning, as opposed to before his injury. Two of the surveys were returned and incorporated into the results of the testing. (See Appendix G for survey.)

Reliability

Scoring Reliability

Measures of inter-rater reliability were conducted for the scoring of the tests administered in this study. A fellow speech-language pathology graduate student experienced in the administration and scoring of formal tests, scored the performances of one of the participants with TBI and one without. She also rated each performance for level of difficulty the participants had in completing the subtests after I trained her

in assigning levels of difficulty. To compute inter-rater reliability for raw scores, the number of agreements was divided by the number of judgments, resulting in an inter-rater reliability of 84%. The reliability for level of difficulty assigned to each subtest was computed using the same method as used for raw-score reliability and resulted in an inter-rater reliability of 89 %.

Coding Reliability

The graduate student who scored the tests for scoring reliability also participated in reliability measures for coding of the participant perceptions. She was trained by myself in the coding procedures developed for this study. She coded one interview transcript which was compared with the same transcript that I coded to test the reliability of observations. Analysis of the two coded transcripts indicated that we consistently saw the same self-perceptions.

Analysis

I analyzed the results of the PTBI and the RAN, the self-perceptions of the participants, and the responses of the teachers on the survey regarding educational status of the participants. To organized the analyses, I used a qualitative case-study methodology adopted from Creswell's (1994) description in which "the researcher explores a single entity or phenomenon ('the case') bounded by time and activity...and collects detailed information by using a variety of data collection procedures during a sustained period of time" (p. 12). Following Creswell's method of data analysis in case study research, I searched for patterns in my results as I compared them with the patterns and predictions reported in the literature in order to find answers to my experimental questions.

I had my research questions in mind as I examined at the relationships among the data gathered in this study. In looking at the results of the PTBI, I paid particular attention to areas of deficits reported in the current literature as setting apart students with TBI, but that are overlooked by traditional language assessment tools. I was interested in determining whether the PTBI tapped into areas of difficulty, especially connected discourse, that were identified by others as lacking from traditional assessment tools. I then examined the results of the PTBI with reports from teachers of the participants' functional status in education. This comparison was important in that I was interested in finding out whether the PTBI results were consistent with real-life academic performance. Next, I compared the informal measures (participant perceptions and educational survey) with the results of the testing in order to see what new information these sources provided. Finally, I compared the performances of the participants with TBI to the performances of the control subjects in order to see the differences in abilities that the PTBI revealed.

CHAPTER IV

RESULTS

This study was designed to examine results of an experimental formal test, specifically designed for children and adolescents with TBI, the Pediatric Test of Brain Injury (PTBI; Hotz, Helm-Estabrooks, & Nelson, 2001), supplemented with a Rapid Automized Naming Test (RAN; Catts, 1993), and the "Acting a Scene" subtest from the research edition of the Test of Integrated Curriculum-Related Language Skills (TICLS; Nelson, Helm-Estabrooks, & Hotz, 2002). The results of formal testing for students with TBI were to be compared with results for students with no TBI on the same formal testing measures and with information gathered from informal measures. The informal measures included interviews of the students themselves (using an extension of the "orientation" subtest on the PTBI), parent input, and teacher response on a questionnaire I designed to assess functional uses of cognitive-linguistic skills in academic settings.

The results were analyzed to address four experimental questions. The first and second questions addressed the validity of the PTBI, (a) with regard to its ability to identify areas of deficit lacking from traditional language assessment tools but important in the TBI population, and (b) with regard to its ability to differentiate students with TBI from those without. To answer these questions, the results of formal testing were analyzed for experimental participants and compared with the results of formal testing for the control participants. The data are presented first in the form of case studies as described by Creswell (1994), and then analyzed in relationship to each other in a subsequent section. The third question (c) asked about

the relationships between formal testing results and teacher reports of educational status. Teacher forms were returned for only two of the students with TBI. These results also are presented first in the case studies, and analyzed subsequently in relation to each other. The fourth question asked about the relationships of evidence coming from the formal and informal measures, specifically, whether the PTBI might reveal any information not obtained through the informal measures (i.e., participant interview and/or educational survey), and whether the informal measures might reveal any information not obtained with the PTBI. These questions are addressed within this chapter by comparing the results of the two sets of measures for the experimental participants.

This chapter is organized to present case study results for individual participants first, starting with the three students with TBI, then the three control students without TBI (for whom only formal test results were gathered). Table 1 summarizes the results of formal testing for all six participants. Following the case studies, the experimental questions are addressed in three sections. The first consists of analysis of data as they relate to the ability of the PTBI to measure the effects of TBI on cognitive-linguistic processes (based on the construct as developed in the review of literature) and to distinguish students with and without TBI. The second addresses the comparability of formal testing results and teacher reports of functional educational status. The third addresses the comparability of formal test results and information gathered from other informal measures. In Chapter Five, these results are discussed further relative to their implications for offering insights into the nature of the pediatric TBI population, providing ideas for closing several of the gaps in assessment, and thoughts of best practices with this population.

Table 1

Levels of Difficulty in Performing Subtests of the PTBI

	Participants with TBI			Participants without TBI		
Subtests	Graham	Scott	Jonathan	Nathan	Jordan	Bradley
Orientation (14 possible)	14 (3)	14 (3)	9 (0)	14 (3)	14 (3)	14 (3)
What Goes Together (20 possible)	19 (2)	16.5 (1.5)	9 (0)	19 (2)	19 (2)	19 (2)
Digit Span (6 possible)	3 (1)	4 (2)	1 (0)	6 (3)	6 (3)	4 (2)
Yes/No/Maybe (15 possible)	10 (1)	11 (1.5)	12 (2)	13 (2)	14 (2)	13 (2)
Confrontation Naming (6 possible)	6 (3)	6 (3)	6 (2)	6 (3)	6 (3)	6 (3)
Story Reconstruction (24 possible)	6 (0)	2 (0)	4 (0)	20 (3)	21 (3)	20 (3)
Reporting the News (Reading) (55 total)	55 (3)	54 (3)	43 (1)	54 (3)	55 (3)	55 (3)
Reporting the News (Writing) (N/A)	N/A (1)	N/A (0)	N/A (0)	N/A (3)	N/A (3)	N/A(1)
Picture Recall (8 possible)	8 (3)	6 (2)	6 (2)	7 (2)	8 (3)	7 (2)
Story Recall (24 possible)	6 (0)	1 (0)	8 (0)	20 (3)	20 (3)	21 (3)
Acting a Scene (66 possible)	50 (2)	35 (1)	18 (0)	64 (3)	65 (3)	62 (3)
Rapid Automatized Naming Task	33 sec. 2 errors	28.5 sec. 1 error	41 sec. 1 error	28 sec. 1 error	24 sec. 0 errors	42 sec. 1 error

Key: The first score in the box represents the student's raw score on that subtest. The number in parentheses indicates whether it was rated as indicating "no difficulty" (3), "little difficulty" (2), "some difficulty" (1), and "great difficulty" (0).

Case Studies for Participants with Traumatic Brain Injury

Graham

Background Information

Graham[1], a 16-year-old, Caucasian, right-handed student, who is now in the 10th grade, sustained a TBI as a passenger in a motor vehicle accident (MVA) when he was 12 years old. Details regarding the accident and subsequent hospitalization information were not accessible; therefore his initial Glasgow Coma Scale (GCS) score, computerized tomography (CT) results, length of coma, and TBI severity level are not reported in this study. Graham and his father reported that Graham underwent brain surgery following the accident and participated in comprehensive inpatient rehabilitation. Although details were sparse, Graham did provide an account of a devastating MVA and declared, "I'm not supposed to be a survivor, but I am...supposedly. I'm lucky, isn't that what the doctor said?"

Information about Graham's educational and social history also was sparse. His father was unable to provide details regarding Graham's childhood. Previous to the accident, Graham lived with his mother and had little contact with his father until one year ago when he came to live with his father. I was unable to approach Graham's mother or siblings for information because they died in the accident.

At the time of testing, Graham was receiving special education services at the local high school in a self-contained special education classroom. He reported that, "I'm in all special ed every class except for gym...They're gonna start putting me in regular ed soon." According to Graham, he had also been in special education previous to his brain injury. He was not receiving rehabilitation services at the time

[1] All names are pseudonyms

of the interview; however, both he and his father indicated that he would be meeting with "the rehab team" [speech-language pathologist, occupational therapist, physical therapist through the rehabilitation hospital] in the near future.

Graham and his father discussed anger management as a major issue for Graham since the accident. At the time of testing, Graham was taking Risperdol (risperidone) and Carbatrol (carbamazepine), which have reportedly been effective thus far. Risperdol is indicated for the management of manifestations of psychotic disorders. Carbatrol is generally prescribed for seizures, although some physicians prescribe this medication for emotional disorders, such as depression or abnormally aggressive behavior. His father reported that Graham had been on a series of different medications prior to starting his current medications two months prior and said it was through "trial and error" that they arrived at this current combination of medications. Graham himself stated, "I've been on many medications that don't work."

Both Graham and his father willingly contributed information and participated in this project. Graham presented as a funny, pleasant, and warm young man. He went out of his way to attempt to fix my watchband, which broke during the meeting. Following the interview and testing session, Graham eagerly showed me items of personal interest and shared personal stories.

Results of the PTBI for Graham

Orientation. Graham performed this subtest without difficulty. His raw score was 14 out of a possible 14 points. He was very quick to respond to all questions and provided the correct answer for each question. There was no evidence of hesitation or uncertainty regarding any of these questions.

What Goes Together. With a raw score of 19 out of 20, Graham performed this subtest with little difficulty. He required two cues to provide more complete explanations for two pairs of words (knife-fork & hammer-axe). On one occasion, he quickly responded with, "I have no idea," however, following a simple prompt from the examiner ("Look again") he was able to provide an accurate answer. Overall, Graham's definitions/explanations of why each pair went together were complete, descriptive, and accurate, suggesting adequate vocabulary skills. He did not require extra time nor did he demonstrate difficulty/struggle in providing answers. His performance on this subtest demonstrated both semantic knowledge and cognitive flexibility, which are important skills for academic success.

Digit Span. Graham performed this subtest with some difficulty as evidenced by his raw score of 3 out of a possible 6 points. For spans of two to four digits, he was 100% accurate. For those with five to seven digits, he was 50% accurate. To explain this in more detail, for each pair of sets (five, six, and seven digit spans), he repeated one of each accurately. For the sets he did not repeat accurately, his errors were characterized by adding and/or transposing numbers. Graham's tendency to respond very quickly may have affected the accuracy of his answers.

Yes/No/Maybe. Graham performed this subtest with little to some difficulty as evidenced by his score of 10 out of 15 points. He inferred information from the story as evidenced by several correct "maybe" answers. In fact, he overlooked only one "maybe" answer. In general, his errors were mostly on items that could have been answered concretely "yes" or "no." His errors were as follows: "yes" for "maybe," "yes" for "no," "maybe" for "no" (twice), and "maybe" for "yes." After two of Graham's errors, the examiner provided cues to "look again," following which he

provided the correct answer. This implies that Graham had inferential and metacognitive skills, but he may have experienced decreased attention to either auditory stimulus or written material. His performance on this subtest could also suggest decreased ability to isolate and attend to relevant details in either the stories or the questions. Graham's quickness in answering each question should be noted. At times, he changed his answer after giving himself some time to think about the question. In the case of spontaneous changes, his final answer was used in scoring. In addition, in all cases when cues were given to "look again" he was able to provide the correct answer. In such instances, his original answer was used in scoring. This suggests that impulsivity may also have played a role in his errors.

Confrontation Naming. Graham performed this subtest without difficulty. He named all body parts and objects accurately and in a timely manner.

Story Reconstruction. Graham performed this subtest with great difficulty. Graham was able to recall only six of the 24 information units required for full credit. The information he did provide was vague and did not include all of the major story elements. The order in which he recalled these information units loosely followed the story. Graham's performance on this subtest could be an indicator of short-term memory impairments. It could also suggest decreased skills in the areas of auditory language processing and/or narrative production, specifically with temporal and causative elements. Further exploration of Graham's abilities in the areas of auditory language processing and narrative production could shed more light on the reasons for his difficulty with this task and provide important information for further academic success, especially in light of his desire to complete post-secondary education.

Reporting the News (Reading). Graham performed this subtest without

difficulty. He read aloud accurately and quickly. Reading fluency did not appear to be an area of difficulty for him; however, it should be noted that reading comprehension was not directly assessed during this task.

Reporting the News (Writing). Graham performed this subtest with some difficulty. He mostly rewrote the simple sentences as they were presented without combining them to make more complex sentence constructions. Just as important as verbal narrative production (see "Story Reconstruction"), written narrative production is critical for academic success. This area also could be further explored for more insight into Graham's ability to use metalinguistic and written narrative discourse skills, which will be very important if he continues his education beyond the high school level.

Picture Recall. Graham performed this subtest without difficulty as seen in his raw score of 8 out of 8 possible points. When he was initially shown the picture, he was not aware that he would be asked to remember it at a later point during the testing. Despite this fact, he recalled all relevant details of the picture without cueing or prompting from the examiner and without obvious struggle to remember. This suggests that he possesses skill in the area of delayed incidental visual memory. Graham's performance on this subtest also demonstrated good grapho-motor and visuo-spatial skills.

Story Recall. Graham performed this subtest with great difficulty. Again, he was able to recall six of the 24 information units, which indicated no change from the immediate story retell task (See "Story Reconstruction" on p. 54). The content and quality of what he retold were the same as that from the previous story retell task. Again, Graham's performance on this subtest suggests that this area be explored

further for insight into and strategies for his academic success.

Acting a Scene

Because this test was administered over the telephone, it was not possible to evaluate Graham's facial expressions and gestures. When considering the linguistic features he used, Graham performed this task with little to some difficulty as evidenced in his score of 50 out of a possible 66 points. He used socially appropriate intonation and tone of voice in most situations, but provided some answers that needed more information to clearly communicate intent.

Results of the RAN

Graham completed the RAN in 33 seconds with two uncorrected errors. He demonstrated multiple false starts followed by self-corrections of these mistakes.

Participant Perceptions

During the interview that was designed to tap into the participants' perceptions of their strengths and weaknesses, Graham provided insightful information. He expressed both positive and negative characteristics regarding his cognitive-linguistic abilities. Verbal expression and naming/word finding were areas with which he reported difficulties, saying that coming up with the "right word" and the way to express his thoughts were sources of frustration. On a scale of one to ten, with one being not frustrating and ten being the most frustrating imaginable, Graham reported his frustration with these two aspects of expressive language to be at a seven. About his writing abilities, he said, "I'm not very good at it...I'm better at saying it than writing it." When asked what was difficult about writing, he responded, "Getting all

the thoughts into it."

Regarding reading, another cognitive-linguistic skill, Graham expressed positive self-perceptions. He stated that reading was one of his strengths and commented, "In the third grade, I was seventh grade reading level." According to Graham, he is currently at appropriate grade level in reading. In addition to positive reading insights, he also implied that talking was a relative strength. This was indicated by his comment, "I'm better at saying it than writing it."

