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Assessing Executive Functioning in Children with a Hearing Loss

Graduate Thesis/Project

Submitted to the Faculty

Of the School Psychology Program

College of Liberal Arts
ROCHESTER INSTITUTE OF TECHNOLOGY

By

Elizabeth Oberg

In Partial Fulfillment of the Requirements
for the Degree of
Master of Science and
Advanced Graduate Certificate

Rochester, New York April 4, 2007

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(Committee Chair)

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Assessing Executive Functioning in Children with a Hearing Loss

Elizabeth Oberg

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Abstract

This study examined a variety of executive functioning assessment methods with a group of deaf children. The relationship between parent/teacher reports of 22 deaf and hard of hearing students' executive functioning, students' performance on cognitive tests and students' performance on selected achievement domains was studied. The findings showed significant positive correlations (p<.01) between the parent/teacher Behavior Rating Inventory of Executive Function (BRIEF) on six of the eight clinical scales. Secondly, there were significantly positive correlations between the parent/teacher BRIEF reports and the students' scores on the Wisconsin Card Sorting Test, the (Children's) Color Trails Test and the Woodcock-Johnson: Writing Fluency subtest. Lastly the importance of considering etiology when assessing deaf children was examined. Students with genetic deafness were rated as significantly different (p<.05) on BRIEF scales and performed significantly different on select student measures than students with other causes of deafness.

CHAPTER ONE

Overview

. Assessment of deaf students (the term 'deaf' will be used to refer to deaf and/or hard of hearing individuals who may or may not identify with the Deaf culture) is fraught with challenges due to the heterogeneous nature of this population, lack of standardized procedures for direction presentation and scoring of student response, construct irrelevance related to language confounds, differential item functioning, and inappropriate application of normative comparisons (Mason, 2005; Maller, 2003; Pollard, 2002; Steward & Ritter, 2001). These challenges frequently lead to ineffective and inaccurate assessment practices within the educational setting (Flanagan & Ortiz, 2002; Maller, 2003; Marschark, 2003; Pollard, 2002).

Two emerging theoretical frameworks and trends in the school psychology assessment field, cross-battery assessment and executive functioning assessment, appear to have utility in providing relevant data that can satisfy legal mandates, and lead to better case conceptualization for deaf learners (Flanagan, & Ortiz, 2001, Flanagan, & Ortiz, 2002; Miller, Thomas-Presswood, Hauser, & Hardy-Press, in press). The cross-battery assessment approach, based on the Cattell-Horn-Carrol (CHC) theory of intelligence, provides a theoretical framework to systematically analyze specific cognitive constructs through the use of various assessment instruments. This method allows the examiner to create an individualized assessment battery that addresses the level of cultural and linguistic bias which may affect test performance (Flanagan & Ortiz, 2002).

Extending the cross-battery assessment to include the assessment of executive functioning provides additional complementary information regarding the manner in which the student modulates his/her cognitive processes in order to reach an intended goal. Research regarding deaf individuals executive functioning has highlighted the influence of reduced audition and a signed communication modality contributing to executive functioning performance (Miller et al., in press; Wilson & Emmorey, 2001). Findings by Rhine (2002) indicate a statistically significant difference between the executive functioning skills between individuals with and without hearing loss in the areas of Inhibit, Shift and Working Memory on the Behavior Rating Inventory of Executive Function (BRIEF) a measure of goal directed problem solving capabilities as reported by parent informants. Overall, there is limited research examining the interrelationship between executive functioning informant reports, neuropsychological measures, and the cognitive capabilities of deaf individuals.

This study was designed to examine the executive functioning characteristics of deaf individuals and executive functioning relationships to cognitive capabilities and achievement performance. It was hypothesized that there would be similar results to Rhine's (2002) findings on the executive functioning capabilities of deaf students as rated by parent report on the BRIEF. Rhine (2002) reported that deaf students rated capabilities on the BRIEF (Parent report) as similar to the hearing control group on all clinical scales except higher levels of difficulties (still falling within the non-clinically significant range) in the areas of Inhibit, Shift, and Working Memory. This study hypothesized that there would be a low to moderate correlation between Parent and Teacher informant reports on the Behavior Rating Inventory of Executive Function (BRIEF) when rating a student's executive functioning capabilities. Corresponding with previous research (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; Mahone, et al., 2002; Vriezen & Pigott, 2002), it was hypothesized that there would not be a relationship between a deaf student's performance on select student performance measures and informant (teacher and parent) reports of deaf student's executive functioning behaviors. Lastly, it was hypothesized that there would be a significant difference between the executive functioning of genetically deaf individuals and non-genetically deaf individuals on both the BRIEF informant reports and student performance measures.

CHAPTER TWO

Literature Review

Multiple contextual factors are affected when an individual experiences a reduced ability to hear and comprehend sounds (Calderon & Greenberg, 2003; Karchmer & Mitchell, 2003; Pollard, 2002). From an ecological perspective, a deaf individual's cultural identity, family interaction patterns, and societal view of deafness are complex. On the individual level characteristics such as age of onset, etiology, age of diagnosis, age of intervention services, level of hearing, progression or stability of hearing loss, use/age of use of assistive technology, presence of additional disabilities, gender, communication modality and ethnicity should be considered when assessing the affects of a hearing loss (Foster & Kinuthia, 2003; Harkins & Bakke, 2003; Karchmer & Allen, 1999; Mitchell, 2004; Rhoades, Price, & Perigoe, 2004; Scheetz, 2004; Schum, 2004; Spencer & Marschark, 2003). The many family contextual elements that can be influential include whether there are other members of the family with hearing loss, how the family views the hearing loss, the type of language and level of communication used in the family, and parental coping strategies (Calderon & Greenberg, 2003; Mitchell, 2004; Pollard & Rendon, 1999; Rhoades et al., 2004; Traci & Koester, 2003; Young, 1997). Societal trends such as the development of medical devices to increase audition including cochlear implants, promotion of the rights of Deaf individuals through the Deaf president Now student protest at Gallaudet University, and a shift in educational practices from serving deaf students primarily in residential facilities to providing services within the students home district also affect a deaf child's experience. A deaf child does not live in isolation but rather may experience a myriad of societal pressures: to 'correct' the hearing deficiency, to identify with the deaf community, and to seek a specific educational placement (Karchmer & Mitchell, 2003; Woll & Ladd, 2003).

Communication modality choices infuse all contextual levels including the individual, familial and societal. Individuals with a hearing loss may have exposure to and engage in a variety of communication modalities including sign only (American Sign Language, Signed Exact English, Signed English), voice only (Spoken English, Cued Speech), and/or simultaneous communication using sign and voice (Total Communication). These communication modalities are not mutually exclusive; a high level of code switching can occur depending on the environmental context (Hauser, 2000; Flanagan & Ortiz, 2002; Scheetz, 2004).

Traditional Assessment practices

Service provision for individuals with a hearing loss within an educational context is determined through alignment with the Individuals with Disabilities Act (IDEA). This act provides mandates for service professionals such as using the child's native language when conducting an assessment, educational placement in the Least Restrictive Environment, and the use of communication services. Individuals with a hearing loss are provided services primarily under the classifications of "Deaf," "Hearing Impairment," "Deaf-Blindness" and "Multiple Disabilities." A special education classification is not mandated for service provision.

Under IDEA, individuals who are suspected of having a disability that is preventing them from learning in a regular educational setting are granted the right to an individualized assessment which aids in the formation of an Individualized Education Plan (IEP) designed to address the student's unique educational needs.

Historically service providers have used traditional assessment practices to conduct assessments even though multiple research studies have highlighted the technical inadequacy of these measures when used with deaf individuals (Maller, 2003; Pollard, 2002). According to the IDEA 2004 regulations, aptitude assessments needs to be "selected and administered so as best to ensure that if an assessment is administered to a child with impaired sensory …skills, the assessments results accurately reflect the child's aptitude… rather than reflecting the child's impaired sensory…skills." (Section 300.304 (c) (3)). These legal mandates prohibit service providers to conducted assessments with commonly used cognitive assessment instruments without intentional consideration of possible cultural and linguistic factors threatening the accuracy of these measures.

Limitations with culturally and linguistically diverse populations

Many service providers tend to use this traditional assessment approach with students who are culturally and linguistically diverse resulting in inappropriate psychological assessment practices (Mason, 2005; Merrell, Ervin, & Gimpel, 2006; Flanagan & Ortiz, 2002; Steward & Ritter, 2001). Deaf individuals have historically been misdiagnosed or erroneous and inappropriate conclusions have been drawn based on the use of inappropriate tests (Pollard 1993; Maller 2003). Conclusions such as 'deaf as inferior' and 'deaf as concrete' thinkers are based on flawed tests and inexperienced examiners who did not consider the multiple threats to validity inherent in blindly using intellectual assessment instruments designed for individuals without a hearing loss (Maller, 2003; Marschark, 2003; Moores, 2001). These assessment results can lead to lower expectations of student performance, more restrictive placement decisions, and societal perceptions of reduced capabilities (Busby, 2001; Marschark, 1993; Pollard, 1993; Vernon & Andrews, 1990). Use of the traditional assessment approach in the schools is threatened by limited examiner competencies, lack of standardized directions in the child's native language, construct irrelevance, lack of scoring guidelines to record a student's response and inappropriate application of normative comparisons.