Graham told of numerous memory difficulties, but when the topic was probed further by the examiner, he also mentioned aspects of memory that were intact. In his first statement about memory, he spontaneously expressed problems in the words, "I was doing pretty good on memory...and then it keeps getting worse." When asked to describe his memory issues, he said he experienced trouble remembering "things I used to know." He provided the example that he did not remember everything he learned in school last year and that, "I don't seem to be remembering the stuff that was just taught me." However, when questioned about learning new things, he responded, "Learning new things has always been easy for me." In addition, he expressed that he remembered things from day to day and did not experience difficulty recalling information covered in school or events from the previous day.

In regards to cognitive-behavioral issues, Graham provided valuable insights. He discussed "getting in trouble" and recalled the exact date of his most recent episode of aggression in which he punched a girl. He expressed awareness of his anger management problems, but also stated that his current medications seemed to be helping. He implied that he had some perception of impulsivity in himself when asked about what things were difficult for him, and he responded, "Not eating a lot." He expanded on that by stressing, "I eat a lot. A lot! I get a lot to eat!" It should be

noted that Graham is not overweight. This comment is an example of how he indicated impulsivity throughout the interview.

When asked about his situation with friends, Graham said, "I'm doing pretty good with friends." He also expressed negative self-perceptions regarding peer relationships and others' perceptions of him. For example, he told the examiner, "I try to do things so that I don't get picked on, but people hate me anyway." He followed that comment by saying that he acted immature, which he expressed in these words: "I acted normal then [before the accident], but cuz everybody acted immature then compared to these standards now. I still act like a twelve-year-old."

Graham expressed academic strengths in comments such as, "I got it going in math" and, "I sometimes correct my English teacher." At one point during the interview he said, "I'm the smartest kid in my [special education] class." Along with his statements of academic strengths, he acknowledged that school has become more difficult since his brain injury. For example, following his comment about his strength in math, he commented, "It's just not as good, but I can...get it done."

Parent and Teacher Perceptions

The examiner spent some time discussing Graham's situation with his father. His father reported that anger management and impulsivity were issues Graham was currently dealing with. When asked for academic concerns, his father did not come up with specific issues.

Graham's teacher completed a survey regarding school-related functional status. (See Appendix G for survey). She was asked to answer questions about Graham's performance in the following five areas: academics, attention, oral communication, class participation, and social behavior.

In the area of general academics, the teacher reported that Graham sometimes met average or above average expectations in school and performed adequately on reading and writing assignments. According to the teacher, he consistently demonstrated carry over of information for new learning. She also stated that Graham "does a fine job as long as he understands what is asked of him."

Concerning attention, Graham's teacher reported inconsistent ability to sit still, to maintain attention for completing tasks, and to respond to oral directions adequately and without confusions. She added that Graham "has good and bad days. Good days he can focus for about a half hour without redirection. On bad days it's continuous reminders."

Regarding Graham's oral communication abilities, his teacher reported that he has adequate vocabulary and word usage skills for communication and is competent in telling stories or relating past events. She indicated that at times he easily comprehends and follows normal conversations. In addition, she commented, "His communication is done very well if he is focused."

In terms of class participation, the teacher said that Graham completes assignments within the allocated time; however, at times he has difficulty starting tasks that require following directions. She also said that he often volunteers information to discussions and answers questions.

Graham's teacher reported that the following three statements are somewhat true regarding Graham's social behavior: (a) Demonstrates behaviors that seem usual and appropriate; (b) Gets along with other students/peers; and (c) Polite, appropriately mature, and maintains emotional control. She commented that Graham "is usually polite, especially to adults. He does have a tendency to irritate his peers because he will interrupt and leave before a conversation is over. He also speaks rather rapidly

and is hard to follow. He does not exhibit the same behaviors toward adults, except he likes to be *really* close! [Graham] is a likeable person…he really needs to learn what social norms are!"

Scott

Background Information

Scott, also Caucasian, is now a 16-year-old left-handed high school sophomore who sustained a severe TBI at eight years of age when he was hit by a car while riding his bike. He subsequently spent two and a half weeks in a coma and was hospitalized for four to five months. He underwent comprehensive inpatient rehabilitation, including services through a school transition program, before returning to school.

Prior to his accident, Scott had been in regular education classrooms and had no recollection of receiving special education services during that time. When he returned to school following his brain injury, Scott was again placed in regular education classrooms where he completed fourth through sixth grades. He attended two schools for regular education curriculum during the seventh grade before enrolling in a special education program to complete this grade. He continued junior high school in this program and is currently attending high school through the same special education program where he is placed in a self-contained classroom for "kids who have temper disorders."

Scott presented as an outgoing, friendly, and easy-going young man who was eager to participate in this study. He was more than willing to share personal information and stories and presented me with several small gifts from his snakeskin collection upon completion of the sessions.

Results of the PTBI

Orientation. Scott performed this subtest without difficulty. He provided the correct answer for each question in a timely manner. There was no evidence of hesitation or uncertainty regarding any of these questions.

What Goes Together. Scott performed this subtest with little to some difficulty. He did not require extra time, nor did he demonstrate struggle in providing answers. For the single meaning section, his definitions/explanations of why each pair went together were complete, descriptive, and accurate. He earned 11.5 points out of 12 possible points. For the double meaning section, however, Scott experienced some difficulty as evidenced his score of five out of eight. He had trouble deciding what words went together on two items. In addition, on several items he put the correct words together, but some of the reasons he provided for why they went together were not as complete and descriptive as the explanations provided in the single meaning section.

Digit Span. Scott performed this subtest with little difficulty as seen in his raw score of 4 out of a possible 6 points. For spans of two, three, four, and six digits, he was 100% accurate in each trial. For spans of five and seven digits, he repeated them accurately in 50% of opportunities. For the strings of numbers he did not repeat accurately, his errors were characterized by transposing and adding digits.

Yes/No/Maybe. Scott performed this subtest with little to some difficulty as evidenced by his score of 11 points out of a possible 15. He did infer correct information from the story by answering all but one "maybe" answer correctly. The

other errors he made were on questions with concrete "yes" or "no" answers in which he answered "maybe" for "no" twice and "no" for "yes" once. This suggests decreased attention to either auditory stimulus or written material or an impaired ability to isolate and attend to relevant details. It could also suggest some type of memory impairment; however, in light of his performance on the memory-specific subtests and the current research on memory and linguistic processing, a short term memory deficit is not likely the only or "pure" factor in his performance on this subtest.

Confrontation Naming. Scott performed this subtest without difficulty. He named all body parts and objects accurately and in a timely manner.

Story Reconstruction. Scott performed this subtest with great difficulty. He was able to recall only one out of the 24 information units required for full credit. Scott did not produce a complete or cohesive narrative with major story elements. His performance suggested verbal memory impairments. It could also be an indicator of decreased integrated linguistic and metacognitive skills necessary for narrative discourse.

Reporting the News (Reading). Scott performed this subtest without difficulty. He read aloud accurately, with the exception of one misread word. Reading fluency does not appear to be an area of difficulty for him; however, it should be noted that reading comprehension was not directly assessed during this task.

Reporting the News (Writing). Scott performed this subtest with great difficulty. He rewrote the simple sentences exactly as they appeared in the stimulus book. He did not combine the kernel sentences to make more complex sentence

structures even though this direction was reviewed during the trial task. In light of Scott's poor performance on the verbal narrative discourse task, his performance on this subtest implied impaired ability to produce complete, cohesive, and complex written narratives.

Picture Recall. Scott performed this subtest with little difficulty. He recalled four out of the five major elements of the picture required for full credit without cueing or prompting from the examiner and without obvious struggle to remember. This suggested that he possesses some ability in the area of incidental visual memory. In addition, his picture adequately represented a boy, demonstrating good grapho-motor and visuo-spatial skills.

Story Recall. Scott performed this subtest with great difficulty. He was only able to recall the name "Tommy the Trickster" but no other accurate details of the story. He produced five sentences that vaguely resembled information presented in the story. These sentences were not produced in a mature narrative form; rather, Scott listed most of the sentences with pauses up to 15 seconds between each one. When prompted by the examiner to recall more details, he replied, "I can't remember." This suggests that incidental verbal memory skills are impaired, as well as the linguistic and metacognitive skills required for narrative discourse.

Acting a Scene

With a score of 35 out of 66 possible points, Scott performed this test with great difficulty as evidenced by not understanding the key concepts in all situations, not providing adequate information in all contexts to clearly communicate intent, and not exhibiting appropriate tone and prosody in all scenes.

Results of the RAN

Scott completed the RAN in 28.5 seconds with one error, which he self-corrected before moving on to the next item.

Participant Perceptions

During the interview regarding participant strengths and weaknesses, Scott willingly provided his perceptions. In the area of cognitive-linguistic abilities, he expressed few difficulties. When asked whether he had problems determining how to say things or coming up with the "right word" he said that he was not having trouble. He stated that he "talked too much," which he felt was different since his brain injury; however, he did not relate any other problems with expressive language. While he said he was "better than everybody else" in reading, he also mentioned that he did not like to read. When pressed for a reason, he replied, "I'm an outdoors kid." Scott repeatedly stated that he found the work at school to be "too easy." When asked what things he was good at in school, he replied, "Volleyball."

This theme of "being active" came through several more times during the interview. Scott expressed that he was good at "outdoor stuff" such as trapping animals. At the end of the interview he again said, "I'm an outdoors kid" and agreed that he would rather be busy "just doing things."

In terms of memory, Scott related minor difficulties, which he described as "Just like my dad...remembers something just at the last minute." He denied any problems with new learning or remembering things from day to day and events and information from school.

In regards to cognitive-behavioral issues, Scott perceived several difficulties

as well as important strengths. His perceived difficulties were in the area of anger management. If he could change one thing he said it would be "my attitude." When the examiner probed this statement, Scott replied, "I get mad very, very easily over stupid things." He described his behavior when this happens as, "I cuss at the principal. Cuss at the teacher over stupid stuff...What do I do when I get out of that stage? I apologize and stuff." He agreed with the examiner's comment of, "It's just like you can't help it." He also stated that at times he had difficulty "getting along with the kids [at school] cuz their temper is a lot worse than mine."

Scott perceived strengths about his communication skills and his general behavior. He told the examiner that he had good relationships with the teachers at school and related several stories about his best friend. Aside from difficulty in getting along with peers in light of, "their temper is worse than mine," Scott did not perceive any relational or communication problems. When asked whether he would change something about his friend situation, he said that he would like to see them more often. In response to a question about communicating with people, he said he was good at "making them laugh." In response to a question about what he would change about communicating with and relating to other people he replied, "What would I change? Just always talking about my accident and stuff. Having to explain it to everybody." At the end of the interview, Scott added several comments when the examiner asked, "Is there anything that you want me to know about the accident or things that you think would be important for me to know about you?" He replied, "I'm nice...Funny...I'm easy to hang out with...I like to listen."

Parent and Teacher Perceptions

Scott's father had no questions or concerns for this examiner. In light of

Scott's time post-injury and the conversations with Scott and his father, the examiner suspects that they have "figured things out." Scott's father expressed that he was happy to assist with a project that could potentially help the pediatric TBI population.

Scott's teacher completed a survey regarding school-related functional status. (See Appendix G for survey). She was asked to answer questions about Scott's performance in the following five areas: academics, attention, oral communication, class participation, and social behavior.

In the area of general academics, the teacher reported that Scott met average or above average expectations in school and performed adequately on reading and writing assignments. According to the teacher, he demonstrated some carry over of information for new learning. She also stated that Scott "is very concrete" and "has difficulty transferring information."

Concerning attention, Scott's teacher reported that he can sit still and is not restless or hyperactive. She added that he is able to maintain attention for completing tasks. According to his teacher, at times Scott has difficulty responding to oral directions adequately and without confusion. She stated that Scott is "sometimes unsure when given oral directions…needs to hear things a couple of times."

Regarding Scott's oral communication abilities, his teacher reported that he has adequate vocabulary and word usage skills for communication. He is perceived as being competent in telling stories or relating past event in comprehending and following normal conversation. Scott's teacher commented that Scott "has good communication skills."

In terms of class participation, the teacher said that Scott completes assignments within the allocated time; however, at times he has difficulty starting tasks that require following directions. According to his teacher, Scott sometimes

volunteers information to discussions or answers questions. She stated that he "tries to get by with doing as little as possible…likes to blend in with the group and not draw attention to himself."

Scott's teacher reported that the following three statements are somewhat true regarding Scott's social behavior: (1) Demonstrates behaviors that seem usual and appropriate; (2) Gets along with other students/peers; and (3) Polite, appropriately mature, and maintains emotional control. She commented that Scott "is very rigid and controlling…has a hard time dropping issues…does have occasional temper outbursts when frustrated…tends to over-react immediately and works things out when he has had time to thing it over." At the end of the survey, Scott's teacher added that he "has a very hard time dropping issues. He will worry and go on and on and on about things that the rest of us would view as trivial. He doesn't like to try new things at all!"

Jonathan

Background Information

Jonathan is an 11-year-old right-handed Caucasian fifth grader who sustained a moderate to severe TBI at six years of age when he was hit by a car while riding his bike. As with the other two TBI subjects, the family did not have medical information regarding initial GCS score and CT scan results. The professional through whom the contact was made with Jonathan also did not have this information. Attempts were made to obtain this information from the hospital where Jonathan was in acute care; however, these attempts were unsuccessful.

Following his accident, Jonathan spent one week in the hospital before he returned home. He received outpatient speech and language services one time per

week for one month. Since Jonathan's accident occurred at the end of the school year, he did not miss any school. When classes resumed in September, he returned to the school he had been attending prior to his accident.

Jonathan was born deaf and received a cochlear implant at the age of four. He was enrolled in an aural deaf program at a local school and attended there until the fourth grade. Now in the fifth grade, Jonathan is in a regular education classroom for two classes and receives the rest of his instruction from the special education/resource room teacher. He also is receiving speech and language services through the school for 15-20 minutes three to four times per week. In spite of his hearing loss, Jonathan's cochlear implant made it possible for him to take the PTBI as it was originally designed. The only modification the examiner made was to repeat several task directions and auditory stimulus items.

According to Jonathan's mother, he is having significant difficulties with aggression and social skills. He is currently on Depakote (divalproex sodium) for his aggression and mood; however, his mother does not feel this medication is effective. Depakote is a common anticonvulsant and is also indicated for treatment of manic episodes associated with bipolar disorder. Some doctors also prescribe this for children and adolescents with explosive tempers and mood variations. Jonathan also experiences severe headaches for days at a time, which his mother describes as "migraine-like." She told the examiner that Jonathan has an upcoming appointment with a neurologist regarding his headaches.

Results of the PTBI

Orientation. Jonathan performed this subtest with some difficulty. He took significant time to answer most questions and required repetitions and prompts for

more complete answers. When asked when his birthday was he could not recall the exact date, nor could he remember exactly how old he was. The examiner is unsure whether Jonathan would have answered more questions correctly with prompts because his mother, who was in the room a short distance away, often responded when he did not immediately come up with the answer.

What Goes Together. Jonathan performed this subtest with great difficulty as evidenced by his score of 7.5 out of 12 on the single meaning section and 1.5 out of 8 on the double meaning section. He had difficulty both determining the correct pairs of words and providing complete and accurate reasons for why the words went together.

Digit Span. Jonathan performed this subtest with great difficulty as seen in his raw score of 1out of 6 points. He was able to repeat both two-digit spans accurately, as well as one three-digit span. He did not repeat any of the four, five, six, or seven digit spans correctly. His errors were characterized by omitting, transposing, and substituting digits. At times, he did not repeat any of the digits saying, "I can't" and "I'm just so confused." It is doubtful whether he was simply unable to hear the numbers. The combined necessities of hearing, perceiving, remembering, and recalling in this task likely overloaded his cognitive-linguistic system due in part to his hearing loss, but also to the effects of TBI.

At one point it became evident that Jonathan was quite frustrated, so the examiner offered him the opportunity to test the examiner on an item. Following his "testing" of the examiner, the examiner presented Jonathan with the same 7-digit span. It is very interesting to note that he repeated all but the last digit on this 7-digit span. When asked whether it helped him to see the numbers or hear them twice, he

said it helped to hear them again.

Yes/No/Maybe. Jonathan performed this task with little difficulty as evidenced by his score of 12 points out a possible 15. His errors were answering "no" instead of "yes," "no" instead of "maybe," and no response. Jonathan's relatively strong performance on this subtest gains even more significance in light of the fact that prior to and during this subtest he complained of being tired and often asked questions such as, "How many more do I have to do?" and "Are we done yet?"

Confrontation Naming. Jonathan performed this subtest with little difficulty. He named all the body parts and objects; however, on the first item ("neck") he provided several incorrect answers ("pokey thing" and "makes it stick up right") before coming up with the word "neck." It may have been that Jonathan experienced word retrieval difficulties as a result of his head injury. It might also be possible that he was uncertain to what the examiner was pointing. The other answers were provided in a timely manner.

Story Reconstruction. This subtest was administered twice – once during the first session and then again during the second session five days later. Jonathan performed this subtest with great difficulty. He recalled 5 of the 24 information units required for full credit both times this was administered. His difficulty with this subtest suggested both verbal memory impairments, as well as decreased linguistic and metacognitive skills necessary for narrative discourse.

Reporting the News (Reading). Jonathan had some difficulty performing this subtest. He made 12 errors while reading aloud and had difficulty sounding out two words ("Wednesday" and "janitor"). The majority of his errors were morphological

omissions (e.g., "close" for "closed" and "skunk" for "skunks") which were consistent with his spontaneous language use in conversation. In addition, he transposed two words, omitted two words, and substituted "and" for several articles and pronouns at the beginning of sentences. Other than the two words which he had difficulty sounding out, Jonathan read the sentences in a timely manner.

Reporting the News (Writing). Jonathan had great difficulty performing this subtest. He included eight out of the 14 kernel sentences and combined two of them using the conjunction "but"; however, the combination was not logical. ("He opened the school, but our school was closed.") Following this combination, Jonathan simply rewrote the sentences as they were presented in the stimulus book and stopped approximately half way through.

Picture Recall. Jonathan performed this subtest with little difficulty. He included four out of the five relevant details listed on the protocol without cueing or prompting from the examiner. This performance indicated abilities in the area of incidental visual memory. In addition, Jonathan's picture adequately resembled a boy, demonstrating good grapho-motor and visuo-spatial skills.

Story Recall. Jonathan performed this subtest with great difficulty. He recalled more information units (8/24) than during the immediate recall task and also presented the information in a more descriptive narrative. While his performance improved from the previous task, he still demonstrated difficulties with verbal memory and the linguistic and metacognitive skills necessary for complete, cohesive, and logical narrative discourse.

Acting a Scene

Jonathan performed this subtest with great difficulty as evidenced by his score of 18 out of a possible 66 points. It appeared as though this was due to both vocabulary deficits as well as inability to use pragmatic discourse skills to generate appropriate responses for specific social-emotional communication contexts.

Results of the RAN

Jonathan completed the RAN in 41 seconds with one error which he immediately self-corrected.

Participant Perceptions

During the interview regarding participant strengths and weaknesses, Jonathan willingly provided his perceptions. In the area of cognitive-linguistic abilities, he expressed several difficulties. He said that all subjects at school were hard, including reading. He told the examiner that at times he has trouble understanding what people say. When the examiner asked whether that was because he could not hear them, Jonathan responded, "I can't hear and it's just hard, just hard to figure out some words means and those kind of stuff." During one of the subtests of the PTBI, he also mentioned that he did not know the meanings for a lot of words. He did not mention any difficulties in expressive language.

On the topic of memory, Jonathan made several interesting comments. Following the orientation subtest of the PTBI, the examiner asked Jonathan whether he generally had trouble remembering "stuff like that" (e.g., personal information, dates, etc) and he responded positively. He also stated, "I keep on forgetting things" and, "They took all my memory."

In the area of cognitive-behavioral issues, Jonathan provided numerous insights. He related several incidents in which he got angry or got into fights with both teachers and peers. He told the examiner that, "I fight too much." He also implied impulsivity when he said, "Like in-interrupt and I, I can't help it! I'm not trying to interrupt!" When the examiner asked Jonathan, "How's it going with friends?" he replied, "Not good." He commented that "a lot of kids make fun of me" and "they keep sayin' that I'm evil." In addition, he made some statements about his general behavior, which included, "I goof off a lot" and, "I just make dumb jokes."

On the topic of general academics, Jonathan stated, "I hate school [because]...really making me frustrating." He gestured "thumbs down" when the examiner asked how he found the subjects at school. When probed for more details he said, "It's very hard. It's just not the kind of work I need." He mentioned math, social studies, science, reading, and "grammar mostly" as areas of difficulty in school. On a more positive note, he expressed that he was good at art and many different sports.

Parent and Teacher Perceptions

Jonathan's mother expressed concern regarding his aggression and social skills, using the word "disconnected" to describe how he seemed at times. She illustrated differences in his comprehension since he had his accident, saying that he used to be able to answer a question immediately, but now it almost appears as if he does not hear her. She also indicated that he had trouble with general language tasks, as well as with short-term memory.

Jonathan's special education teacher was asked by the examiner to complete a brief survey regarding Jonathan's academic and classroom behavior; however, the

survey was not returned.

Case Studies for Control Subjects without Traumatic Brain Injury

Nathan

Nathan is a Caucasian, 15-year-old 10th grade regular education student. He presented as an outgoing, friendly, humorous young man and eagerly participated in the testing activities of this project. The following paragraphs describe his performances on the tests administered.

Results of the PTBI

Orientation. Nathan performed this subtest without difficulty. He provided the correct answer for each question in a timely manner. There was no evidence of hesitation or uncertainty regarding any of these questions.

What Goes Together. Nathan performed this subtest with little to no difficulty as evidenced by his score of 19 out of a possible 20 points. He provided complete and accurate explanations for why each pair of words went together. He did not require repetitions or prompts from the examiner to expand his answers.

Digit Span. Nathan completed this subtest without difficulty. He was able to repeat all digit spans with 100% accuracy.

Yes/No/Maybe. Nathan performed this subtest with little difficulty as evidenced by his score of 13 out of a possible 15 points. His two errors were consisted of answering "no" for "maybe" and "maybe" for "yes."

Confrontation Naming. Nathan performed this subtest without difficulty. He named all body parts and objects accurately and in a timely manner.

Story Reconstruction. Nathan performed this subtest with little to no difficulty. He recalled 20 out of the 24 information units required for full credit. In addition to recalling much of the story, he also produced a cohesive, sequential, and creative narrative, suggesting that he possesses the linguistic and metacognitive skills necessary for narrative discourse.

Reporting the News (Reading). Nathan performed this subtest without difficulty. Aside from one error in which he substituted the word "it" with "he," he read aloud smoothly and with expression.

Reporting the News (Writing). Nathan completed this subtest without difficulty. He combined all sentences to form more complex structures and produced a cohesive and creative written narrative.

Picture Recall. Nathan performed this subtest with little to no difficulty. He recalled four out of the five major elements of the picture required for full credit without cueing or prompting from the examiner and without obvious struggle to remember. This suggested that he possesses some ability in the area of incidental visual memory. In addition, his picture adequately represented a boy, demonstrating good grapho-motor and visuo-spatial skills.

Story Recall. Nathan performed this subtest with little difficulty. He recalled 20 out of the 24 required information units. As with the first story retell task, he produced a cohesive, sequential, and creative narrative, suggesting not only that he possesses the skills necessary for narrative discourse, but that he also has adequate

verbal memory abilities.

Acting a Scene

Nathan performed this subtest without difficulty as evidenced by his dramatic and complete responses to specific communication expectations. It should be noted that at the time of testing, Nathan was involved in an improvisational acting group and was very comfortable acting in front of this examiner.

Results of the RAN

Nathan completed the RAN in 28 seconds with one error.

Jordan

Jordan is a Caucasian, 16-year-old male who attends a regular education 10th grade classroom. He presented as a quiet, but friendly young man and willingly participated in the testing activities of this project. The following paragraphs describe his performances on the tests administered.

Results of the PTBI

Orientation. Jordan performed this subtest without difficulty. He provided the correct answer for each question in a timely manner. There was no evidence of hesitation or uncertainty regarding any of these questions.

What Goes Together. Jordan performed this subtest with little to no difficulty as evidenced by his score of 19 out of a possible 20 points. He provided complete and accurate explanations for why each pair of words went together. He did not

require repetitions or prompts from the examiner to expand his answers.

Digit Span. Jordan completed this subtest without difficulty. He was able to repeat all digit spans with 100% accuracy.

Yes/No/Maybe. Jordan performed this subtest without little to no difficulty as evidenced by his score of 14 out of 15 points. His error was answering "maybe" for "no" on one question.

Confrontation Naming. Jordan performed this subtest without difficulty. He named all body parts and objects accurately and in a timely manner.

Story Reconstruction. Jordan performed this subtest with little to no difficulty. He recalled 21 out of the 24 information units required for full credit. In addition to recalling most details of the story, he also produced a cohesive and sequential narrative, suggesting that he possesses the linguistic and metacognitive skills necessary for narrative discourse.

Reporting the News (Reading). Jordan completed this subtest without difficulty. He made no errors and read aloud in a timely and smooth manner.

Reporting the News (Writing). Jordan completed this subtest with little difficulty. He combined the majority of the sentence kernels into a cohesive and sequential written narrative. There were several sentences, however, which he left as they appeared in the stimulus manual.

Picture Recall. Jordan performed this subtest with no difficulty. He recalled all of the major elements of the picture required for full credit without cueing or prompting from the examiner and without obvious struggle to remember. This

suggested that he possesses ability in the area of incidental visual memory. In addition, his picture adequately represented a boy, demonstrating good grapho-motor and visuo-spatial skills.

Story Recall. Jordan performed this subtest with little to no difficulty. He recalled 20 out of the 24 required information units. As with the first story retell task, he produced a cohesive and sequential narrative, suggesting not only that he possesses the skills necessary for narrative discourse, but that he also has adequate verbal memory abilities.

Acting out a Scene

Jordan performed this subtest without difficulty as evidenced by his score of 65 out of 66 possible points. He clearly understood the concepts, and provided complete and appropriate responses for each situation. It should be noted that he appeared shy and expressed hesitancy about acting some of the scenes.

Results of the RAN

Jordan completed the RAN in 24 seconds with no errors.

Bradley

Bradley is a Caucasian, 11-year-old fifth grade student in the regular education curriculum. He is receiving school-based speech services two times per week for remediation of the /r/. He presented as a fun-loving and easy going boy who willingly participated in the testing activities of this project. The following paragraphs describe his performances on the tests administered.

Results of the PTBI

Orientation. Bradley performed this subtest without difficulty. He provided the correct answer for each question in a timely manner. There was no evidence of hesitation or uncertainty regarding any of these questions.

What Goes Together. Bradley performed this subtest with little to no difficulty as evidenced by his score of 19 out of a possible 20 points. He provided complete and accurate explanations for why each pair of words went together. He required prompts to expand his answers on several occasions, but overall he independently produced adequate reasons for each pair.

Digit Span. Bradley completed this task with little difficulty. For digit spans of two, three, four, and five he was 100% accurate. For the digit spans of six and seven, he repeated the numbers accurately two out of four times.

Yes/No/Maybe. Bradley performed this subtest with little to no difficulty as evidenced by his score of 13 out of a possible 15 points. His errors consisted of answering "no" for "maybe" on two questions in different stories.

Confrontation Naming. Bradley performed this subtest without difficulty. He named all body parts and objects accurately and in a timely manner.

Story Reconstruction. Bradley performed this subtest with little to no difficulty. He recalled 20 out of the 24 information units required for full credit. In addition to recalling much of the story, he also produced a cohesive and sequential narrative, suggesting that he possesses the linguistic and metacognitive skills necessary for narrative discourse.

Reporting the News (Reading). Bradley completed this subtest without difficulty. He made no errors and read aloud in a timely and smooth manner.

Reporting the News (Writing). Bradley performed this subtest with some difficulty. He combined some sentences into more complex structures and produced a written narrative that showed evidence of some higher level linguistic organizational skills. Although he did combine some sentences, he also left many of the kernel sentences as they were presented in the stimulus book.

Picture Recall. Bradley performed this subtest with little difficulty. He recalled four out of the five major elements of the picture required for full credit without cueing or prompting from the examiner and without obvious struggle to remember. This suggested that he possesses ability in the area of incidental visual memory. In addition, his picture adequately represented a boy, demonstrating good grapho-motor and visuo-spatial skills.

Story Recall. Bradley performed this subtest with little to no difficulty. He recalled 21 out of the 24 required information units. As with the first story retell task, he produced a cohesive and sequential narrative, suggesting not only that he possesses the skills necessary for narrative discourse, but that he also has adequate verbal memory abilities.

Acting a Scene

With a raw score of 62 out of 66 points, Bradley performed this test without difficulty as evidenced by his creative and complete response to most of the situations. He used appropriate linguistic and paralinguistic feature to clearly communicate intent in all but one of the scenes.

Results of the RAN

Bradley completed the RAN in 42 seconds with one error which he immediately self-corrected.

Ability of the PTBI to Identify Cognitive-Linguistic Symptoms of TBI

Comparison of Subjects with TBI and Control Subjects

Overall, the control subjects performed better on most subtests of the PTBI when compared with the performances of the subjects with TBI. There were a number of areas in which scores did not differ, however. The areas of greatest discrepancy between the groups were the subtests involving verbal and written discourse skills, as well as digit span memory. The tasks with the least differences across performances were those tapping into visual memory, vocabulary skills, and reading. Interestingly, discourse skills were also major areas of discrepancy in the literature looking at the performances of children with and without TBI, whereas vocabulary skills were often found not to differ significantly between the populations. The following paragraphs compare the performances of the two groups on each subtest.

Orientation. All participants performed this subtest without difficulty with the exception of Jonathan who had difficulty answering questions about personal information such as birth date and city of residence. It is important to note that his language skills have been compromised by his significant hearing loss. One would expect this subtest to be more difficult shortly following the injury as post traumatic amnesia (PTA) may be a factor at that point. This subtest's main purpose is to rule

out PTA in the early stages of recovery.