Direction Presentation and Examiner Qualifications. The Individuals with Disabilities Act (IDEA) 2004 amendments continue to mandate administration in the child's native language. Part 300.29 of this act states:

> (a) *Native Language*, when used with respect to an individual who is limited English proficient, means the following:
>
> (1) The language normally used by that individual, or, in the case of a child, the language normally used by the parents of the child, except as provided in paragraph (a)(2) of this section.
>
> (2) In all direct contact with the child (including evaluation of the child), the language normally used by the child in the home or learning environment.
>
> (b) For an individual with deafness or blindness, or for an individual with no written language, the mode of communication is that normally used by the individual (such as sign language, Braille, or oral communication) (p. 59).

Prior to administration of psychological assessments, a linguistic assessment must be conducted in order to determine a child's 'native language' with consideration of factors such as exposure to accessible language, quality of language models, consistency of language used, the use of code switching, and linguistic competency (Hauser, 2000; Jamieson, 2003; Marschark, 2003; Maller, Singleton, Supalla, & Wix, 1999; Mayer & Akamatsu, 2003).

Within the field, there are limited service providers who have the linguistic fluency and educational training to provide psychological services to a deaf student which may drastically affect the quality of test selection and interpretation (Moores, 2001; Pollard, 1993; Scheetz, 2004). As a result, service providers may engage in traditional assessment testing modifications that may have face validity of reducing potential direction presentation bias even though the threats to validity continue to be present (Moores, 2001; Vernon & Andrews, 1990). For example, a service provider may use gesture, pointing, and/or exaggerated facial expressions to convey the standardized English directions, and/or limit the test battery to only performance/non-verbal measures (Pollard, 2002). This practice violates the legal mandate of assessing the child in his/her native language, unjustly denies the student's right to equitable directions which was given to his/her peers without hearing loss, reduces the comprehensive nature of the assessment and uses measures with limited correlation with academic performance (Flanagan, Ortiz, Alfonso, & Mascolo, 2002; Maller, 2003; Marschark, 1997; Paul & Jackson, 1993; Pollard, 2002; Scheetz, 2004; Schum, 2004).

Using an interpreter or an outside consultant who is linguistically fluent in the child's native language satisfies this legal requirement but does not negate the fact that standardized administration is being compromised (Maller, 2003; Merrell et al., 2006; Vernon & Andrews, 1990). In addition, direct translation of test directions from English into another communication modality is not recommended based on the iconic nature of sign language, the lack of a signed equivalent for an English word/concept, inadvertent changes in task difficulty level, and possible threats to inaccurate interpretations (Maller, 2003; Mason, 2005; Flanagan & Ortiz, 2002; Schum, 2004). For example, with the test item "What is a hat?" the interpreter/consultant must determine if he/she will sign the word hat (a motion in which an individual is placing an imaginary cap on one's hat) decreasing item difficulty or use finger spelling (making hand shapes that represent each letter) which requires knowledge of English spelling increasing item difficulty (Scheetz, 2004; Schum, 2004).

Student Response. Cognitive assessment measures are used in order to determine a student's cognitive functioning capabilities, which are determined by the quality of student response as scored through the use of the assessment manual. Unfortunately, cognitive assessment instruments do not provide scoring guidelines for responses given in a signed communication modality, leaving scoring interpretation to the professional judgment of the examiner decreasing the accuracy of the results (Flanagan & Ortiz, 2002; Kaufman & Kaufman, 2004; Mather & Woodcock, 2001; Naglieri & Das, 1997; Roid, 2003; Wechsler, 2003).

Normative Comparisons. Within the traditional assessment manual, normative comparisons are used in order to determine the student's level of cognitive functioning as compared to his/her same aged hearing peers. A normative comparison between deaf students and their hearing counterparts is questionable as a result of individual, familial, societal and communication contextual factors between these groups (Pollard, 2002; Scheetz, 2004). Due to the diversity within the deaf population, the creation of a deaf norm group does not solve this presented difficulty (Braden, 1992; Maller, 2003; Pollard, 2002).

Construct Irrelevance. Cognitive assessment measures were designed for individuals without hearing loss to assess specific intellectual constructs through administration of test items to elicit knowledge and skills related to this construct. Maller (2003) and Pollard (2002) found that these individual test items function differently with deaf individuals thus hindering measurement of the desired construct. Individual test items may be beyond the individual's cultural/linguistic experience and these items may vary in difficulty due linguistic translation. For example, a letter-number sequencing memory test may measure an individual's familiarity with English numerical and alphabetical ordering rather the intended construct of memory (Pollard, 2002).

In-depth analysis of construct relevance and individual item functioning conducted through Maller's work using Item Response Theory (IRT) found that the Universal Nonverbal Intelligence Scale (UNIT) is the only intelligence test which measures the same intended construct with items functioning similarity when administered to individual's with and without hearing loss. Without consideration of cultural and linguistic factors, service providers currently tend to administer a single assessment battery and obtain subtest and composite scores which are interpreted to represent the deaf student's intellectual capabilities and future potential. This commonly used practice within the field is inherently flawed due to using intellectual assessment instruments which have construct irrelevance and differential item functioning for deaf individuals (Flanagan & Ortiz, 2002; Maller, 2003; Marschark, 2003; Pollard, 2002).

Construction of new cognitive instruments and identification of current testing instruments which measure the same construct for deaf individuals as assessed through Item Response Theory (IRT) would give service providers technically sound instruments to use within the field. Possibly to address the current needs for accurate service provision with the general lack of technically sound instruments for deaf students, a practitioner could use the cross-battery assessment technique which may provide a clearer picture of the student's strengths and needs.

Cross battery assessment

A cross-battery approach generally refers to a service provider using various assessment measures to gain information to inform case conceptualization (Flanagan & Ortiz, 2001). Within the field of school psychology, this method of selectively choosing needed assessment instruments was paired with the Cattell-Horn-Carrol (CHC) theory of intelligence to provide a framework to create intellectual assessment batteries.

Cross-battery assessment used in the field of school psychology, allows the examiner to create, administer, and interpret assessment batteries which were specifically designed to assess the cognitive functioning of the child based on his/her presenting need (Flanagan et al., 2002; Flanagan, & Ortiz, 2002). In contrast to traditional assessment model which dictates the use of obtaining a global composite score from cognitive and achievement instruments, cross-battery assessment promotes domain-specific analyses to identify specific areas of strength and needed improvement. This model examines the consistency between cognitive functioning domain-specific skills and academic achievement requiring the use of these skills (Flanagan & Ortiz, 2001). For example, if the child was referred for low academic reading performance the examiner would compose a cognitive assessment battery, based on the CHC stratum, which was designed to assess the cognitive skills required for effective reading such as auditory processing, short-term and long term memory, and comprehension knowledge. Consistency between selected subtest/instruments within the strata can serve as useful information to inform intervention strategies related to the specific area of concern (Flanagan & Ortiz, 2001).

Flanagan, Ortiz, Alfonso and Mascolo (2007) provide an examiner with specific guidelines regarding implementation of this model with culturally and linguistically diverse individuals. Subtests within commonly administered psychological tests were analyzed on two dimensions, cultural loading (familiarity with the mainstream culture) and linguistic demand (English competency), in order to determine the level (low, moderate, high) of inherent bias within the task demand (Flanagan & Ortiz, 2002). Within this model, low level of cultural loading and linguistic demand leads to more valid/reliable results. Performance is most greatly affected by high levels of these two dimensions. This cross-battery assessment model provides the examiner with subtest level specific guidelines to assist in selection, administration and interpretation for students who are culturally and linguistically diverse such as individuals who are deaf. Due to the current lack of adequate traditional assessment cognitive measures for deaf students, the use of cross-battery assessment provides the examiner with guidelines of assessment that are more culturally and linguistically appropriate. Even carefully selected subtests with "low bias" classifications have not undergone item response analysis and therefore may not be measuring the construct for which is was intended thus calling into question the true accuracy of the subsequent score interpretations.

Executive functioning

The cross-battery assessment approach focuses on methods to provide cognitive assessment services; the emerging executive functioning model, in contrast, assesses an individual's ability to modulate these cognitive capabilities in order to reach an intended goal (Gioia, Isquith, & Guy, 2001). The term executive functioning has slight definitional variation due to its long history of use in multiple disciplines (Anderson, 2001; Gioia &

Isquith, 2004; Gioia, Isquith, Kenworthy, & Barton, 2002; Miyake, Emerson, & Friedman, 2000). A common characteristic among definitions is that executive functioning is an umbrella construct which refers to an individual's ability to engage in goal-directed problem-solving with novel tasks (Anderson, 2001; Gioia, Isquith, & Guy, 2001).

Based on a commonly used conceptualization by Gioia, Isquith, Guy and Kenworthy (2000), the term executive function is composed of discrete interlocking skills including the ability to inhibit impulses, shift attention, control emotions, start a task, have the ability to plan for the future, organize materials, monitor progress and use working memory capabilities. Unlike other psychological constructs, an 'executive functioning disorder' can not be diagnosed as a result of the heterogeneous nature of student's behavioral and metacognitive manifestations (Gioia et al., 2002).

Neuropsychological Assessment

Neuropsychological assessment measures require the use of abstract reasoning, activation of working memory, inhibitory control, and the use of future-time orientation. Prior to administration of any neuropsychological assessment measure, cognitive processes must be determined to be intact in order to confirm that performance is indeed directly related to difficulties in the area of executive functioning (Anderson, 2001; Gioia, Isquith, & Guy, 2001). Common assessment measures include the Verbal Fluency (express as many words as possible beginning with a common letter), Tests of Variables of Attention (endorse the correct stimulus presented on a computer screen), Wisconsin Card Sorting Test (sort cards based on a changing criterion), Color Trails Test (connect numeric circles in alternating color order), Tower of Hanoi (replicate a tower model by moving shapes to various pegs), and Rey-Osterreith Complex Figure Test (copy and recall a visually-complex geometric shape) (Anderson, 2001; Gioia, Isquith, & Guy, 2001).

The Wisconsin Card Sorting Test (WCST) is a commonly used test to assess executive functioning (Lawrence, et al., 2004; Riccio, et al., 1994; Romine, et al. 2004). For this task, the examinee matches stimulus cards based on characteristic similarities (color, number, and form). During administration, the examiner provides limited prompts to the examinee by either stating "Right" or "Wrong" as the sorting criteria changes unannounced. This task requires the student to engage in abstract reasoning while engaging in cognitive set shifting, working memory, and a planned systematic approach for successful completion (Heaton, 2005).

Historically neuropsychological assessments have provided information regarding the executive functioning capabilities of individuals with and without hearing loss. These studies, analyzing domain-specific executive functioning skills, provide useful information regarding the problem-solving capabilities of deaf students and the possible affects of reduced audition and a signed communication modality. For this study, the Gioia et al. (2000) executive functioning framework was used to review the current research findings related to deaf individual's executive functioning. This framework divides an individual's executive function capabilities into eight distinct skills. These skills include: Inhibit (resist impulses), Shift (redirect one's attention), Emotional Control (manage emotions), Initiate (start a task), Working Memory (hold and manipulate information in one's mind), Plan/Organization (create steps to reach future goals), Organization of Materials (functional work space), and Monitor (awareness of one's behavior/level of understanding).

Inhibit. Inhibition refers to an individual's ability to resist behavioral impulses. Historically, findings have suggested that deaf individuals are more impulsive than hearing individuals (Parasnis, Samar, & Berent, 2003; Samar, Parasnis, & Berent, 1998). Mitchell and Quittner (1996) indicate that deaf individuals between the ages of 6 and 14 years (39 deaf participants; mean age = 9 years) made more overall errors (commission, anticipatory and unrelated errors) than their hearing counterparts on a continuous performance test designed to measure one's ability to correctly identify the number nine which was preceded by the number one.

Parasnis, Samar, and Berent, (2003) administered the Tests of Variables of Attention (T.O.V.A) to 44 deaf college students between the ages of 20 and 28 years (23 woman, 21 men; mean age 22 years) who were selected because these participants did not previously display characteristics of Attention Deficit Hyperactivity Disorder (ADHD). This assessment is presented within the central visual field and does not assess attention capabilities within the periphery. Findings suggest that deaf individuals made more errors on this measure as compared to their hearing counterparts (17 women, 21 men; between the ages of 20 and 27 years), which is expected given the central placement of this assessment measure. Deaf individuals' broader allocation of resources of attention across a large visual field lowers their capabilities to identify target stimuli within the central field as accurately as their hearing counterparts. These noted errors on the T.O.V.A assessment measure appear to reflect differences in attention allocation rather than sole difficulties related to inhibition.

Bosworth and Dobkins (2002) investigated differences in sustained, divided and selective attention as it relates to deaf signers (16 participants; mean age = 31 years), hearing signers (10 participants; mean age = 32 years), and hearing non-signers (15 participants; mean age = 28 years). All tasks of attention for this study were presented within the peripheral visual field as compared to Parasnis, Samar, and Berent (2003) study with tasks presented within the central field. Results suggest that deaf participants demonstrated a slight advantage in their ability to orient spatial attention with similar levels of divided attention capabilities noted between all three groups. During the selective attention task, deaf subjects performed better when identifying the motion target among distracters as compared to the motion target without distracters. This finding indicates that deaf adults may be more affected by the presence of distracters within the peripheral field as compared to their hearing counterparts. In sum, both of these studies noted a difference in deaf individual's allocation of resources of attention as compared to their hearing counterparts. This difference is often perceived as difficulties with inhibition but rather these are affects most likely due to the lack of or reduce auditory input.

Previous findings have supported this above claim stating that characteristics of attention allocation between individuals with and without hearing loss may affect characteristics of inhibition (Parasnis, Samar, & Berent, 2003) Deaf individuals tend to use a visually encoding strategy to take in information from the environment which leads to allocation of attention to both the central and peripheral visual fields (Bavelier et al., 2000; Rothpletz, Ashmead, & Tharpe, 2003; Sladen, Tharpe, Ashmead, Grantham, Chun, 2005). Deaf individuals need to utilize this broader visual field to gain environmental information whereas their hearing counterparts can rely solely on their central visual field and process the additional information through the use of audition. In addition, encoding sign language requires allocation of attention to the central field to see facial expression and the peripheral field to view the signs within the sign field.

Signed communication also influences deaf individual's performance on neuropsychological assessments. Wolff, Radecke, Kammerer, and Gardner (1989) administered the Stoop Color test (naming the color ink on written names of colors) to 27 deaf adults signers between the ages of 23 and 44 years (mean age = 34 years) and 29 hearing individuals fluent in sign with the same age range (mean age 33 years) . Results indicate a significant slower rater of completion when signed (hearing or deaf) as compared to the oral communication modality. Overall, these findings suggest that deaf individuals when completing this task may appear to display lower levels of inhibition but this is rather a reflection of a slower rater of completion using as signed communication modality as opposed to a spoken mode.

Shift. Shift refers to an individual's ability to transition between different activities or move between steps within an activity. As indicated previously, the differing characteristics between attention allocation among deaf and hearing groups may directly affect an individual's shifting capabilities. For example, the influence of a wider spread of resources of attention may result in a deaf student frequently shifting his/her attention away from the activity at hand in order to attend to movement within the periphery (relevant or interference) more often than a hearing individual who may obtain this environmental information though audition (Bosworth & Dobkins, 2002; Proksch & Bavelier, 2002).

Kelly (1995) administered the Category Test (a card sorting task with examiner feedback –similar to the WCST) and Trail Making Test Part A (connect numbers in ascending order) and Part B (connect alternating numeric and alphabetic stimuli) in order to determine potential differences between deaf individuals and matched hearing controls in relation to the executive functioning skill of shifting. This study consisted of 84 participants (42 deaf and 42 hearing) between the ages of 12 and 14 years (mean age 13.2 years). Results indicate no significant difference between the groups on their Category Test and the Trail Making Test Part A performance. In contrast, deaf participant scores on the Trail Making Test Part B fell within the normal limits but were significantly below the scores obtained by the hearing control group. Overall, further confirmatory support is needed in order to resolve the current inconsistencies regarding shifting capabilities and the potential influence of attention allocation with deaf individuals (Miller et al., in press).

Emotional Control. Emotional Control refers to an individual's ability to regulate and modulate emotions when solving academic and/or social problems. There is a general lack of neuropsychological measures designed to assess the executive functioning capabilities of emotional control for individuals with and without hearing loss. As a result, emotional control is most commonly assessed by observations and completion of behavior rating scales.

Initiate. Initiate refers to an individual's ability to begin a task as measured by latency and reaction time. Rothpletz, Ashmead, and Tharpe (2003) examined the speed of initiation when comparing the performance of deaf and hearing adults. This study consisted of 20 participants (10 deaf and 10 hearing) between the ages of 18 and 45 years (mean age 30.75 years). Within this study participants engaged in four presented tasks with two changing variables: locations within the periphery and the presence of visual distracters. Findings suggest that deaf adults demonstrated slower reaction time as compared to the hearing counterparts during a non-distracter task nearest to the central field and both tasks involving distracters regardless of the location in the periphery. These findings suggest that deaf adults, who tend to gather the majority of environmental information visually, may be more deliberate in their response patterns as compared to their hearing counterparts thus resulting in slower initiation behaviors.

Sladen et al. (2005) further analyzed the initiation characteristics of deaf and hearing adults when presented with information in different locations within the visual field. This study consisted of 20 participants (8 men and 12 women) between the ages of 21 and 45 years (mean age = 30 years). These participants were further divided into two groups: a deaf group (4 women and 6 men) and a hearing group (8 women and 2 men). Findings suggest that deaf adults had a significantly slower response speed with fewer errors as compared to the hearing control group. Both of these findings suggest that deaf individuals may initiate presented tasks more slowly, which appears to be related to the need to efficiently manage his/her visual field by responding deliberately and intentionally when needed.

Working Memory. Working memory refers to an individual's ability to take in and hold information in his/her immediate awareness, mentally manipulate the information, and produce the needed output. There is currently limited research as to the working memory capabilities of deaf students, due to the influencing modality specific constraints (Marschark, 2003). In contrast, memory capabilities related to Short-Term Memory and

Long-Term Memory have been analyzed with deaf students with some studies using the term 'Working Memory' interchangeably when referring to these two memory areas.

Research findings, in the area of short-term memory, indicate that the auditory loop is a more effective memory process for sequential information as compared to the visual-based encoding system, which favors more effective recall of spatial information (Boutla, Supalla, Newport & Bavelier, 2004; Emmorey, 2002). Deaf native American Sign Language (ASL) users performed equally well on the digits forward and digits backward tasks, whereas hearing individuals performance on these two different memory tasks was not equal (Wilson & Emmorey, 2001). The fixed-location signs (eg., "lemon", "metal") were more difficult to remember as compared to neutral-location signs (eg., "Texas," "library") (Wilson & Emmorey, 2001). Therefore, findings indicate that the use of the visual-based encoding strategy and characteristics of the signed modality affect performance on short-term memory tasks (Wilson, 2001).

In the area of long-term memory deaf individuals tend to use less taxonomic organization techniques and less automatic use of categories, but are more apt to determine the category when given exemplars while hearing students demonstrated reverse patterns (Marschark, Convertino, McEvoy, & Masteller, 2004). Overall, these findings suggest that short and long term memory and the executive functioning skill of working memory are affected by reduced audition and communication modality for deaf individuals.