What Goes Together. Nathan, Jordan, and Bradley (control subjects) had little difficulty completing this task. They did not have trouble making correct word pairs with the exception of one error each. In addition, they all provided complete and accurate explanations for why each pair of words went together. Graham also completed this task with little difficulty, performing similarly to the subjects without TBI, although he answered impulsively at times and required several cues to "look again" before providing complete word-pair descriptions. Scott had some difficulty performing this subtest, with the majority of his errors occurring in the double meaning section. He had trouble both matching words and producing complete and descriptive explanations. Jonathan had great difficulty completing this task as evidenced by his score of nine out of twenty points. Since vocabulary is an area usually not significantly compromised by brain injury, Graham and Scott's performances are not surprising. Jonathan's performance likely reflects language abilities compromised not only by brain injury, but also by limited exposure to language because of his congenital deafness.

Digit Span. The participants without TBI completed this subtest with little to no difficulty, falling within normal limits for age expectations. Scott completed this task with little difficulty. He was able to repeat both six digit spans and one each of the five and seven digit spans. Graham experienced some difficulty with this task and Jonathan had great difficulty repeating the numbers, making comments through out the task such as, "I can't!" and "I'm so confused!" Interestingly, Jonathan had the opportunity to view and read aloud one seven-digit span, following which he was able to repeat all but the last number in the string.

Yes/No/Maybe. There was a slight difference in the performances of the two groups on this subtest. All control subjects completed the task with little difficulty and Jonathan only had one additional error when compared to the average of the control subjects. Graham and Scott had some difficulty with the task as evidenced by their respective scores of 10 out of 15 and 11 out of 15. Graham, however, often answered very quickly and was able to correct his errors when he took time to think through the answer.

Confrontation Naming. All of the participants performed this subtest with no difficulty except Jonathan who provided several incorrect answers before coming up with the word "neck." Overall, no significant differences were observed in speed or accuracy of naming.

Story Reconstruction. This subtest revealed major differences between the two groups. The participants without brain injury performed this task without difficulty both in regards to memory and discourse. They each remembered most of the relevant details from the story and constructed linguistically mature narratives. On the other hand, Graham, Scott, and Jonathan had great difficulty with this task. They only remembered several details from the story and did not construct complete narratives.

The following samples are characteristic of the differences between the performances of the participants with TBI and those without.

Story Stimulus – "Tommy the Trickster"

Tommy's mother thought he was eating too much junk food. She stocked the refrigerator with lots of fruit and carrot sticks so he wouldn't snack on candy and

cookies. She even put these things in his lunch box. But Tommy was a fast talker. At school he convinced his friends that sweets were bad for them. Then he traded his fruit and raw carrots for their cookies and brownies. His mother never figured out why Tommy kept gaining weight when all he had for lunch and snacks were healthy foods.

Sample Story Reconstruction – Participant without TBI (Bradley)

One day, um, there's this boy named Tommy and he liked junk food. And um, his mother thought he was eating too much junk food so she stocked up the refrigerator with vegetables, fruit, and carrots so that he wouldn't, so that he can't eat any more junk food. And she even put it in his lunch box. But when he went to school, he started telling kids that junk food was bad for them. But he started trading his carrot sticks and food for other kids' cookies and brownies. And his mother never knew why he kept on gaining weight, even if he was only eating fruit and carrot sticks.

Sample Story Reconstruction – Participant with TBI (Jonathan)

So, you're saying that Tommy, his mother was supposed to give him carrots and she, she didn't want him to eat junk food. And so Tommy traded. So, that's what it's all about.

Reporting the News (Reading). All the participants performed this subtest without difficulty, with the exception of Jonathan who had some trouble with this task. He made twelve errors while reading aloud, including problems sounding out two words. Many of his errors were consistent with his spontaneous language use. Despite his problems with reading all words correctly, Jonathan read the sentences

without unusual pauses or hesitations.

Reporting the News (Writing). This was also an area of significant discrepancy in performances between the two groups. The participants with brain injury had difficulty combining the kernel sentences into more complex structures, where as the control subjects demonstrated more skill in this area. It should be noted that the 11-year-old control subject did not perform as well as the 16-year-old control subjects, which was to be expected considering the continued normal development that occurs between the ages of 12 and 16. Interestingly, this control subject performed similarly to Graham, the16-year-old participant who sustained his TBI at age 12. In addition, Graham completed this task with less difficulty than the Scott and Jonathan who sustained their brain injuries at much earlier developmental stages at ages eight and six.

The following samples provide an example of the differences between the narrative of a participant with TBI and the narrative of one without.

Kernel Sentences Provided as Stimulus for Task

Story Title: When our School Closed

Our school was closed.
It was last Wednesday.
The janitor came at 6:00am.
He opened the school.
He smelled something.
It was strong.
It almost knocked him over.
He searched.
He found skunks.
There were two.
He called the fire department.
The firemen came.
They took the skunks.
They took them to the woods.

Written Narrative Sample – Participant without TBI (Nathan)

The school was closed last Wednesday when the janitor of the school opened it at 6:00am and noticed a weird smell. Firemen rushed to the scene after the janitor searched and found two skunks. The fireman took the skunks back to the woods to prevent any further closings.

Written Narrative Sample – Participant with TBI (Graham)

Our school was closed last Wednesday. The janitor came at 6:00am. He opened the school. He smelled something strong that almost knocked him over. He searched. He found two skunks. He called the fire department and they came. They took the skunks to the woods.

Picture Recall. There were no significant differences between the performances of the two groups on this task. One member of each group forgot to include one item on the picture. Aside from these two omissions, all participants recalled the relevant details and demonstrated good graphomotor and visuospatial skills.

Story Recall. Performances on this subtest revealed major differences between the two groups as in the previous narrative discourse task, "Story Reconstruction." There were no changes from previous story reconstruction in terms of both memory and narrative construction.

Acting a Scene. The most significant difference in performances could be seen between the three control subjects and two of the participants with TBI, Scott and Jonathan. Overall, the control subjects effectively used their pragmatic discourse

skills to analyze contextual communication experiences and generate the most appropriate response for each situation. Scott and Jonathan appeared to have a difficult time analyzing each situation and coming up with responses that clearly communicated intent. Graham's performance on this subtest fell between the two extremes seen in the other two groups in that he did not score as high as the control subjects, but did not have as much difficulty as the other two participants with TBI.

Variability in Performance on Subtests within the PTBI

Figures 1 and 2 illustrate the variations within the PTBI for each participant and show that there was greater variability among subtests for each participant with TBI when compared to those without TBI. Figures 3 and 4 show greater variability among the participants with TBI when compared with each other. Graham and Scott's performances on the different subtests spanned all levels of difficulty from no difficulty to great difficulty. Jonathan's scores fell within three levels of difficulty from little difficulty to great difficulty. The performances followed similar patterns, in that all three students with TBI did poorest on the story retell and writing tasks and best with confrontation naming, picture recall, and reading. Mediocre performances were noted for all three on the subtest "Yes/No/Maybe." The participants without TBI also demonstrated variability within their performances on the PTBI; however, the variability was not as great. Nathan and Jordan's scores ranged from little difficulty to no difficulty, and Bradley's scores spanned three levels from no difficulty to some difficulty, although only one of his subtest scores fell in the "some difficulty" category.