The development of memory capabilities is intricately intertwined with the development of language (Marschark 2003; Miller et al., in press). Language, as a symbol system, provides a medium in which material can be organized and stored

(Marschark, 1997; Moores, 2001). The question remains how does memory function in the absence of language? When working with deaf individuals who experience late or even limited exposure to language as a result of reduced audition and poor early language intervention this question is paramount.

Plan/Organize and Organization of Materials. Plan and Organization refers to an individual's ability to use future-orientation to identify and sequence needed steps to complete the intended goal whereas Organization of Materials focuses primarily on utilizing materials effectively. To examine plan/organization processes Luckner and McNeill (1994) administered the Tower of Hanoi (use a planned approach to move pieces between pegs in the lowest number of moves to match the given model) to deaf and hearing individuals. Results indicate that individuals with hearing loss demonstrated lower performance in planning as compared to the hearing counterparts with a narrowing performance gap between these two groups as a function of age. Observationally, it was noted that deaf and hearing individuals may engage in different organizational methods of completing the Rey-Osterrieth Complex Figure (ROCF) (recall and copy of a complicated geometric shape), suggesting differing processing methods within this area. Overall, there is limited research in regarding Plan/Organization and no research at this time regarding patterns of material organization for deaf individuals (Miller et al., in press). Systematic observations, informant reports, and neuropsychological assessment are needed within this area.

Monitor. Monitor refers to an individual's ability to have self-awareness as to his/her progression to a given goal and the skills to modify behavior if needed. Assessment in this area is limited due to a lack of neuropsychological measures to assess this skill. The Behavioral Rating Inventory of Executive Function (BRIEF) informant report is recommended as a useful measure to assess self-monitoring with deaf individuals (Rhine, 2002). Studies are needed in order to determine the monitoring capabilities of deaf individuals as compared to hearing controls.

Informant Report

The ecological validity of these neuropsychological assessment measures has been questioned (Burgess, et al., 2006; Gioia et al., 2002; Miyake et al., 2000). Examinees' responses are confined by the artificial testing setting which is executively controlled by the examiner. This contrived situation is far different than real-world contexts (Anderson, 2001; Gioia & Isquith, 2004). Findings indicate that there is a low correlation between a hearing student's performance on a neuropsychological measure and his/her actual executive functioning in the environment (Anderson et al., 2002; Mahone, et al., 2002; Vriezen & Pigott, 2002).

Even though informant reports appear to have greater utility when assessing a student's everyday executive functioning behaviors, these measures also have limitations. Unlike neuropsychological assessments that measure a student's actual behavioral performance, informant reports rely solely on raters to assess and accurately report the occurrence of these target behaviors. Multiple research findings report a low to moderate correlation between parent and teacher ratings for hearing individuals, suggesting behavioral differences between the home and school environment (Achenbach, McConaughy, & Howell, 1987; Youngstrom, Loeber, & Stouthamer-Loeber, 2000). These differences may be attributed to varying setting demands between the home and school setting and contrasting interpretations of 'typical behavior' between raters. Due to the overall lack of research comparing parent and teacher ratings for deaf students, the relation between parent and teacher ratings is unknown but assumed to be similar to the correlations for hearing children.

Behavior Rating Inventory of Executive Function

The Behavioral Rating Inventory of Executive Function (BRIEF), developed by Gioia et al. (2000) was designed to capture the individual's executive functioning capabilities within a real-world context through the use of an informant report (Gioia & Isquith, 2004).

Research studies using the BRIEF have confirmed specific profile characteristics for disabilities such as Attention Deficit Hyperactivity Disorder (ADHD), Bipolar Disorder, Tourette syndrome, Autism Spectrum Disorder, Reading Disability and Traumatic-Brain Injury (Gioia, Isquith, & Guy, 2001; Gioia et al., 2002; Mahone, et al., 2002; Shear, DelBello, Rosenberg, & Strakowski, 2002). In addition, specific BRIEF profile patterns have been found present for individuals with spina bifida, hydrocephalus, phenylketonuria and maternal phenylketonuria, and obstructive sleep apnea, (Anderson et al., 2002; Antshel & Waisbren, 2003; Beebe et al., 2004; Burmeister, et al., 2005).

Attention Deficit Hyperactivity Disorder. Overall findings suggest that individuals with Attention Deficit Hyperactivity Disorder (ADHD) exhibit elevated levels of executive functioning difficulty in the behavioral regulation area (depending on subtype the raters Inhibit scale varied) and the metacognitive area (specifically in the areas of Working Memory, Plan/Organization, and Monitor) (Gioia et al., 2002; Jarratt, Riccio, & Siekierski, 2005; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). In addition, these patterns are consistent regardless of setting as noted by a high statistically significant correlation (.46 to .72) between the Parent and Teacher BRIEF with statistically significant levels ($p<.001$) for seven of the eight clinical scales ($p<.01$ was reported for the remaining scale) (Jarratt, et al. 2005).

Tourette Disorder. Individuals with Tourette disorder (without ADHD) were rated as having similar behavioral patterns as compared to the controls in the assessed areas of the Parent BRIEF (composite, indices, and Inhibit clinical scale) with noted elevated difficulties in the area of Working Memory (Mahone, et al., 2002). At this time, there is no data regarding the level of correlations between Parent and Teacher report for individuals with Tourette Disorder.

Bipolar Disorder. Individuals with Bipolar Disorder (without ADHD) executive functioning capabilities on the Parent BRIEF, were significantly elevated and clinically meaningful on each clinical scale (Shear et al., 2002). This finding suggests that individuals with Bipolar disorder would benefit from highly intensive executive functioning support throughout the day. Information regarding correlations between the BREIF Parent and Teacher report is unknown due to lack of empirical studies.

Autism Spectrum Disorder. Overall, individuals on the autism spectrum demonstrate more difficulty with executive functioning tasks as compared to a control group (Ozonoff & McEvoy, 1994; Prior & Hoffmann, 1990; Tsuchiya, Oki, Yahara, & Fujieda, 2005). Profile analysis of students on the autism spectrum indicated consistent clinically significant elevation (above 65) with the Parent BRIEF mean t-scores in the areas of Shift, Working Memory, Plan/Organization, and Monitor with inconsistent elevation for Inhibit (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Gioia et al., 2002). Individuals experiencing Autism Spectrum Disorder may need external executive support in the areas of transitions, simultaneously holding and manipulating two or more ideas in immediate awareness, using a schedule to plan for future events, pragmatic communication support to aid in self-monitoring skills, and possible strategies to resist impulses. Further research studies to determine possible differences in parent and teacher informant reports on the BRIEF are needed.

Reading Disorder. Individuals with reading disorder were rated on the Parent BRIEF as having significantly higher difficulties in the areas of Working Memory, Plan/Organization and Monitor scales as compared to the matched control group with one scale (Working Memory) falling within the Clinically Significant range (Gioia et al., 2002). This finding suggests that individuals may benefit from memory strategies, methods of organization, and self-monitoring strategies. Further information is needed as to the level of correlation between Parent and Teacher BRIEF reports for students with reading disorder.

Traumatic-Brain Injury. Individual's who have experienced a Traumatic-Brain Injury (TBI) may experience executive functioning difficulties (Brookshire, Levin, Song, & Zhang, 2004; Gioia & Isquith, 2004; Vriezen & Pigott, 2002). Research studies have indicated that more severe TBI directly relates to greater difficulties in areas of executive functioning capabilities as measured by the Parent BRIEF (Gioia et al., 2002; Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002). These findings confirm the importance of a clear medical history regarding the severity and possible effects of the student's Traumatic Brain Injury in order to provide effective services. Further information is needed regarding the level of executive functioning capabilities of students with TBI as rated by teachers, in order to compare between informants.

Hearing Loss. Rhine (2002) measured the overall executive functioning capabilities of deaf individuals using the BRIEF Parent form. This study consisted of 62 deaf students (30 men and 32 women) with a mean age of 11 years (standard deviation: 4.15) with a hearing control group matched on gender, age and ethnicity. According to parent report, the majority of the participants were diagnosed with a severe to profound hearing loss with reported use of hearing aids with a few students using cochlear implants. Within this sample, 24.2% were deafened as a result of genetics/family history and 24% lived in a family with another deaf member. Within the Rhine (2002) sample, 27% were taking medications typically taken for Attention-Deficit Hyperactivity disorder, asthma/allergies, seizures, and general anxiety disorder/depression. Overall students primarily used a signed or oral communication modality (Rhine, 2002).

Rhine found that the mean clinical scales, indices, and composite t-scores for the deaf sample all fell below the clinically significant range (cut-off score of 65). In addition, the deaf sample Parent BRIEF mean t-scores were significantly higher than the hearing control group on the clinical scales of Inhibit, Shift, and Working Memory. This difference may be due to sensory deprivation, a possible differing developmental progression, or neuropsychological factors affecting memory components (Rhine, 2002).

Rationale for this study. It was hypothesized that there would be similar results to Rhine's (2002) findings on the executive functioning capabilities of deaf students as rated by parent report on the BRIEF. Rhine (2002) reported that deaf students rated capabilities on the BRIEF (Parent report) was similar to the hearing control group on all clinical scales except higher levels of difficulties (still falling within the non-clinically significant range) in the areas of Inhibit, Shift, and Working Memory. This study hypothesized that there would be a low to moderate correlation between Parent and Teacher informant reports on the Behavior Rating Inventory of Executive Function (BRIEF) when rating a student's executive functioning capabilities similar to those reported in the BRIEF manual for the normative sample. Corresponding with previous research (Anderson et al., 2002; Mahone, et al., 2002; Vriezen & Pigott, 2002), it was hypothesized that there would not be a relationship between a deaf student's performance on select student performance measures and informant (teacher and parent) reports of deaf student's executive functioning behaviors. Lastly, it was hypothesized that there would be a significant difference between genetically deaf individuals and non-genetically deaf individuals on both the BRIEF informant reports and neuropsychological tests.

CHAPTER THREE

Method

Participants

Students. Students were recruited at a western New York residential school with a school population of approximately 160 students, ages 5 to 18 years. Students whose reevaluation for special education was due for the 2005-2006 school year were selected to participate. Out of the 33 student participants who qualified to participate in this study, 23 students participated. One participant was ultimately excluded from analysis based on a motor impairment. The subsequent sample used for analysis included 22 student participants (16 male and 6 female); between the ages of 5 and 18 with an average age of 11 years, 9 months. Displayed in Table 1 and Table 2 are the demographic characteristics of this student sample. All student participants were diagnosed with a stable hearing loss ranging from moderate-severe (n=1), severe-profound (n=5) and profound (n=16). According to school records, 8 of the 22 students had a member in his/her immediately family who had a hearing loss this included students who had documented hereditary deafness (n=5), had siblings (n=1) or extended family members (n=1) who were deaf, or who were adopted into families with deaf members with a medical etiology of deafness (n=1). Within this sample, 5 out of 22 students were reported to have an etiology of hereditary deafness (children of deaf parents). Cognitive functioning abilities, as reported in the student record (n=17), ranged in standard scores from 60 to 120 with an average score of 94.

Parents/ Legal Guardians. Twenty One Parents/Legal Guardians (6 deaf, 16 hearing) completed the Behavioral Rating Inventory of Executive Function: Parent Form

(Gioia et al., 2000) to rate the student participants' problem-solving behavior within the home environment. For the remainder of this document, the term 'Parent' will refer to the child's legal guardian or biological parent.

Teachers. Teacher participants were identified based on who had the highest hourly contact per week with the student participant. Of the 22 student participants, 15 of the teachers were selected to participate in this study. These selected teachers ranged in hearing status (deaf to hearing) and signing background (children of deaf adults to acquired sign language competencies).

Instrumentation

This study consisted of the use informant reports, two neuropsychological measures, seven cognitive assessments and three achievement measures.

Behavioral Inventory of Executive Function (BRIEF) Parent and Teacher Form. The Behavioral Inventory of Executive Function (BRIEF) (Gioia et al., 2000), appropriate for ages 5 to 18, was completed by the student participant's parent and the identified teacher. Structurally, the BRIEF uses a Likert-scale format (Never, Sometimes, Often) for behavioral reporting. A scored report consists of a Global Executive Composite (all eight clinical scales), a Behavioral Regulation Index (Inhibit, Shift, Emotional Control), a Metacognition Index (Initiate, Working Memory, Plan/Organize, Organization of Materials, Monitor), and two validity scales (Inconsistency and Negativity). The BRIEF has high internal consistency (alpha= .80-.98) and a test-retest reliability of .82 for parents and .88 for teachers.

Wisconsin Card Sorting Test Computer Version 4: Research Edition. The Wisconsin Card Sorting Test: Computer Version 4: Research Edition (WCST) (Heaton, 2005), is a problem-solving and decision making task which requires the student participant to use external clues to guide behavior. The WCST requires the student participant to determine the sorting rule (color, form, or number) based upon computer generated feedback of "right" or "wrong." After correctly identifying ten consecutive sequences of the sorting rule in effect, the sorting rule changes unannounced to the student participant. As the student participant moves through the stack of cards displayed on the computer screen, the criterion changes until either the student successfully completes the six criterion sets or until all 128 cards are administered. The generalize coefficient for hearing individuals falls between .37 and .72.

Color Trails Test (CTT). The Color Trails Test (CTT) (D'Elia, Satz, Uchiyama, & White, 1996) Form A was administered to 4 participants who were 18 years old. This neuropsychological measure consists of two parts: Trail 1 (CTT-1) and Trail 2 (CTT-2). In CTT-1, the participant uses a pencil to sequentially and rapidly connect circled numbers 1 through 25 on the provided stimulus page. For CCT-2, the participant continues to rapidly connect the numbered circles in sequence while alternating between two colors. The examiner uses a stopwatch to record the amount of time required for completion and qualitative features of performance. The temporal stability of this instrument fell between .64 -.78 for hearing individuals.

Children's Color Trails Test (CCTT). The Children's Color Trails Test (CCTT) (Llorente, Williams, Satz, & D'Elia, 2003), Form K follows the similar properties of the Color Trails Test previously described but was designed for assessment of children between the ages of 8 through 16 (Williams et al., 1995). Unlike the Color Trail Test, the

Children's Color Trail Test requires numeric sequences from 1 to 15 instead of 1 to 25. The temporal stability of this instrument fell between .46-.68 for hearing individuals.

Leiter International Performance Scale: Revised: Attention Sustained. The Leiter International Performance Scale: Revised (Leiter-R) subtest Attention Sustained (AS) (Roid & Miller, 1997) was administered to all student participants using either Booklet B or Booklet C depending on the student's age. Each booklet contained four practice and four scored stimulus prompts, which increased in visual complexity. Each prompt consisted of selected geometric shape(s) at the top of the page that corresponded to the same identical shape(s) present in a framed visual field on the same page. The student was instructed to cross-off the corresponding shapes within a specified timeframe. The internal consistency of this instrument for hearing individuals fell between .83-.92.

Woodcock Johnson: Tests of Cognitive Abilities: Third Edition: Selected Subtests. The Woodcock Johnson Tests of Cognitive Abilities: Third Edition (WJ-III COG) (Mather & Woodcock, 2001), selected subtest was administered to all students. The Visual Matching subtest requires the student participant to visually scan a row of five numbers and use a pencil to cross off the two identical repeating numbers. For hearing individuals, the Test Re-Test reliability for this instrument fell between .70 and .87.

The Visual Auditory Learning and Visual Auditory Learning Delayed subtests were administered. The Visual Auditory Learning subtest requires the student participant to learn the one-to-one correspondence between a rebus symbol and a given word. The participant must use this knowledge to "read" stimulus prompts presented in a symbol format. After approximately 45 minutes the student participant was required to "read" the stimulus prompts without review of the symbol-word correspondence for the Visual

Auditory Learning delayed subtest. The reliability of this specific subtest was not reported in the technical manual.

Kaufman Assessment Battery for Children: Second Edition: Hand Movements. The Kaufman Assessment Battery for Children Second Edition (KABC-II) (Kaufman & Kaufman, 2004), Hand Movements subtest requires the student participant to copy the hand shape sequences presented by an examiner. The manual reports an internal consistency between .73 and .84 when administered with hearing individuals.

Stanford Binet: Fifth Edition: Procedural Knowledge and Picture Absurdities. The Stanford Binet Fifth Edition (SB-V) (Roid, 2003), subtests of Procedural Knowledge and Picture Absurdities were administered. The Procedural Knowledge subtest requires student participants to view pictured objects and demonstrate the corresponding action. The Picture Absurdities subtest requires the student participant to identify the area of strangeness or the impossible nature of a presented picture stimulus. The internal consistency of this subtest for hearing individuals is between .74 and .88.

Woodcock Johnson: Tests of Achievement: Third Edition: Selected Subtests. The Woodcock Johnson: Tests of Achievement: Third Edition (WJ-III ACH) (Mather & Woodcock, 2001), Reading, Writing and Math Fluency subtests were selected for this study. These subtests measure a student participants ease and speed when completing paper and pencil tasks. Reading Fluency requires a student to rapidly read printed statements and mark if the statement is true or false. The Writing Fluency subtest requires the student to write simple sentences when given a picture or word prompt. Math Fluency requires the student participant to rapidly complete addition, subtraction and multiplication problems. The Test- Retest reliability of the Reading Fluency, Writing

Fluency, and Math Fluency subtests range from .80-.94, .76-.84, and .89-.95, respectively.

Procedures

All parents were sent an informational letter signed by the superintendent, a study description, and an informed consent form. The primary investigator contacted parents through phone calls (voice, TTY, videophone), face-to-face discussion, and via email to discuss the purpose of this study. Following this conversation, an informational letter composed by the primary investigator, parent BRIEF, and a self-addressed postage paid envelope was sent home via the child's backpack or through the postal mail. The primary investigator conducted follow-up conversations, resent materials, and enlisted the consultative services of the school psychologist in order to obtain informed consent and completed Parent BRIEF rating forms. Depending on the parents preference the BRIEF was either completed through a written form or items were read/signed with response documented by the primary investigator. Of the potential 33 student participants between kindergarten and twelfth grade, there was a 66.67 % response rate (n=23).

During the initial months of the school year, two presentations were conducted to the school personal (administrators and teachers) explaining the purpose of this study with a request for completion of the Behavioral Inventory of Executive Function (BRIEF). Following the teacher presentation, the primary investigator placed a written request and the BRIEF Teacher form in the teacher's school mailbox. Written and face-to-face contacts were conducted in order to ensure a 100% response rate.

After obtaining parental consent, the primary investigator analyzed the student participant's schedule and determined the most ideal assessment time based on feedback from the principal, director of curriculum and instruction, and the school psychologist. The primary investigator created a tentative schedule and sent out individualized emails to request the specified assessment time.

Administration Preparation. The subtests were presented in a random order to reduce the potential of ordering effects. Also to reduce the potential biased in test translation, the primary investigator created a videotape of the signed directions which was viewed and critiqued by two psychologists who work with deaf individuals.