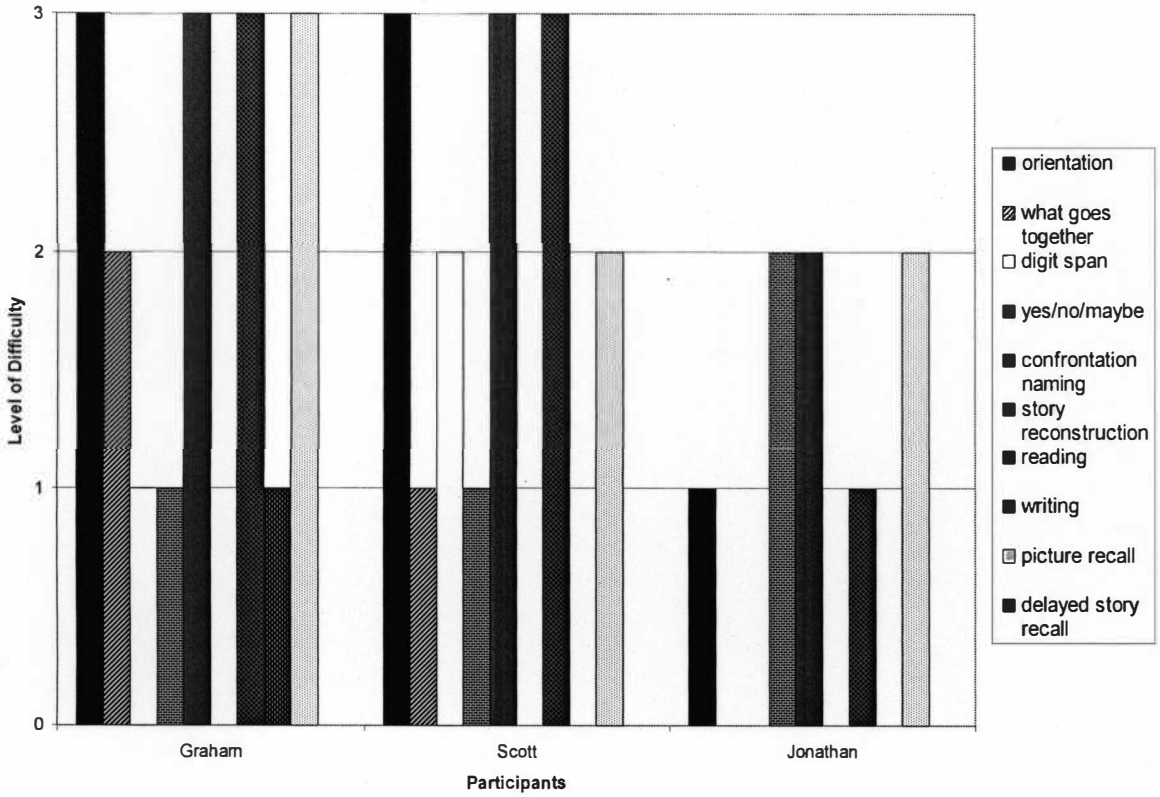


Figure 1 Variability among PTBI subtests for each participant with TBI

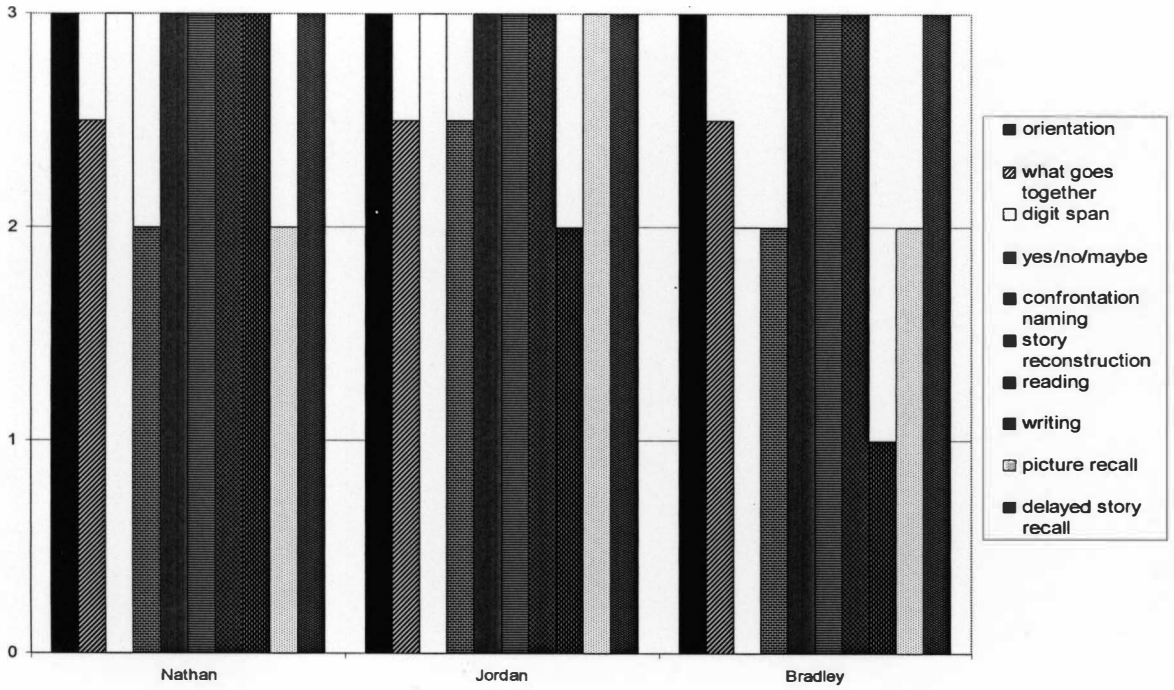


Figure 2 Variability among PTBI subtests for each participant without TBI

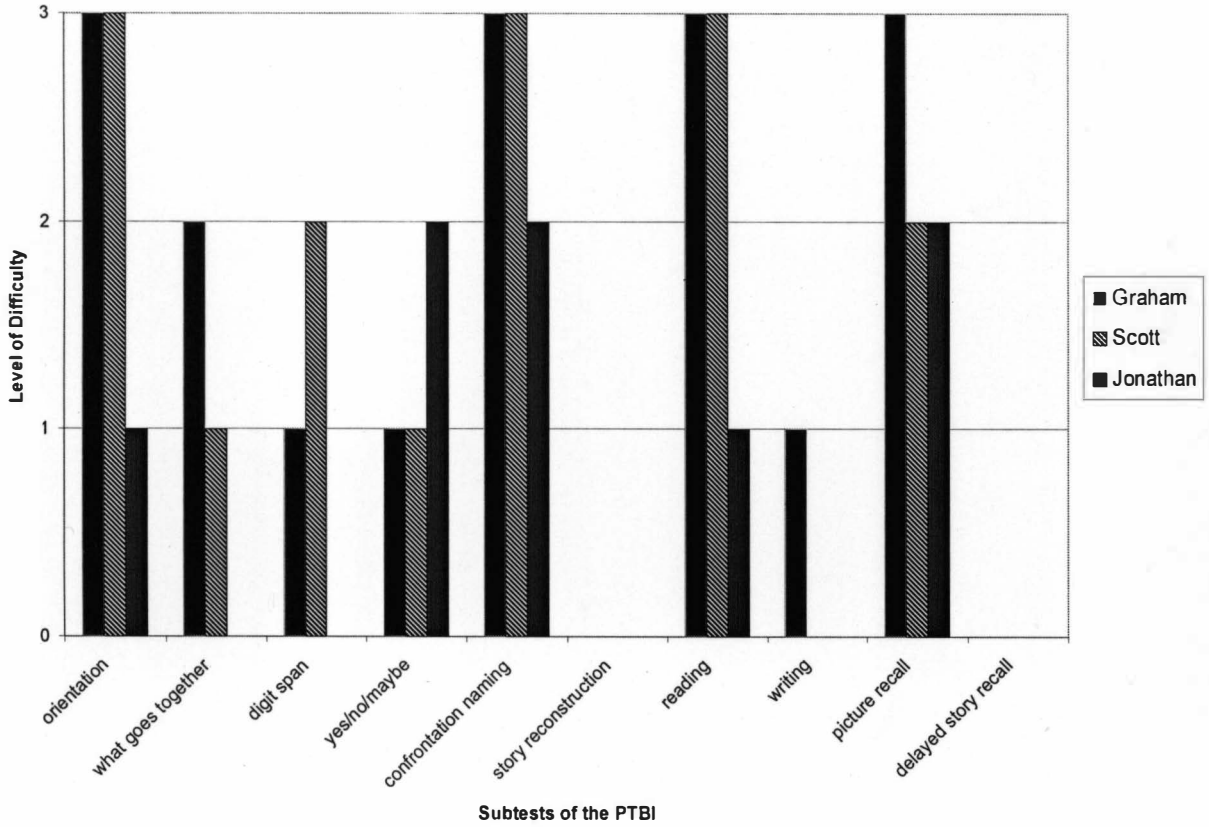


Figure 3 Variability among participants with TBI

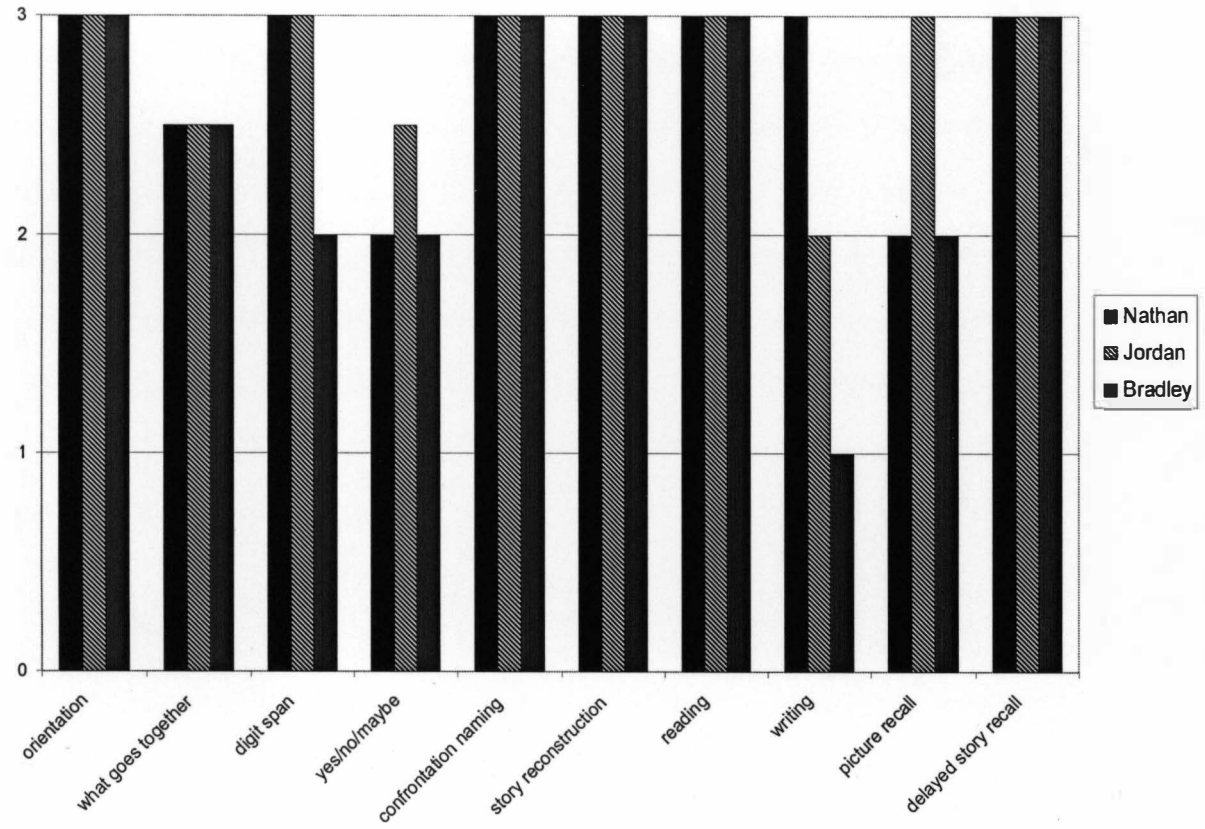


Figure 4 Variability among participants without TBI

Comparison of PTBI Results with Functional Educational Status

In general, the PTBI tapped into cognitive-linguistic deficits of the participants, whereas teacher input tended to point out cognitive-behavioral deficits. The impairments in connected spoken and written discourse that were identified by the PTBI were not mentioned by their teachers. On the other hand, the teachers stressed anger management and appropriate social interaction as major areas of need, whereas the PTBI did not pick up on the anger management portion of this. The PTBI did, however, identify pragmatic issues in the students with TBI as evidenced by their performances on "Acting a Scene."

The teachers pointed out specific classroom behavior that was not identified by the PTBI. For example, Graham's teacher expressed concern about Graham's awareness of social norms (e.g., how closely he stood to peers), whereas the PTBI did not directly address this issue. The "Acting a Scene" test did address social-emotional aspects of language, but did not pick up on specific peer interaction problems that Graham's teacher reported. The teachers commented on inconsistent abilities in following directions, which is consistent with what the performances on tasks involving auditory language processing (Story Reconstruction, and to a lesser degree, Yes/No/Maybe) suggested.

Comparison of PTBI Results with Informal Measures

The participants pointed out cognitive-behavioral issues as primary problems, as well as addressing abilities in the academic arena. The PTBI also tapped into cognitive-linguistic deficits of the participants that affect academics, but explored these areas in more detail. For example, the difficulties the participants with TBI experienced with spoken and written narrative production were not specified by the students themselves. Some strengths and weaknesses in general academics and behavior reported by the participants were not altogether consistent with the results of the PTBI. For example, Scott did not report any problems with writing skills, yet his performance on the PTBI suggested written discourse as an area of great difficulty. As with the teachers, the students stressed anger management as a major area of need, whereas the PTBI did not pick up on this area; however, the participants' perceptions of trouble with peer relationships was reflected in their poor performances on "Acting a Scene."

The scope of information provided by the multiple sources used in this study

stresses the importance of numerous informants, both formal testing and informal measures such as interviews, in conducting thorough and accurate assessments with the pediatric TBI population.

CHAPTER V

DISCUSSION

Disconnections and Gaps

The needs of the pediatric TBI population are complex. Such needs challenge the skills of many professionals, including those involved with the assessment and intervention of cognitive-linguistic deficits. As mentioned previously, a lack of appropriate tools makes it difficult to provide relevant information regarding the cognitive-linguistic strengths and needs of this population (Hotz, Helm-Estabrooks, Nelson, 2001; Sohlberg & Mateer, 1989; Turkstra, 1999; Ylvisaker, 1998). Without accurate assessments, appropriate and effective rehabilitation efforts and other interventions are hindered.

The nature of pediatric TBI leads to disconnections within and among developing cognitive-linguistic and social-emotional processes within the child or adolescent who has sustained injury. Similarly, many gaps are apparent within the medical-educational systems that seek to provide assessment and rehabilitative services. Although better assessment tools and methods will not solve all of the problems, they can contribute better information for addressing the issues.

The immediate objectives of this project were to assess several aspects of the validity of a new assessment tool, the Pediatric Test of Brain Injury (Hotz, Helm-Estabrooks, & Nelson, 2001), which was designed to fill some of the current gaps in the assessment process for children and adolescents with traumatic brain injury. The broader goals were to offer some insights into the nature of this population, provide

ideas for closing several of the gaps in assessment, and present some thoughts on best practices with the pediatric TBI population. In this chapter, I first discuss the findings of the research related to each of the experimental questions, prefaced with a brief discussion of what the investigation revealed about the nature of pediatric head injury. Then, I discuss the implications of these findings for addressing the broader issues facing the rehabilitation and education communities. I also summarize the conclusions, describe limitations of the study, and offer suggestions for further research.

Disconnections in Understanding the Population

Children and adolescents with TBI share many traits such as the cognitive, linguistic, and behavioral deficits discussed in Chapter Two. Each child with TBI also is unique, however, and each has abilities and needs that reflect this individuality. Many factors contribute to a particular child's or adolescent's profile, such as age at onset of injury; location of lesions; extent of damage; previous learning abilities; family, social, and education support; and the individual's own personality and view of the world. The findings of this study are consistent with that picture, in that each participant brought his own background and qualities with him to this study.

Graham brought with him a background of special education, as well as significant socio-emotional issues stemming from his family and social history prior to a vehicular accident four years ago that changed his life, and in which his mother and siblings died. Scott reported a history of good academic and interpersonal skills prior to the vehicular accident in which he was involved eight years ago, but he has experienced changed status after his injury and now is identified with special education needs. Jonathan brought the unique experiences of a deaf child with a

cochlear implant and an educational history that included an aural-deaf program and speech-language services before his head injury in a bicycle accident five years ago. Since the head injury, Jonathan's problems have been compounded, but it is difficult to sort out the effects of the multiple influences on his linguistic and cognitive development. In addition, each participant had a different age at onset of injury. Graham was oldest when he sustained his injury at age 12, where as Scott and Jonathan who were injured at age 8 and 5 respectively, were at much earlier stages of development than Graham. Interestingly, Graham's performances on the discourse and pragmatic tasks were better than those of Scott and Jonathan, suggesting that Graham, who was not injured until age 12, had more time to develop aspects of these skills than did Scott and Jonathan. All of these factors contributed to the participants' profiles, and all are important to consider in interpreting the specific results of assessment.

One factor that became apparent from the interviews of participants is that head injury can leave individuals struggling to know how to fit into their peer groups, as well as struggling to manage the complex demands of schooling. That is a factor that emerged more clearly from the interviews than from the formal testing. Formal testing did add some important information as well, however. In particular, the PTBI revealed discourse problems that were consistent with the literature and with some of the individual participants' comments regarding difficulties holding in mind multiple pieces of information, integrating them, and keeping them constructed in cohesive sets of ideas. Although these discourse-level problems differ from the classic sentence-level and word-level symptoms of specific language impairment (SLI), which tend to involve basic vocabulary and morpho-syntactic elements that are measured by traditional language tests, they do signal some of the disconnections that

keep children and adolescents from fitting into their social and academic milieus.

With regard to the social-behavioral issues raised by parents, students, and teachers, the anger and frustration the students with TBI experienced could have some direct links to the brain changes subsequent to the injury, as is often assumed. The rehabilitation and special education teams may miss, however, the less easily identified problems in connecting ideas through external discourse,. Without an understanding of discourse management problems, interventions may focus on behavior as separate from communication. The treatment implications of this missing puzzle piece are that an important element may be missing from intervention. If discourse problems are identified, interventions then may be designed to help students connect ideas, actions, and motivations with goal-directed behavior through the discourse of narratives and of social-interactions. That, in turn, may set the stage for helping them to develop new inner discourse and other strategies to reconstruct the language of academic discourse. Even more importantly, it may help them learn better ways to deal with the anger and frustration issues that are interfering noticeably with their everyday functioning.

Gaps In Assessment Practices

The review of literature in Chapter Two revealed major gaps in current assessment practices. Speech-language pathologists may not be involved in assessing the needs of students with TBI, whose speech might "sound okay" upon their return to school, but whose discourse and social-pragmatic issues make it difficult for them to "function okay." Only one of the experimental students in this study was receiving speech-language services (i.e., Jonathan), and even then, it was only for 20 minutes three to five times a week. Without appropriate assessment tools it is unlikely that this

situation will change so that a more appropriate interdisciplinary team approach can be provided.

This study was partially aimed at closing the assessment gap between the performances of children and adolescents with TBI on traditional language assessment tools and their real-life functioning. Formal tests often overestimate the abilities of students with TBI, masking problems they may have in their natural environments (Turkstra, 1999; Ylvisaker, 1998). The authors of the PTBI (Hotz, Helm-Estabrooks, & Nelson, 2002) attempted to include subtests sensitive to the deficits experienced by the pediatric TBI population in order to identify impairments that affect academic functioning. The discourse tasks, in particular, seemed to be successful in this regard. The authors of PTBI based most of its subtests on the companion general language assessment instrument, The Test of Integrated Curriculum-Related Language Skills (TICLS; Nelson, Helm-Estabrooks, & Hotz, 2002), but the research edition of the PTBI did not include the "Acting a Scene" subtest from TICLS. My results suggest that adding it to the PTBI may assist in identifying pragmatic communication deficits that contribute to the social difficulties the students and their teachers reported. On the other hand, the RAN task (Catts, 1993) seemed to add nothing to the assessment picture for these students who were several years post injury.

As noted, the PTBI does show promise for closing the major gap pointed out in the literature between the cognitive-linguistic abilities assessed by traditional language assessment tools and the discourse-level cognitive-linguistic deficits actually experienced by children and adolescents with TBI. As discussed in Chapter Two, studies by Chapman et al. (1997 & 2001) and Yorkston et al. (1999) point to impairments in spoken and written discourse as significant and persistent in their

subjects with TBI, yet these are also areas that most traditional assessment tools overlook. The results of the "Story Reconstruction" and "Writing the News" subtests of the PTBI both show promise for identifying this area of difficulty, which was previously overlooked in traditional language tests.

Conclusions Regarding Answers to Experimental Questions

Content and Predictive Validity of the PTBI

Content validity refers to the ability of a test to "measure what it purports to measure" (Nelson, 1998, p. 199). One of my experimental questions addressed content validity in that it asked whether the PTBI actually taps into the cognitive-linguistic problem areas identified by others as significant for the pediatric TBI population. The results of this study provide evidence that the PTBI can identify some of these deficits reported as primary in the literature (e.g., Turkstra, 1999), but which have been overlooked by traditional language assessment tools.

Most notable were the major discrepancies found between the participants with TBI and the control subjects in tasks involving connected spoken and written discourse. On the other hand, vocabulary abilities and deficits were found where they were expected. That is, the control subjects and the older two participants with TBI did not demonstrate significant differences in performance on the tasks measuring vocabulary skills; whereas Jonathan's performance on the same task revealed impaired vocabulary knowledge, which was likely connected primarily to his hearing loss. This was consistent with the literature reviewed in Chapter Two in that vocabulary skills were reported to be relatively spared by TBI (Chapman et al., 1998; Yorkston et al, 1999), which is what Graham and Scott's performances indicated. On the other hand, Jonathan's vocabulary deficits were interpreted in light of language

skills compromised not only by TBI, but also by his hearing impairment. The importance of the identification of these integrated skills is that it suggests that the PTBI does, in fact, tap into areas of deficit (especially connected discourse) identified by others as lacking on formal language assessment tools.

Predictive validity addresses the ability of a test to identify differences between subgroups and to predict problems that appear in real-life (Nelson, 1998). Predictive validity was the focus of my experimental question that asked what differences the PTBI reveals for students with moderate to severe TBI compared to a control group matched for age and gender, but without injury,. The findings of this study suggest that the PTBI does hold promise for differentiating those with TBI from those without, but not all subtests were equally discriminative.