Student Administration. The primary investigator met the student at his/her classroom at the assigned administration time. Upon entering the designated assessment room, the primary investigator discussed with the student his/her preferred mode of communication and complied with this request throughout the examination. Prior to assessment, the student participant was provided with an assent form, explained the purpose of assessment, and asked if he/she would like to voluntary participate. The student performance assessment battery took between 45 minutes to 1 hour and 15 minutes depending on the needs of the student and the assessment battery administered. All assessments were conducted on the same day except for two students who each required an additional session based on time limitations. The Woodcock Johnson Test of Achievement: Third edition (WJ-III ACH) fluency data was collected from the Educational Evaluator, throughout the 2005-2006 school year. The student participant's performance was compared to that of his/her same age hearing peers as found in the instrument manuals.

The age limitations of select student measures and informants ability to rate a student's observed student capabilities affected the sample size for this study. Twenty out of the Twenty-two student participants engaged in all student performance measures and both parent and teacher raters were able to record the student's capabilities on all BRIEF scales. The two youngest students (age 5), were unable to engage in the Wisconsin Card Sorting Test (age range is between 6 years, 6 months and 89 years) and the Children's Color Trails Test (age range is between 8 and 16 years). In addition, the BRIEF clinical scale of Plan/Organization was unable to be scored due to more than 2 missing responses within this scale. Upon follow up with the raters, it was noted that these students have not yet acquired writing skills and didn't have regular homework so these items on the BRIEF could not be reported. Data analysis accounted for this difference by noting the respective sample size used for each given scale or calculation on each table.

CHAPTER FOUR

Results

Comparison to research data collected by Rhine (2002) using the BRIEF

A one sample t-test with the Test Value based on data from the Rhine (2002) Parent BRIEF for the deaf sample was conducted. The BRIEF mean Parent t-scores from this study were statistically higher than the deaf sample means from the Rhine (2002) study on the clinical scales of Initiate, Plan/Organize, and Organization of Materials (See Table 3).

Paired BRIEF Informant Reports

All BRIEF Parent and Teacher means for the eight clinical scales, two indices, and composite score, fell below the cut-off criterion (t-score =65), indicating that no clinically significant mean elevations were present (See Table 4). As shown in Table 5, significant positive correlations ($p<.01$) were found between teachers' and parents' ratings on all eleven BRIEF measures except Shift, Emotional Control, and the Behavioral Regulation Index (BRI).

Informant and student performance correlations

A Pearson Product-Moment correlation was used to compare five of the clinical scales (Inhibit, Shift, Working Memory, Plan/Organize, and Monitor) from the Parent and Teacher BRIEF to two neuropsychological, five cognitive and three achievement measures.

The Wisconsin Card Sorting Test two scoring factors, Total Errors and Perseverative Responses were significantly negatively correlated to Parent and Teacher BRIEF clinical scales, as shown in Table 6. Four out of five clinical scales (Shift, Working Memory, Plan/Organize, Monitor) and the remaining clinical scale (Inhibit) from the Parent BRIEF was significantly negatively correlated ($p<.01$, $p<.05$, respectively) to the WCST Total Errors and Perseverative Reponses. Three out of five clinical scales (Inhibit, Plan/Organize, and Monitor) and one clinical scale (Working Memory) from the Teacher BRIEF was significantly negatively correlated ($p<.01$, $p<.05$, respectively) to the WCST Total Errors. One out of five clinical scales (Inhibit) and one clinical scale (Monitor) from the Teacher BRIEF was significantly negatively correlated ($p<.01$, $p<.05$, respectively) to the WCST Perseverative Reponses.

The Children's Color Trails Test/Color Trails Test Part One (CCTT/CTT-1) and Part Two (CCTT/CTT-2) were not significantly correlated to the Teacher BRIEF. The Parent BRIEF was significantly correlated to the CCTT/CTT-2 but not the CCTT/CTT-1, as shown in Table 7. Three out of five BRIEF Parent clinical scales (Inhibit, Shift, Working Memory) and the remaining two clinical scales (Plan/Organize, Monitor) were significantly negatively correlated ($p<.01$, $p<.05$, respectively) to the CCTT/CTT-2.

The Leiter International Performance Scale: Revised (Leiter-R) Attention Sustained scores of Full Scale, Correct Responses, and Errors were not significantly correlated to the informant reports except for a significant difference between the Leiter-R Errors and the Parent BRIEF report, as shown in Table 8. Three out of five clinical scales (Shift, Working Memory, and Monitor) and one clinical scale (Inhibit) from the Parent BRIEF was significantly negatively correlated ($p<.05$, $p<.01$, respectively) to the Leiter-R Errors scale.

The Woodcock Johnson Tests of Cognitive Abilities: Third Edition (WJ-III COG) subtest Visual Matching was not significantly correlated to the BRIEF informant reports except for a significant negative correlation ($p<.05$) between the Visual Matching subtest and the Monitor clinical scale on the BRIEF Parent report, as shown in Table 9.

The Kaufman Assessment Battery for Children Second Edition (KABC-II) Hand Movements was not significantly correlated to the BRIEF informant reports except for a significant negative correlation ($p<.05$) between this subtest and one clinical scale (Working Memory) from the Teacher BRIEF and two clinical scales (Plan/Organize, Monitor) from the Parent BRIEF, as shown in Table 9.

The cognitive assessment including Stanford Binet Fifth Edition (SB-V) subtests of Procedural Knowledge and Picture Absurdities and the Woodcock Johnson Tests of Cognitive Abilities: Third Edition (WJ-III COG) subtests of Visual Auditory Learning and Visual Auditory Learning Delayed were not significantly correlated to any of the BRIEF scores for either informant.

The Woodcock Johnson: Tests of Achievement: Third Edition (WJ-III ACH) Reading and Math Fluency subtests were not significantly correlated to the BRIEF informant reports. There was a significant negative correlation ($p<.05$) between the WJ-III ACH Writing Fluency and one clinical scale (Shift) from the Teacher BRIEF and two clinical scales (Inhibit, Monitor) from the Parent BRIEF, as shown in Table 10.

Partial correlations were conducted between the BRIEF (Parent and Teacher) and the student performance scores (neuropsychological, cognitive and achievement) controlling for the possible influence of the age variable. Results indicate a similarity between the bivariate and partial correlations overall, however; higher partial correlations with the WJ-III Visual Matching and KABC-II Hand Movements were present.

Multiple Regressions with the Parent and Teacher BRIEF

Six hierarchical regressions were used to determine the best set of predictors (neuropsychological, cognitive or achievement) for the three executive functioning measures Global Executive Composite (GEC), Behavioral Regulation Index (BRI), and the Metacognition Index (MCI) for both the Parent and Teacher BRIEF, as shown in Table 11 and 12.

Three executive functioning scores (GEC, BRI, MCI) from the Parent and Teacher BRIEF served as the dependent variables for analysis of multiple regression. Independent variables was selected if the majority of correlations (without controlling for age) were significant at the .01 or .05 level, which resulted in predictors including the Wisconsin Card Sorting Test Total Errors (TE) and Perseverative Responses (PR), and the Children's Color Trails Test/Color Trails Test-Trail 2 (CCTT/CTT-2) scores. The achievement variable of Writing Fluency from the Woodcock-Johnson Third Edition was selected because it was the most highly correlated to the BRIEF as compared to the other achievement measures. These four independent variables (WCST Total Errors, WCST Perseverative Responses, CCTT/CTT-Trail 2, WJ-III Writing Fluency) served as the predictors for all analyses of regression.

Three dependent variables (GEC, BRI, MCI) of the Parent BRIEF were predicted from the established set of independent variables. The effect of WCST Total Errors and Writing Fluency on the dependent variable (GEC) was statistically significant, $F(2, 14) = 16.553$, $p<.000$ and accounted for 70% of the variance. Similar to the GEC, the effect of WCST Total Errors and Writing Fluency on the dependent variable (MCI) was statistically significant, $F(2, 14) = 14.506$, $p<.000$ and accounted for 68% of the variance. The effect of CTT/CTT-2 on the dependent variable (BRI) was statistically significant, F

(1, 15) = 16.915, p<.001 and accounted for 53% of the variance. Table 11 highlights the regression and variance for the Parent BRIEF.

Three dependent variables (GEC, BRI, MCI) of the Teacher BRIEF were predicted from the established set of independent variables. The effect of WCST Total Errors and Writing Fluency on the dependent variable (GEC) was statistically significant, F (2, 14) = 13.175, p<.001 and accounted for 65% of the variance. The effect of WCST Total Errors on the dependent variable (MCI) was statistically significant, F (1, 15) = 4.854, p<.044 and accounted for 24% of the variance. The effect of the WCST Perseverative Responses on the dependent variable (BRI) was statistically significant, F (1, 15) = 6.823, p<.020 and accounted for 31% of the variance. Table 12 highlights the regression and variance for the Teacher BRIEF.

Independent samples t-test by etiology classification

An independent samples t-test was conducted to determine the possible discriminative validity between genetically deaf students (N = 4-5) compared to students with alternative etiologies of deafness (N = 12-16) including medical illnesses or unknown causes. The informant reports, Parent and Teacher BRIEF, mean t-scores for the genetically deaf were consistently below the alternative etiologies group on every measure, as shown in Table 13. Six out of the eleven Parent BREIF mean t-scores (Inhibit, Shift, Initiate, Working Memory, Monitor, and BRI) and the remaining five Parent BRIEF mean t-scores (Emotional control, Plan/Organization, Organization of Materials, MCI, and GEC) was statistically significant, (p<.01, p<.05, respectively) when comparing etiologies of deafness. When analyzing the Teacher BRIEF scores, one mean t-score (Working Memory) and four mean t-scores (Initiate, Organization of Materials, MCI, and GEC) was statistically significant, ($p<.01$, $p<.05$, respectively) when comparing etiologies of deafness.