On most of the subtests, the participants with TBI performed worse than the control subjects; however, there were a number of areas in which scores did not differ. The areas of greatest discrepancy between the two groups were the subtests involving verbal and written discourse skills, as well as digit span memory. The tasks with the least differences across performances were those tapping into visual memory, vocabulary skills, and reading. According to the literature reviewed in this study, discourse skills were consistently found in prior research to be major areas of deficit for students with TBI; whereas vocabulary skills were often found not to differ significantly between the populations.

The Rapid Automatized Naming task (RAN; Catts, 1993) also was administered as a possible addition to the PTBI, but it turned out not to show significant differences between the two groups. The RAN has been used as a tool to identify high risk for reading difficulty (Catts, 1993; Catts et al., 2001), and the current findings of no reading decoding problems are consistent with no difficulty on

the RAN. My intention was to investigate whether the RAN task could assist in identifying word retrieval difficulties associated with brain injury, but it did not do so, which was inconsistent with reports by one of the experimental students, who complained of having major difficulties with word retrieval in his everyday life. Unfortunately, the body part naming task also was not sensitive to this area of functional difficulty for these experimental students. Either of these two naming tasks may work better to identify word finding difficulties for children and adolescents in the earlier days of recovery than they do multiple years after the injury. Meanwhile, other tools need to be identified or developed to provide formal test evidence of such problems. For the time being, student-report may be the most reliable method.

One additional finding that may have important implications for predicting real-life problems in the social arena is the potential of the "Acting a Scene" subtest. The participants with TBI all performed poorly on this task; whereas the control subjects had very few difficulties with it. Since "Acting a Scene" was able to pick up on students' difficulty expressing communicative intent, it may be related to pragmatic issues that bear some relationship (although currently an unclear relationship) to the anger management and social interaction issues brought up by both students and their parents. To have a formal test that can identify pragmatic issues, supplemented by teacher and parent reports about specific problem areas, may support speech-language pathologists and other members of the special education/rehabilitation team to know that this is an area of assessment and intervention in which communication skills may be playing a role.

Relationships of Formal and Informal Measures

Criterion-referenced validity is the ability for a test to show "that the test

scores are related to some measure of outcome, such as predicting school performance" (Nelson, 1998, p. 199). My third experimental question addressed the criterion-referenced validity of the PTBI by comparing its results with the responses of teachers on the educational status survey. In answering the question whether the PTBI results were consistent with information regarding functional status in education gathered from teachers, I found that in some instances they were.

The teacher survey and the PTBI reflected similar findings in the area of comprehension. The teachers commented on problems with direction following, and the "Yes/No/Maybe" subtest measured some difficulties in language comprehension. This task uses auditory stimuli augmented by print, in that the examiner reads the one to three sentence vignette as the examinee reads along, then asks the comprehension questions. The availability of the print stimuli reduces demands on short-term memory, which may be a factor in the direction-following problems at school. Although the problems experienced by the students with TBI were not severe, the test was more difficult for them, suggesting that it may assist in identifying language processing problems that likely play a role in the students' abilities to follow oral directions at school. Perhaps a specific measure of listening comprehension (without print support such as the "Yes/No/Maybe" subtest provides) might better reflect teachers' concerns about remembering and following directions. These results do suggest that students may experience some syntax decoding and inferential problems, along with the acknowledged problems in working memory that should be assessed and treated as well. The fact that two of the participants with TBI had special education needs before their head injuries, however, makes it difficult to sort out potential sources of difficulty.

Main concepts that came through in the teacher surveys, but not on the PTBI

involved peer relationships, social appropriateness, and anger issues. The teachers hinted at academic issues (such as the one mentioned above), but the questions on the survey were not specific enough to obtain information about the cognitive-linguistic tasks looked at by the PTBI and how abilities in these areas affected the participants' academic success. A follow-up interview with the teachers to explore "red flag" areas would likely provide more helpful information to complete a thorough assessment.

It is important to note, however, that not enough information was available from this study to truly know whether there are connections between the discourse impairments identified by the PTBI and some of the issues that the teachers identified as major concerns. In addition, the teachers who responded to the surveys were special education teachers primarily concerned with emotional control issues. Their perspectives may have been different from mine, which were focused more academic and social issues affected by cognitive-linguistic impairments. An important question arises out of these findings. What would it take for these students to be placed successfully into the general education curriculum and general education classrooms? A system to facilitate these students and their peers in interacting with each other in small collaborative learning groups might provide the necessary support for both the academic and social concerns raised by the different sources in this study.

My final experimental question asked whether the PTBI would reveal any information not gathered through the informal measures (i.e., participant interview and teacher survey) and whether there is information that must be obtained in other ways (i.e., participant interview and teacher survey). Overall, the results of the PTBI for the participants with TBI were consistent with the input received from the participant interviews and teacher surveys; however, because these formal and informal measures did not provide identical information, my conclusion is that both

types of measures are needed. In general, the participants, parents, and teachers emphasized cognitive-behavioral issues, where as the PTBI tapped into cognitive-linguistic abilities, as it was designed to do, but either source of information without the other would be incomplete.

Although there was general consistency, there appeared to be several gaps between what the PTBI revealed and what the participants and teachers reported. The results of the participant interviews pointed to difficulties with anger management, peer relationships, and some academic difficulties. The main themes of Graham and Scott's discussions were emotional control and social relationships, where-as Jonathan's self-perceptions revealed problems in academics, as well as emotional control and social relationships. At times, the strengths reported by the participants themselves, especially in Scott's case, were not consistent with the results of the PTBI. For example, Scott did not report any academic difficulties and, in fact, stated that he found schoolwork to be "too easy." On the other hand, results of the PTBI revealed considerable problems in connected spoken and written discourse, which are major elements of school success.

Whereas Graham, Scott, and Jonathan all discussed problems controlling their anger and getting along with peers, the PTBI did not reveal problems with cognitive-behavioral areas. Even though "Acting a Scene," which purports to measure pragmatic skills, did reveal differences between the two groups, it did not address all aspects of the social interaction and anger issues that the participants, teachers, and parents talked about. This gap particularly can be seen in Graham's case. His teacher expressed concern about Graham's lack of awareness of social norms, yet Graham's performance on "Acting a Scene" did not reveal the specific interaction difficulties his teacher reported.

It is important to ask then, whether the PTBI can reveal problems with cognitive-linguistic issues that might be hidden contributors to the cognitive-behavioral problems that tend to be more obvious and, therefore, receive the majority of the intervention focus. The "Acting a Scene" subtest highlighted pragmatic difficulties in all the participants with TBI, providing a possible link with the cognitive-behavioral issues reported by participants, parents, and teachers. Perhaps treatment of the discourse and pragmatic impairments identified by the PTBI and in the current literature might help address the cognitive-behavioral concerns.

In addition to providing information about peer relationships and executive functioning regarding anger management that were not directly revealed by the PTBI, the participant interviews also contributed to constructing a whole picture of the individual rather than bits and pieces. As Spradley (1979) indicated, an important value of ethnographic interviewing is its ability to uncover basic patterns and unique frames of references. The perspectives of parents, teachers, and the students themselves, in their own words, play an important role in interpreting assessment results in the appropriate context. At the same time, assessment procedures cannot simply rely on self-perceptions because students' self perceptions, in particular, may be affected by denial or unawareness of deficits (Body & Parker, 1999; Hillier & Metzer, 1997). Furthermore, as this study suggests, participant reports may not address all of the specific cognitive-linguistic skills that are vital for academic and social success. In this study, the PTBI provided some information the informal sources did not, and vice versa. Because cognitive-linguistic and behavioral areas are vital for academic success and social acceptance, the gaps seen between these areas highlight the importance of a multifaceted approach to assessment.

The manner in which the participants interacted with me provided valuable

information about who they are as individuals and their skills for relating to adults. The interviews gave them an opportunity to reveal aspects of their personalities that would have otherwise gone unnoticed. Although "Acting a Scene" did uncover aspects of pragmatic abilities, interacting with me provided a venue for the participants to demonstrate features such as eye contact, body language, tone of voice, and other mannerisms in an authentic, rather than contrived, conversational setting. Aspects of personality were not as apparent with my contact with the control subjects who participated only in testing, not an interview. I did not feel that I was able to "get to know" the control subjects as I did the participants with TBI. This highlights the importance of an interview component to creating a complete profile.

Parent comments added information and concerns regarding cognitive-behavioral issues that were consistent with the participants' perceptions. Although the parent's comments did not supply altogether new information, they were important contributors to creating the "whole picture." Overall, the parents did not point out specific difficulties at school, but provided a general overview of how their children were doing. The parent input becomes extremely important in setting goals and providing the support of follow through with intervention plans.

Summary of Conclusions

The gaps discussed above suggest areas for improvement in assessment procedures with the pediatric TBI population. In regard to the gap between the performances of children and adolescents with TBI on traditional language assessment tools and their real-life functioning, the PTBI included subtests sensitive to the deficits experienced by the pediatric TBI population in order to identify impairments that may affect academic and social functioning.

The discrepancy between the cognitive-linguistic abilities assessed by traditional language assessment tools and the cognitive-linguistic deficits actually experienced by children and adolescents with TBI is addressed to some degree by the PTBI. In particular, the PTBI subtests that assessed connected spoken and written discourse seemed best suited to tapping into the deficit areas identified in the current literature as primary for the pediatric TBI population. The results of this study show that the "Story Reconstruction" and "Reporting the News (Writing)" subtests identified the cognitive-linguistic deficits specific to children and adolescents with TBI as reported in the literature.

The PTBI results were consistent with the information provided by the teachers on the educational surveys. Both measures suggested difficulties with auditory language processing, pointed out by the teachers as trouble following directions. The PTBI and the survey also highlighted social pragmatic issues as problematic for the students with TBI. The teachers, however, provided specific information regarding anger management and social norms that the PTBI did not directly address. The participant interviews and survey provided important supplemental information to the PTBI, which tapped into significant discourse impairments, but did not specify social and emotional behaviors discussed by the participants, parents, and teachers.

Implications

Considering the gaps between the information gathered from the PTBI, participant and parent interviews, and educational survey, it becomes evident that multiple sources of information are needed to complete a thorough and accurate assessment. In this study, formal testing via the PTBI was necessary to provide data

regarding the participants' skills in cognitive-linguistic areas important for academic and social success. Important information about cognitive-behavioral issues, such as anger management and social competence, was provided by the participants, parents, and teachers through the interviews and survey. Additionally, the teacher surveys pointed to general academic strengths and needs, which provided direction for further exploration of specific educational matters. Since children spend much of their time in school and often are in school when academic difficulties resulting from TBI become evident, as suggested by the theory regarding "growing into a deficit" (Mateer, Kerns, & Eso, 1996; Szekeres & Meserve, 1994), teacher involvement, input, and support are vital to their success.

Collaboration of various disciplines, family, and other significant people in the lives of those with TBI, is another component necessary for obtaining accurate and thorough assessment data. In this study, special education was involved; however, input on the part of speech-language pathologists, psychologists, social workers, and neurologists, as well as further input from special and general education teachers, would have added valuable information that was missing from this study. Collaboration involves much more than gathering "input" opinions and suggestions, however. As Ylvisaker and Gioia (1998) stressed, collaboration involves brainstorming and problem solving together as a team. This can only occur when professionals from several disciplines work together as a team.

Ylvisaker and Gioia (1998) outlined five main reasons for conducting collaborative assessment with the pediatric TBI population. The first and most obvious reason they presented is that collaboration "increases the number of people available to interact with and observe the child in varied contexts, to brainstorm about hypotheses, and to apply the results of the experiments to planning and implementing

intervention" (p. 164). Secondly, they stated that collaborative assessment can facilitate "collegiality and cohesion" within the rehabilitation team. The third reason centered on the family's involvement and the importance of that involvement for follow-through of intervention plans. Education for staff regarding TBI is presented as the fourth reason for conducting collaborative assessment. Finally, Ylvisaker and Gioia stated that collaboration is a "powerful statement of respect" (p. 164).

Thoughts on Best Practices with the Pediatric TBI Population

Based on the results of this study, my experiences with the participants in this study and their families, and the current literature, the following thoughts on best practice have evolved:

- Include the child or adolescent in the assessment process.
- Include parents and families in the assessment process.
- Include teachers, both special and regular education, in the assessment process. They are the ones who work with these children everyday.
- Collaborate with everyone involved to create an assessment team in early stages of recovery *and* at various points in the student's educational career when "hidden" deficits may become apparent.
- Look deeper than traditional language tests and be wary of results of any test in isolation.
- Look for ways to create success. Avoid merely identifying weaknesses.
- Use multiple sources of information. Avoid looking at any one

source as able to provide the "whole story."

- Interpret all assessment data in the context of each child's world. Take into consideration his or her family history, educational history, and social relationship background.
- Be relevant to the child's life.
- Remember that each child and adolescent with TBI is unique and has a profile of strengths and needs that reflects that individuality.
- Look for strengths. They are there, always.

Limitations of the Current Study

Limitations of this study include the small sample size used, as well as the wide variation of time post injury for each of the participants with TBI. Including subjects whose injuries were more recent would have provided a way to determine whether the PTBI subtests that did not reveal difficulties with the current participants with TBI, may have been more appropriate with students immediately post-onset. Two of the three participants with TBI experienced additional disabilities which confounded the effects of their injuries, limiting this study's ability to obtain definite parameters of the consequences of TBI on functioning. The lack of initial neurological data and early recovery information left a blank in terms of analyzing the influence of levels of severity and neurological pathologies on cognitive-linguistic abilities. Gathering input from other professionals involved in the participants' lives would have added depth to the data and perhaps would have identified further areas of strengths and needs. Observation of the participants in the context of peer interaction and classroom activities would have contributed the contextual aspect of assessment

that Ylvisaker and Gioia (1998) discussed.

Need for Future Research

More research clearly is indicated in the area of assessment with the pediatric TBI population. For example, further exploration of the different factors involved with integrated cognitive-linguistic tasks would be appropriate. Specifically, when taking Just and Carpenter's (1992) capacity theory of comprehension or FWM (Montgomery, 2002), how does memory contribute to the language processing skills of children and adolescents with TBI? Also, what roles do visual versus auditory stimuli play in the linguistic comprehension abilities of this population? In other words, if the participants in this study had been able to read the story from the "Story Reconstruction" subtest of the PTBI, would they have been better able to reconstruct the narrative? If the "Yes/No/Maybe" subtest had not allowed print stimuli to remain present, would the task have been more sensitive to the memory difficulties that likely play a role in what the teachers observed about direction-following difficulty?

The findings of this study and the current literature suggest deficits in connected spoken and written discourse in the pediatric TBI population. Further exploration of exactly how spoken and written discourse deficits relate to academic performance would provide important insight. In addition, research examining the ability of the PTBI to predict academic functioning is warranted in light of the need for formal testing to be more relevant to functional contexts and educational success. Also important to explore would be the impairments that speech-language pathologists are addressing with their students with TBI, and to what extent they feel part of a team involved with the academic and social intervention of these students.