Statistically significant differences between neuropsychological and cognitive performance measures were also present between these two groups (genetically deaf vs. alternative causes) with consistent higher performance for the generically deaf group, as shown in Table 14. The WJ-III Visual Matching, WJ-III Reading Fluency, WJ-III Math Fluency, CCTT/CTT-2, Leiter-R Errors, and KABC-II Hand Movements mean standard/scaled scores were statistically significant between these two groups ($p<.01$). In addition, there was a significant difference between the genetically deaf vs. alternative causes of deafness groups on the WCST Perseverative Responses ($p<.05$).

CHAPTER FIVE

Discussion

This research study focused on the assessment procedures when assessing children with a hearing loss. Specifically, the executive functioning of deaf students was studied. The findings showed significant positive correlations between the parent/teacher ratings of the children's observed executive functioning behavior. In addition there were significant correlations between the parent/teacher reports on the BRIEF indexes and the students' scores on the Wisconsin Card Sorting Test, the (Children's) Color Trails Test and the Woodcock-Johnson: Writing Fluency subtest. Another noteworthy finding was that parents/teachers observed ratings of students with genetic deafness executive functioning and student's performance on individual executive tasks were significantly different from the parents/teachers ratings and student performance measures for students with other causes of deafness.

Differences between Parent Informants

It was hypothesized that there would be no difference between the Rhine (2002) study and this study when comparing parent ratings of deaf students executive functioning as measured by the BRIEF. Consistent with this hypothesis, all mean t-scores fell within the normal range for both studies. Also, five of the eight clinical scales (Inhibit, Shift, Emotional Control, Working Memory, Monitor) were statistically similar to Rhine's study. In contrast, three of the eight clinical scales (Initiate, Play/Organize, Organization of Materials) were statistically different with more executive functioning difficulties noted for this present study. The differences in these three metacognitive scales could be attributed to differences in sample characteristics related to sample size, gender distribution and location of the obtained sample.

Sample Size. There is a significant sample size differences between Rhine's study (62 deaf student participants) and this study (22 deaf student participants). This notable difference could have influenced the accuracy in comparing these two studies, thus leading to possible statistically significant differences, which may not be apparent if the sample sizes were more similar.

Gender Distribution. There is also a noteworthy difference between the gender distribution between Rhine's study (48.39% male participants) and this study (72.12% male participants). This difference could have affected the significant differences on these three metacognitive scales. Based on these results, it may be possible the deaf male student may experience more difficulties in these metacognitive areas as compared to deaf females based upon comparison of mean t-scores. Further information is needed to support this claim.

Location of the obtained sample. These differences may also be attributed to differences related to where these samples were obtained. Rhine's sample consisted of students from public school mainstream inclusion settings and residential placements whereas the participants in this study attended one residential school for the deaf. Current trends within the field of deafness indicate a shift in service provision from deaf students being primarily educated within residential schools to more varied placements with students with multiple disabilities being serviced primarily within a residential school placement (Karchmer & Mitchell, 2003). Therefore, it is possible the student sample within this study may have more individuals with multiple disabilities as compared to the Rhine (2002) study. If this is indeed the case, then it could be further speculated that students with disabilities in addition to deafness may have more difficulties with the executive functioning characteristics of task initiation, engaging in plan/organizing skills and self-monitoring.

With possible individual differences related to additional disabilities aside, it could also be the case that students within this sample are provided with more executive functioning metacognitive support within their environment as compared to students within the Rhine (2002) sample. Based on the current trends noted above, notable differences in educational setting characteristics between a residential placement and a mainstream environment can be expected. Based upon the differences between these two studies, it is possible that deaf students within a residential setting may be provided with more executive functioning support such as being provided with greater staff prompts to begin a task, more support when planning long-term projects, and more staff assistance. When the environment provides this support, then students may rely less on developing their own capabilities.

General Parent and Teacher Agreement

Results from this study found a high level of correlation (.58 to .76) between the BRIEF Parent and Teacher informant reports for six of the eight clinical scales with two scales (Shift and Emotional Control) obtaining a low correlation (.23). Within the field, there is a lack of information regarding the correlations between teacher's and parent's ratings of deaf students' behaviors. In general, parents ratings and teachers ratings of hearing children's' social-emotional behavior is low to moderate, with higher correlations for externalizing behaviors (Achenbach et al., 1987; De Los Reyes & Kazdin, 2005).

Moreover, according to the BRIEF manual the correlations between parents and teachers from the BRIEF normative sample were low to moderate. In contrast, Jarratt, et al. (2005) found that the BRIEF ratings between the teachers and parents of students with ADHD had high correlations.

In contrast to the research that finds higher correlations between teachers and parents ratings for hearing children's externalizing behaviors, it is possible that for deaf children the behaviors that are related to behavior regulation (eg. shift, emotional control) are exhibited differently at home and at school, whereas the metacognitive behaviors (e.g, working memory, planning/organizing) are more similar across the two domains.

Relationship between informant reports and student performance measures

In order to expand upon previous research, students performance on assessment measures (neuropsychological, cognitive, and achievement) were correlated with the parent and teacher ratings of the student's observed executive functioning. In correspondence with previous research (Anderson et al., 2002; Mahone et al., 2002; Vriezen & Pigott, 2002), it was hypothesized that there would not be a relationship between a deaf student's performance on select student performance measures and informant (parent and teacher) reports of a deaf students executive functioning behavior within the home and school setting. This hypothesis was not supported. Findings from this study indicate that the BRIEF informant ratings were significantly correlated to the student's performance on select neuropsychological measures. A student's higher level of executive functioning difficulty as reported by the BRIEF (Parent/Teacher) was directly related to lower levels of demonstrated executive functioning capabilities on the student performance measures of the Wisconsin Card Sorting Test (WCST) Total Error and Perseverative Responses measures. High levels of correlation were also noted between the BRIEF Parent report and the Children's Color Trails Test (ages 8-16)/Color Trails Test (age 18) Trail Two task. In contrast to previous research, this study found a high level of correlation between executive functioning informant measures and a student's performance on neuropsychological measures. This unexpected difference between the BRIEF and the Wisconsin Card Sorting Test may be attributed to the method of administration.

Previous research studies have reported this low level correlation between the traditional from of the Wisconsin Card Sorting Test which involves the examiner manually presenting the stimulus cards to the student and recording the student's response pattern and informant reports (Miyake, 2000). In addition, some research studies have found statistically significant performance differences between the traditional scoring version and the computerized scoring version, highlighting possible threats to accuracy with the WCST traditional scoring method (Feldstein, et al., 1999; Greve, 1993; Ozonoff, 1995; Paolo, Axelrod, Ryan, & Goldman, 1994; Tien, et al., 1996). This study highlights the possibility that a higher correlation may be obtained between the BRIEF informant reports and the WCST neuropsychological measure when the computerized is used. Further information is needed to support this finding for students with and without hearing loss.

In contrast to the expected result, this study also found a significant correlation between parental rating of their child executive functioning behaviors and their child's performance on the Children's Color Trails Test. Based on this research study, it appears as if the task demands for this measure most closely parallel the possible demands within the home environment (correlation with Parent report) as compared to the school environment.

Informant and cognition/achievement relationship. As expected, there was nonexistent to minimal correlation between the BRIEF (Parent and Teacher) informant report and the cognitive and achievement student performance measures. These findings provide further confirmatory support that executive functioning is a construct with unique properties and cannot be directly assessed using commonly used cognitive and achievement assessment measures (Gioia, Isquith, & Guy, 2001).

Kalback's (2006) findings suggest that language ability measures can significantly predict a student's executive functioning capabilities in the area of working memory and inhibitory control. She specifically found that the language performance measures tended to be better predictors of a students performance on executive functioning measures as compared to ratings of executive functioning behaviors.

Therefore, it is possible that executive functioning student performance measures are more effective at gathering useful information as to the student's everyday executive functioning behaviors within his/her home and school environment for deaf individuals as compared to individuals without hearing loss.

Predictive Power of these student measures

To further analyze the relationship between informant reports and student performance measures a multiple regression analysis was conducted. Similar to the expected low correlation between student performance measures and informant reports; it was hypothesized that the assessment measures used within this study would not be good predictors of informant reports of deaf individuals executive functioning within their everyday environments.

The findings from this study does not support this hypothesis with deaf individuals rated executive functioning capabilities being predicted using a combination of four scores derived from three student performance measures (WCST Total Errors, WCST Perseverative Responses, CCTT-2/CTT-2, and the Woodcock Johnson -III Writing Fluency). For example, the WJ-III Writing Fluency and the WCST Total Errors predicted 70% and 65% of the variance of the BRIEF Global Executive Composite for Parents and Teachers, respectively. This finding suggests that not only can these neuropsychological measures correlate with the BRIEF they can predict expected performance. In addition, the WJ-III Writing Fluency subtest may have predictive capabilities related to executive functioning. There is a general lack of research regarding possible relationships between achievement and executive functioning measures for individuals without a hearing loss, with no research studies looking at characteristics with deaf students. Further research is needed as to the predictive power of these measures and subsequent applications to service provision.