The consequences of pediatric TBI are immense. Lives of children and

adolescents with TBI greatly change as they adjust to new ways of thinking. Their parents also cope with major adjustments as they find new ways to parent. Whatever studies are completed in the future, it is important that they build the knowledge base in order that rehabilitation professionals and educators may have the tools to assist families in finding effective rehabilitation services, answers to the many questions of families and educators, and methods to compensate for new limitations.

Appendix A

WMU HSIRB Approval Notification

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-5456
616 387-8293

WESTERN MICHIGAN UNIVERSITY

Date: August 21, 2001

To: Nicola Nelson, Principal Investigator
Heather Koole, Student Investigator for thesis

From: Mary Lagerwey, Chair Mary Lagerwey

Re: HSIRB Project Number 01-07-02

This letter will serve as confirmation that your research project entitled "Evaluation of the Pediatric Test of Brain Injury" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

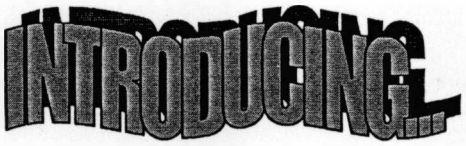
Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: July 18, 2002

Appendix B

Information Flyer



the Pediatric Test of Brain Injury

What is it?

The Pediatric Test of Brain Injury (or "PTBI") is a new tool for assessing the cognitive and linguistic skills of school aged children and adolescents who have had traumatic brain injury. It was developed to look at attention, memory, language, reading, writing, metalinguistic, and metacognitive skills that are relevant to students' school work.

Why another test?

To date, there is no one single test available to assess all of the cognitive and linguistic impairments that go hand-in-hand with pediatric traumatic brain injury. Instead of giving students several different tests, the goal of the PTBI is to assess all these areas with one compact test.

Why do we need your help?

To make the PTBI a valid tool, it must go through a process of validation. This means that this test and similar tests must be given to groups of students to make sure the scores are accurate.

Who are we looking for?

We are looking for students between the ages of 6 and 15 who have had a traumatic brain injury.

What is involved in participating in this project?

- two tests: the PTBI (approx. 45 min.) and a naming task (approx. 15 min.)
- testing time at your convenience (no testing will take the place of therapy sessions)
- testing may be done at your home
- testing will be audio and video recorded
- you will be given a summary of the results for your child
- all data and information will be confidential

How do I sign-up my child for this project?

If you and your child are interested in participating in this project or would like more information, just fill out the form below and return it in the stamped envelope provided. Once we receive the form, we will contact you with further details. **Please respond by March 27, 2002.**

My child is interested in participating in this project.

My Child's Name: _____ My Child's Birthdate: _____

My Name: _____ Phone: _____

Best time to reach me is
- ☐ morning (between ____ AM & _____ AM)
- ☐ afternoon (between ____ PM & _____ PM)
- ☐ evening (between ____ PM & _____ PM)

Appendix C

Parental Consent Form

Parental or Guardian Permission

Western Michigan University
Department of Speech Pathology
Principal Investigator: Dr. Nickola W. Nelson
Student Investigator: Heather Koole

My child has been invited to participate in a research project entitled "The Evaluation of the Pediatric Test of Brain Injury." The purpose of the study is to determine the usefulness of a new test of pediatric brain injury in evaluating individual rehabilitation progress. In addition, this project is being conducted to fulfill Heather Koole's thesis requirement.

My permission for my child to participate in this project means that my child will be administered the Pediatric Test of Brain Injury (PTBI) and three other similar tests. My child may also be screened with the Children's Orientation and Amnesia Test if this or a similar test has not already been administered to my child at his/her rehabilitation facility. The testing will take place during the fall of 2001 or the winter of 2002. It will involve about 4 hours over the course of several sessions. My child will be tested individually by someone trained in test administration who has also worked with children who have traumatic brain injury. The testing will be audio and video recorded to ensure accurate scoring of the tests. My child will be free at any time – even during the test administration – to choose not to participate. If my child refuses, quits, or shows agitation there will be no negative effect on his/her rehabilitation or school programming. Although there may be no immediate benefits to my child for participating, there may eventually be benefits to the validity and reliability of tests for pediatric brain injury and subsequently to children who have had traumatic brain injury.

The researchers will consult with my child's medical records to confirm that my child meets the criteria for participating in this project. My child's teacher or speech-language therapist will provide the researchers with scores from my child's latest cognitive and/or language tests so they may be compared with these new scores. My child's teacher or speech-language pathologist may also be asked to complete a survey about his/her classroom or therapy behavior. Clinical data from the testing will go into my child's medical chart. Research data and a copy of the clinical data will be kept by the researcher in a locked location. All test data and information will remain confidential. That means my child's name will be omitted from all test forms and labels and a code number will be attached. The principal investigator will keep a separate master list with the names of the children and the corresponding code numbers. The researchers will provide me with a summary of the report and if I find the results useful, I may share the results with my child's teacher and/or speech-language therapist. Once the data are collected and analyzed, the master list will be destroyed. All other forms will be retained for at least three years in a locked file in the principal investigator's office. No names will be used if the results are published or reported at a professional meeting.

The risks typically experienced by children when they are being tested, which include boredom, fatigue, mild stress in the testing situation, and agitation, may be exaggerated for individuals affected by traumatic brain injury. Using my child's time to evaluate their strengths and needs could potentially take away time from their participation in rehabilitation and/or classroom activities. All of the usual methods employed during standardized testing to minimize discomforts will be employed in this study. This means that many short breaks will be built into testing time and available data from previous testing will be used instead of re-administering test protocols whenever possible. Testing will be discontinued at any time in the event of agitation. In the case of agitation in repeated sessions, testing will be permanently discontinued. As in all research, there may be unforeseen risks to my child. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to me or my child except as otherwise specified in this permission form.

I may also withdraw my child from this study at any time without any negative effect on services to my child. If I have any questions or concerns about this study, I may contact either Dr. Nickola Nelson at 616-387-8058 or Heather Koole at 616-458-0959. I may also contact the chair of the Human Subjects Institutional Review Board at 616-387-8293 or the vice president for research at 616-387-9298 with any concerns I have.

This permission document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Subjects should not sign this document if the corner does not have a stamped date and signature.

My signature below indicates that I, as parent or guardian, can and do give my permission for

_____ *(child's name)*

- to be tested with the Pediatric Test of Brain Injury and three other similar tests;
- to be audio and video recorded during all testing;
- to have his/her teacher or speech-language therapist complete a survey about his/her classroom or therapy behavior;
- to have his/her medical records looked at by the researchers; and
- to have his/her latest individual cognitive and linguistic test scores be released to the researchers.

_____ _____
Signature of Parent or Guardian Date

Permission obtained by: _____ _____
initials of researcher Date

Appendix D

Example of Student Profile

Pediatric Test of Brain Injury[1]-Student Profile
Student Name: Graham

This profile describes each subtest of the Pediatric Test of Brain Injury (PTBI) and Graham's performance on each of these. The PTBI was administered on xxx by Heather Koole at the home of Graham and his parents. Graham's father was present for approximately half of the testing session.

Task 1: Orientation

Description. This task consists of 14 questions relating to previously learned personal information and orientation to current place and date, e.g., "What school do you go to? What month is this?"

Graham performed this subtest without difficulty. He was very quick to respond to all questions and provided the correct answer for each question. There was no evidence of hesitation or uncertainty regarding any of these questions.

Rationale. It is important to assess status of orientation early in the recovery process. Good response to a test of orientation depends on memory for old and new information, and language skills for understanding and answering questions. Thus, deficient performance on this PTBI task may be secondary to orientation, memory, or language problems, or any combination of the three.

Task 2. What Goes Together

Description. The PTBI task, What Goes Together, has 10 word-triads ordered according to age/grade difficulty (6 use single-meaning words and 4 use double meaning words). Students are shown word-triads read aloud by the examiner. Students must provide sound rationale for their pairings (e.g., "bark, growl, tree" – bark is found on trees; dogs both bark and growl), thus demonstrating good semantic/conceptual knowledge, vocabulary skills, verbal expression, and cognitive flexibility.

Graham performed this subtest with little difficulty. He required two cues to provide more complete explanations for two pairs of words (knife-fork & hammer-axe). On one occasion, he quickly responded with, "I have no idea," however, following a simple prompt from the examiner ("Look again") he was able to provide an accurate answer. Overall, Graham's definitions/explanations of why each pair went together were complete, descriptive, and accurate, suggesting adequate vocabulary skills. He did not require extra time nor did he demonstrate difficulty/struggle in providing answers. His performance on this subtest demonstrated both semantic knowledge and cognitive flexibility, which are important skills for academic success.

Rationale. Semantic/conceptual knowledge forms the basis of language acquisition and use. Vocabulary is used to communicate that knowledge. Impairment of previously

[1] G. Hotz, N. Helm-Estabrooks, & N.W. Nelson. (2001). *Development of the pediatric test of brain injury.* (Draft No. 7). Miami, FL: University of Miami School of Medicine, Division of Neurorehabilitation.

acquired language skills after brain damage (aphasia) can result from traumatic brain injury. Furthermore, such deficits in children may interrupt maturation of semantic/ conceptual knowledge and negatively affect academic performance. One way to test this knowledge is to pair words according to a common semantic/conceptual relationship. For example, given the words "dog, cat, knife," one would pair "dog" and "cat" because they are both animals. If the third word is related to one of the other two (e.g., "bone"), then a different pairing can be made based on other semantic knowledge (i.e., "dog" and "bone" because dogs eat bones). To make both these pairings requires not only expanded semantic knowledge but cognitive flexibility. When one of the words has a double meaning (e.g., "bark"), the task makes even greater demands on semantic knowledge and cognitive flexibility. The latter skill is often affected by traumatic brain injury, with serious implications for academic success and productive, independent living.

Subtest 3: Digit Span

Description. The classic format for testing digit span is used in the PTBI. Numbers are presented by the examiner and immediately repeated by students, beginning with two digits and progressing to seven. For each number series, two sets are presented. The subtest is terminated at the level where both sets are failed.

Graham performed this subtest with some difficulty. For spans of two to four digits, he was 100% accurate. For those with five to seven digits, he was 50% accurate. To explain this in more detail, for each pair of sets (five, six, and seven digit spans) he repeated one of each accurately. For the sets he did not repeat accurately, his errors were characterized by adding and/or transposing numbers. Graham's tendency to respond very quickly may have affected the accuracy of his answers.

Rationale. Immediate verbal recall of numbers presented auditorally is a test of attention as well as short-term memory capacity. Individuals with traumatic brain damage may show digit-span deficits, particularly in the first months following injury when attention and memory skills are most likely to be affected. In addition, processing and verbalizing numbers depends on an intact language system, so aphasia may lead to poor performance. Interpretation of the scores earned on Digit Span, therefore, must be done in the context of performance on other PTBI tasks such as Orientation, Confrontation Naming and Story Reconstruction.

Task 4: Yes/No/Maybe

Description. Students are presented with printed "stories" of increasing length and syntactic complexity that are read aloud by the examiner. To reduce memory as a reason for poor performance, the print form of the "stories" remains in view while students are asked three questions for each story. The correct answer can be "yes," "no," or "maybe." An example follows.

The kids ran after an ice cream truck. It turned the corner before they could catch it.
a. Did the kids chase an ice cream truck?
b. Did the kids catch the truck before it turned the corner?
c. Did the kids get any ice cream?

Graham performed this subtest with some difficulty. He inferred information from the story as evidenced by several correct "maybe" answers. In fact, he overlooked only one "maybe" answer. In general, his errors were mostly on items that could have been answered concretely "yes" or "no." This implies that Graham has inferencing and metacognitive skills, but perhaps experiences decreased attention to either auditory stimulus or written material, or short term memory deficits. His performance on this subtest could also suggest decreased ability to isolate and attend to relevant details in either the stories or the questions. I would like to note Graham's quickness in answering each question. At times, he changed his answer after giving himself some time to think about the question. In addition, when cues were given to "look again" he was able to provide the correct answer. This suggests that impulsivity may also have played a role in his errors.

Rationale. The ability to listen and understand language across sentence boundaries requires language skills, semantic and syntactic decoding, inference, and metacognitive judgment. Impairment of these skills as a result of brain trauma can negatively affect knowledge acquisition, academic performance, and daily communicative interactions.

Task 5: Confrontation Naming

Description. Students are shown a line-drawing picture of a boy with a skate board wearing a distinctive shirt and shorts and a "Band-Aid" on his knee. Students are asked to name three body parts and three other items in the picture. In pointing to these, the examiner draws attention to all parts of the picture because (unknown to students) the 9th PTBI task requires that the picture be recalled and drawn.

Graham performed this subtest without difficulty. He named all body parts and objects accurately and in a timely manner.

Rationale. The ability to name pictured objects is referred to as "confrontation" naming. This form of word retrieval is especially vulnerable to the acquired language disorder of aphasia. In fact, word retrieval problems (anomia) are a cardinal symptom of aphasia. Depending on the site and size of the damage, children with traumatic brain injury may manifest aphasia with serious consequences for learning, self-expression, and social interactions. In the PTBI, confrontation-naming skills are assessed briefly. Less than fully correct performance on this task should be explored briefly and, thus, a comprehensive naming test may be required.

Task 6: Story Reconstruction

Description. Students are alerted to the fact that they will hear a story only once and must immediately repeat it back verbatim. The examiner then reads aloud the "Tommy the Trickster" story comprising 24 information units. A list of these units is provided so examiners can check-off and number each in the order given.

Graham performed this subtest with great difficulty. Graham was able to recall six of the 24 information units required for full credit. The information he did provide was vague and did not include all of the major story elements. The order in which he recalled these information units loosely followed the story. Graham's

performance on this subtest could suggest short term memory impairments. It could also be an indicator of decreased skills in the area of narrative production, specifically with temporal and causative elements. Further exploration of Graham's abilities in the areas of short term memory and narrative production could shed more light on the reasons for his difficulty with this task and provide important information for further academic success, especially in light of his desire to complete post-secondary education.

Rationale. The ability to listen to a story and repeat that story verbatim requires verbal memory as well as language skills including auditory comprehension and verbal expression, syntax and story grammar skills and sequencing of factual events. The importance of these skills to academic performance and social interactions cannot be overstated, and they are often impaired following pediatric brain injury. For that reason, a story reconstruction task is included in the PTBI.

Subtest 7: Reporting the News (Reading)

Description. For both the reading and writing version of Reporting the News, students are shown a list of kernel sentences that, together, tell the story "When Our School Closed." For the reading task, the student reads the kernel sentences aloud ("Our school was closed. It was last Wednesday." etc.).

Graham performed this subtest without difficulty. He read aloud accurately and quickly. Reading fluency does not appear to be an area of difficulty for him; however, it should be noted that reading comprehension was not directly assessed during this task.

Rationale. The ability to read words aloud accurately and quickly is an indicator of reading fluency and a predictor of reading comprehension. Children with TBI, especially those in earlier grades, may read slowly and with errors similar to those with developmental reading disorders. These reading problems can affect development of higher-order reading skills.

Subtest 8: Reporting the News (Writing)

Description. To establish the correct cognitive "set" for this task, students are shown the following core sentences: "There was a dog. He was little. He was brown. He was white. A car hit him. He was scared. He was okay." They are then shown how this information can be combined to tell a story someone would want to read (e.g., "A little brown and white dog got hit by a car. He was scared but he was okay.") Students then are given 5 minutes to write a cohesive story using the kernel sentences presented for reading in Task 5.

Graham performed this subtest with some difficulty. He mostly rewrote the simple sentences as they were presented without combining them to make more complex sentence constructions. Just as important as verbal narrative production (see "Story Reconstruction"), written narrative production is critical for academic success. This area could also be further explored for more insight into Graham's

ability to use metalinguistic and written narrative discourse skills, which will be very important if he continues his education beyond the high school level.

Rationale. The task of combining kernel sentences to write a cohesive story requires reading comprehension, graphomotor, syntactic, metacognitive, and narrative discourse skills that include the abilities to combine and sequence events leading to a logical conclusion. Problems in any of these areas can affect performance and only qualitative analyses of products, along with more in-depth testing, can begin to determine the underlying causes of poor performance. Because writing problems are possible sequelae of childhood brain injury, we included a narrative writing task in the PTBI.

Subtest 9: Picture Recall

Description. Students are asked to recall the picture of the boy they looked at when naming body parts and objects. Then they are asked to draw that picture on the back of the record form. After completing the picture, they are asked to sign their name at the bottom of the picture. The product is analyzed for resemblance to a boy, recall of stimulus picture details, and the ability to write one's name.

Graham performed this subtest without difficulty. When he was initially shown the picture, he was not aware that he would be asked to remember it at a later point during the testing. Despite this fact, he recalled all relevant details of the picture without cueing or prompting from the examiner and without obvious struggle to remember. This suggests that he possesses skill in the area of delayed incidental visual memory. Graham's performance on this subtest also demonstrated good graphomotor and visuospatial skills.

Rationale. Memory problems are common and may be long-lasting or even permanent following traumatic brain injury and perhaps no impairment is more devastating to achievement of productive, independent living. Both verbal and visual memory problems have been reported in children with TBI, and these problems have important implications for classroom performance as well as other spheres of children's lives. In the classroom, there is the general expectation of remembering material presented. In other situations, elements must be remembered incidentally during the course of activities. For the PTBI, Task 3 (Digit Span), students are fully aware of their need to remember the stimuli. In contrast, Task 9 (Picture Recall) calls upon incidental memory for the picture used for Confrontation Naming (Task 5). To demonstrate their recall of this picture, they are asked to draw it as they remember it and, when finished, to sign their drawing. Thus, this task calls upon graphomotor and visuospatial skills as well as delayed, incidental memory.

Appendix E

Sample Items from *The Pediatric Test of Brain Injury – Research Edition*

Sample Items from Task 1 (Orientation)

What is your full name?

When is your birthday?

What is your address?

What is the name of your school?

Sample Items from Task 2 (What Goes Together)

knife – fork – saw (single meaning)

dog – cat – bone (single meaning)

bark – growl – tree (double meaning)

cube – square – plaza (double meaning)

Sample Item from Task 4 (Yes/No/Maybe)

Stimulus:	One morning Susan missed the school bus. She thought she would be late for school, but her mother got her there on time.
Questions:	Did Susan miss the bus?
	Was Susan late for school?
	Was it raining that morning?

Appendix F

Description of Coding for Student Interviews

Coding for Themes of Participant Perceptions

All coding is in reference to the participants' perceptions of themselves. For example, impulsivity would only be coded if a participant actually commented on or eluded to his impulsivity. In other words, if a participant demonstrated impulsivity during the interview, this would not be coded. Perceptions can be coded as more than one theme. All codes are marked as either positive or negative. (+) indicates a perceived strength / area of no difficulty; (-) indicates a perceived weakness / area of difficulty)

Code:	Theme:	Examples from Transcripts:		
		Graham	**Scott**	**Jonathan**
Cognitive/Linguistic				
VE	Verbal Expression	Sometimes, it's the way to say it (-)	I talk too much (-)	[none]
AP	Auditory Processing	[None]	[none]	I don't understand something they say (-)
NWF	Naming/ Word finding	I tried to complement my friend, but I couldn't think of the right word (-)	[none]	[none]
R	Reading	[Do you find that's one of your strengths?] Yes, in 3rd grade I was at 7th grade reading level (+)	Better than everybody else, I'm tellin' ya (+)	[What kinds of things are hard for you? ...] Math, social studies, science, and, um...reading (-)
W	Writing	I'm not very good at it. I'm better at saying it than writing it (-)	[none]	[none]
Cognitive				
M	Memory	I don't remember things I used to know (-)	I remember more names than my parents do (+)	I keep forgetting things (-)
Cognitive/Behavioral				
AE	Anger/ Emotion	I've been on this [medication] since the last time I got in trouble which was February (-)	I get mad very, very easily over very stupid things (-)	I fight too much (-)
I	Impulsivity	[What other things are hard for you?] Not eating a lot (-)	[none]	Like in-interrupt and I, I can't help it! (-)
S	Social issues	I'm not good at doing stuff as a team (-)	[Are there some things that are harder?] Getting along with the kids (-)	[How's it going with friends?] Not good (-)
OP	Other's Perceptions of Self	I try to do things so that I don't get picked on, but people hate me anyway (-)	[none]	They keep saying that I'm evil (-)
GB	General Behavior	I still act immature (-)	I'm nice (+)	[none]
Other				
Ac	Academics (general)	I got it going in math (+)	Some of the work is just too easy (+)	[What about school work...like subjects in school?] [J gestures "thumbs down"] (-)
Ath	Athletics	[none]	[What kinds of things are you good at at school?] Volleyball (+)	[I'd like to hear what kinds of things you're good at.] Hockey (+)
AC	Art/Creativity	[none]	[none]	Um, I'm good... art (+)
G	General self-perception	Not good at things anymore (-)	[none]	[What kinds of things are hard for you?] Everything (-)

Appendix G

Informal Survey: School-Related Functional Status of Students with TBI

INFORMAL SURVEY:
SCHOOL-RELATED FUNCTIONAL STATUS OF STUDENTS WITH TBI

Name of student: _____ Age of student: _____

Name of adult completing survey: _____ Relationship to student: _____

Date survey completed: _____

Below is a list of statements that describe students. Based on your observations and knowledge as a parent, teacher, or rehabilitation professional of this student, please circle the appropriate number (0, 1, or 2) describing this student *now* (rather than before his/her injury). Please use the space after each section to add any observations you feel are relevant to this student in addition to the statements listed.

0 = Not True (as far as you know) 1 = Somewhat or Sometimes True 2 = Very True or Often True (NA = Not Applicable)

ACADEMICS

Meets average or above average expectations in school work	0	1	2	NA
Performs adequately on reading and writing assignments	0	1	2	NA
Demonstrates carry over of information for new learning	0	1	2	NA

Other observations:

ATTENTION

Can sit still and is not restless or hyperactive	0	1	2	NA
Able to maintain attention for completing tasks	0	1	2	NA
Responds to oral directions accurately and without confusion	0	1	2	NA

Other observations:

ORAL COMMUNICATION

Has adequate vocabulary and/or word usage skills for conversation	0	1	2	NA
Competent in telling stories or relating past events	0	1	2	NA
Easily comprehends or follows normal conversations	0	1	2	NA

Other observations:

CLASS PARTICIPATION

Volunteers information to discussions or answers questions	0	1	2	NA
Completes assignments within allocated time	0	1	2	NA
Able to start tasks without difficulty following instruction	0	1	2	NA

Other observations:

SOCIAL BEHAVIOR

Demonstrates behaviors that seem usual and appropriate	0	1	2	NA
Gets along with other students/peers	0	1	2	NA
Polite, appropriately mature, and maintains emotional control	0	1	2	NA

Other observations:

Please list any other observations that you feel are relevant to this student's rehabilitation and academic success:

BIBLIOGRAPHY

Blosser, J.L., & DePompei, R. (1989). The head-injured student returns to school: Recognizing and treating deficits. *Topics in Language Disorders, 15*, 67-77.

Blosser, J.L., & DePompei, R. (1994). *Pediatric traumatic brain injury: Proactive intervention*. San Diego: Singular Publishing Group, Inc.

Body, R., & Parker, M. (1999). The use of multiple informants in the assessment of communication after traumatic brain injury. In S. McDonald, L. Togher, & C. Code (Eds.), *Communication disorders following traumatic brain injury* (pp. 147-171. Hove, UK: Psychology Press Ltd, Publishers.

Caplan, D. & Waters, G.S. (1999). Verbal working memory and sentence comprehension. *Behavioral and Brain Sciences, 22*, 77-126.

Catts, H. W. (1993). The relationship between speech-language impairments and reading disabilities. *Journal of Speech and Hearing Research, 36,* 948-958.

Catts, H. W., Fey, M. E., Zhang, X., & Tomblin, J. B. (2001). Estimating the risk of future reading difficulties in kindergarten children: A research based model and its clinical implications. *Language, Speech, and Hearing Services in Schools, 32*, 38-50.

Chapman, S.B. (2000a). Discussion of developmental plasticity: Factors affecting cognitive outcome after pediatric traumatic brain injury. *Journal of Communication Disorders, 33*, 333-344.

Chapman, S.B. (2000b). The revealing discourse of pediatric brain injury. Presented at the Brain Injury Association 19th Annual Symposium.

Chapman, S.B., McKinnon, L., Levin, H.S., Song, J., Meier, M.C., & Chiu, S. (2001). Longitudinal outcome of verbal discourse in children with traumatic brain injury: Three-year follow-up. *Journal of Head Trauma Rehabilitation, 16*, 441-455.

Chapman, S.B., Levin, H.S., Wanek, A., Weyrauch, J., & Kufera, J. (1998). Discourse after closed head injury in young children. *Brain and Language, 61*, 420-449.

Chapman, S.B. (1997). Cognitive-communication abilities in children with closed head injury. *American Journal of Speech-Language Pathology, 6,* 50-58.

Clark, E., Russman, S., & Orme, S.F. (1999). Traumatic brain injury: Effects on school functioning and intervention strategies. *The School Psychology Review, 28*, 242-250.

Creswell, J.W. (1994) *Research design: Qualitative and quantitative approaches.* Thousand Oaks, CA: SAGE Publications, Inc.

Donders, J. (1997). Sensitivity of the WISC-III to injury severity in children with traumatic head injury. *Assessment, 4*, 107-109.

Fabiano, R.J., & Daugherty, J. (1998). Rehabilitation considerations following mild traumatic brain injury. *Journal of Rehabilitation, 193*, 9-14.

Ewing-Cobbs, L., Levin, H.S., & Fletcher, J.M. (1998). Neuropsychological sequelae after pediatric traumatic brain injury: Advances since 1985. In M. Ylvisaker (Ed.), *Traumatic brain injury rehabilitation: Children and adolescents.* (pp. 11-26). Boston: Butterworth-Heinemann.

Farmer, J.E., Clippard, D.S., Luehr-Wiemann, Y. (1996). Assessing children with traumatic brain injury during rehabilitation: promoting school and community reentry. *Journal of Learning Disabilities, 29*, 532-548.

Glang, A., Singer, G., Cooley, E., & Tish, N. (1992). Tailoring direct instruction techniques for use with elementary students with brain injury. *Journal of Head Trauma Rehabilitation, 7*, 93-108.

Hillier, S. L., & Metzer, J. (1997). Awareness and perceptions of outcomes after traumatic brain injury. *Brain Injury, 11*, 525-536.

Hotz, G., Helm-Estabrooks, N., & Nelson, N.W. (2001). Development of the pediatric test of brain injury. *The Journal of Head Trauma Rehabilitation, 16*, 426-440.

Green, B.S., Stevens, K.M., & Wolfe, T.D.W. (1997). *Mild traumatic brain injury: A therapy and resource manual.* San Diego: Singular Publishing Group, Inc.

Jordan, F.M., & Ashton, R. (1996). Language performance of severely closed head injured children. *Brain Injury, 10*, 91-97.

Jordan, F.M., Murdoch, B.E., & Buttsworth, D.L. (1991). Closed-head-injured children's performance on narrative tasks. *Journal of Speech and Hearing Research, 34*, 572-582.

Just, M.A., & Carpenter, P.A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99*, 122-149.

Kinsella, G., Murtagh, D., Landry, A., Homfray, K., Hammond, M., O'Beirne, L., Dwyer, L., Lamont, M., & Ponsford, J. (1996). Everyday memory following traumatic brain injury. *Brain Injury, 10*, 499-507.

Levelt, W.J.M., Roelofs, A., & Meyer, A.S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22*, 1-38.

Lezak, M.D. (1983). *Neuropsychological assessment.* (2nd ed.). New York: Oxford University Press.

Mateer, C.A., Kerns, K.A., & Eso, K.L. (1996). Management of attention and memory disorders following traumatic brain injury. *Journal of Learning Disabilities, 29*, 618-632.

Montgomery, J.W. (2002). Understanding the language difficulties of children with specific language impairments: Does verbal working memory matter? *American Journal of Speech-Language Pathology, 11*, 77-91.

Nelson, N. W., Helm-Estabrooks, N., & Hotz, G. (2002). *Test of Integrated Curriculum-Related Skills.* Unpublished research edition, Western Michigan University.

Nelson, N.W. (1998). *Childhood language disorders in context: Infancy through adolescence.* (2nd ed.). Needham Heights, MA: Allyn & Bacon.

Rosen, C.D., & Gerring, J.P. (1986). *Head trauma: Educational reintegration.* San Diego: College-Hill Press.

Spradley, J.P. (1979). *The ethnographic interview*. Orlando, FL: Holt, Rinehart, & Winston.

Sohlberg, M.M., & Mateer, C.A. (1989). The assessment of cognitive-communicative functions in head injury. *Topics in Language Disorders, 9*, 15-33.

Szekeres, S.F., & Meserve, N.F. (1994). Collaborative intervention in schools after traumatic brain injury. *Topics in Language Disorders, 15*, 21-36.

Turkstra, L.S. (1999). Language testing in adolescents with brain injury: A consideration of the CELF-3. *Language, Speech, and Hearing Services in Schools, 30*, 132-140.

Ylvisaker, M., Kolpan, K.I., & Rosenthal, M. (1994). Collaboration in preparing for personal injury suits after TBI. *Topics in Language Disorders, 15*, 1-20.

Ylvisaker, M., & Feeney, T.J. (1994). Communication and behavior: Collaboration between speech-language pathologists and behavioral psychologists. *Topics in Language Disorders, 15*, 37-54.

Ylvisaker, M., & Gioia, G.A. (1998). Cognitive assessment. In M. Ylvisaker (Ed.). *Traumatic brain injury rehabilitation: Children and adolescents*. (2nd ed.). (pp. 159-179). Boston: Butterworth-Heinemann.

Yorkston, K.M., Jaffe, K.M., Liao, S., & Polissar, N.L. (1999). Recovery of written language production in children with traumatic brain injury: Outcomes at one year. *Aphasiology, 13*, 691-700.