Importance of the Etiology of Deafness

The hypothesis that there would be a significant difference between the ratings and performance of genetically deaf individuals and non-genetically deaf individuals (unknown etiology or medical causes) was supported (Hauser, Wills, & Isquith, 2006; Rehkemper, 2004). Genetically deaf students had lower levels of reported executive functioning difficulties on the BRIEF and higher performance on all administered student performance measures.

These differences were statistically significant on select BRIEF scales and select student performance measures (neuropsychological, cognitive and achievement). This finding provides further confirmatory support regarding the importance of examining etiology when reporting the capabilities of individuals with hearing loss.

Integration of Results

These findings suggest that assessment of deaf individuals executive functioning can be conducted through informant reports and neuropsychological measures, which tend to provide similar information spanning across the assessment session and the student's home and school environments. The use of these select measures and the Woodcock-Johnson: Tests of Achievement Third Edition (WJ-III) Writing Fluency provides strong predictive power as to the student's daily engagement in executive functioning skills. This comprehensive assessment battery also highlighted the importance of considering the etiology of deafness with noted consistent differences between these two groups (genetic vs. unknown/medical causes). Additional information is needed as to the executive functioning capabilities of deaf students.

Limitations

The ability to generalize from this study is limited as a result of the small sample size. Conclusions comparing specific demographic groups within this study should be interpreted with caution as a result of the limited sample size, in which these comparisons were based. Students from this study were selected from a residential school for the deaf limiting the ability to generalize to deaf individuals in other educational placements. A major limitation to this study was the lack of a control group of individuals without hearing loss. This prevented comparisons to individuals without hearing loss who were administered a similar test battery. Follow-up studies in this area may strongly benefit from obtaining a matched hearing control group. Overall, this study should serve as preliminary guide regarding the possible executive functioning patterns of deaf individuals but further follow-up studies are needed to confirm these findings.

Future Implications

Further information is needed regarding the executive functioning behaviors of deaf students as measured by informant reports and student performance measures. Due to the findings from this study not supporting all of the proposed hypotheses, it is critical for additional studies to be conducted to provide further research in this area.

If these findings are indeed representative of the executive functioning patterns of deaf students, these findings could affect the method of providing evaluation services to students within the school system.

This study's findings also clearly suggest that students with differing etiologies of deafness demonstrate different levels of executive functioning. This finding informs practitioners that students with unknown/medical etiologies of deafness may need further educational supports to gain executive functioning skills, process information, and acquire academic skills. This finding also suggests that future research in this field must consider the etiology of deafness during analysis.

Within the field, there are still many unanswered questions in the areas of assessment of deaf individual's capabilities in multiple domains including executive functioning, cognitive and achievement. In order to provide appropriate services for these students further information needs to be gathered within these multiple domains.

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Table 1

Demographic Characteristics of the Student Population Sample (N=22)

General characteristics	Percentage (n)
Gender	
Male	72.27 (16)
Female	27.27 (6)
Handedness	
Right	77.27 (17)
Left	22.72 (5)
Race	
Caucasian	68.18 (15)
African American	13.64 (3)
Hispanic	9.09 (2)
Other	9.09 (2)
Modified Classroom	
Non-Modified Class[a]	63.34 (14)
Modified Class[a]	36.36 (8)
Diagnostic Classification	
Deafness	36.36 (8)
Deafness and learning disabled	36.36 (8)
Deafness and mentally retarded	4.45 (1)
Deafness and attention deficit hyperactivity disorder	18.18 (4)
Deafness and other	4.45 (1)
Vision	
No diagnosed vision loss	63.64 (14)
Vision loss with use of correction	22.73 (5)
Vision loss without the use of correction	13.64 (3)
Communication of Evaluation	
Sign without voice	77.27 (17)
Sign with voice	22.73 (5)
History of Educational Placements	
Only residential school for the deaf placement	36.36 (8)
1 to 2 placements	50.00 (11)
3 or more placements	22.73 (5)
Residency Classification	
Residential student	18.18 (4)
Day student	81.82 (18)
Medication[b]	18.18 (4)

[a]Grade modification begins in Grade 6. [b]Only psychotropic medications.

Table 2

Hearing Loss Characteristics of the Student Population Sample

Hearing loss	Percentage (n)
Etiology	
Unknown	50.00 (11)
Heredity	22.73 (5)
Other[a]	27.27 (6)
Deafness within the family	36.36 (8)
Age of diagnosis	
0 to 1 years	54.55 (12)
1 to 2 years	22.73 (5)
2 to 3 years	18.18 (4)
3 to 4 years	4.55 (1)
Level of hearing loss	
Moderate to Severe	4.55 (1)
Profound	72.73 (16)
Severe to Profound	22.73 (5)
Assistive Listening Devices	
Current cochlear implant use	9.09 (2)
Current hearing aid use	36.36 (8)
Past hearing aid use	54.55 (12)

[a] Primarily meningitis.

Table 3

Comparison of Mean Differences on BRIEF scales for this present sample and Rhine (2002) sample of Parent BRIEF scores

	Present Sample	Rhine (2002) Sample	
BRIEF Scales (N= 20-22)	Mean	Mean	t
Inhibit	58.7	62.2	-1.403
Shift	60.1	57.4	1.021
Emotional Control	54.5	53.3	.515
Initiate	58.5	52.9	2.329*
Working Memory	60.4	58.9	.572
Plan/Organize	62.9	55.4	2.367*
Organ. of Materials	52.3	47.1	2.127*
Monitor	55.6	54.2	.485
BRI	58.5	58.5	.016
MCI	60.2	54.7	1.803
GEC	60.2	56.2	1.344

*p<.05.

Table 4

Mean Performance Scores of the BRIEF: Parent and Teacher Form (N=20)

BRIEF Scales	Mean T-scores
Inhibit	
Parent	59.48
Teacher	59.70
Shift	
Parent	60.60
Teacher	58.80
Emotional Control	
Parent	55.40
Teacher	58.93
Initiate	
Parent	59.96
Teacher	63.75
Working Memory	
Parent	60.70
Teacher	60.65
Plan/Organize	
Parent	62.90
Teacher	61.93
Organization of Materials	
Parent	52.73
Teacher	59.55
Monitor	
Parent	56.60
Teacher	60.20
Behavioral Regulation Index	
Parent	59.40
Teacher	60.50
Metacognition Index	
Parent	60.15
Teacher	61.45
Global Executive Composite	
Parent	60.23
Teacher	63.03
Organization of Materials	

Note. All non significant mean differences

Table 5

Paired Samples Correlation of BRIEF Parent and Teacher Forms (N=20)

	Present Sample	Normative Sample
BRIEF Scales	r	r
Inhibit	.63**	.50
Shift	.23	.15
Emotional Control	.23	.18
Initiate	.67**	.18
Working Memory	.76**	.30
Plan/Organize	.67**	.35
Organization of Materials	.58**	.15
Monitor	.58**	.42
Behavioral Regulation Index	.40	.31
Metacognition Index	.65**	.34
Global Executive Composite	.64**	.34

**p<.01.

Table 6

Pearson Product-Moment Correlation between BRIEF and Wisconsin Card Sorting Test (N=20)

BRIEF	Total Errors		Perseverative Responses	
Inhibit				
Parent	-.48*	(-.44)	-.50*	(-.51*)
Teacher	-.78**	(-.77**)	.71**	(-.71**)
Shift				
Parent	-.59**	(-.57*)	-.60**	(-.62**)
Teacher	.21	(-.20)	-.29	(-.29)
Working Memory				
Parent	-.68**	(-.66**)	-.67**	(-.67**)
Teacher	-.53*	(-.54*)	-.35	(-.36)
Plan/Organize				
Parent	-.75**	(-.73**)	-.69**	(-.68**)
Teacher	-.58**	(-.66**)	-.44	(-.48*)
Monitor				
Parent	-.69**	(-.69**)	-.65**	(-.64**)
Teacher	-.59**	(-.59**)	-.48*	(-.48*)

Note. Items in Parentheses indicate the Partial Correlation controlling for Age.

*p<.05. **p<.01.

Table 7

Pearson Product-Moment Correlation between BRIEF and Children's Color Trails Test/Color Trails Test (N=19)

BRIEF	CCTT/CTT-1[a]		CCTT/CTT-2[b]	
Inhibit				
Parent	-.20	(-.17)	-.61**	(-.61**)
Teacher	.05	(.06)	-.44	(-.43)
Shift				
Parent	.38	(-.37)	-.65**	(-.66**)
Teacher	-.03	(.04)	-.36	(-.35)
Working Memory				
Parent	-.29	(-.27)	-.68**	(-.67**)
Teacher	.17	(.16)	-.17	(-.19)
Plan/Organize				
Parent	.31	(-.29)	-.57*	(-.56*)
Teacher	.17	(.14)	-.37	(-.44)
Monitor				
Parent	-.15	(-.15)	-.57*	(-.57*)
Teacher	.19	(.18)	-.39	(-.40)

Note. Items in Parentheses indicate the Partial Correlation controlling for Age.

[a]CCTT/CTT Trail 1 = Children Color Trails Test/Color Trails Test-1;

[b]CCTT/CTT Trail 2 = Children Color Trails Test/Color Trails Test-2

*p<.05. **p<.01.

Table 8

Pearson Product-Moment Correlation between BRIEF and Leiter-R Attention Sustained (N=20)

BRIEF	Full Scale		Correct Responses		Errors	
Inhibit						
Parent	.08	(-.28)	.08	(-.27)	-.58**	(-.57**)
Teacher	.08	(-.06)	.05	(-.10)	-.36	(-.34)
Shift						
Parent	.05	(-.35)	.05	(-.36)	-.54*	(-.53*)
Teacher	-.09	(-.15)	-.17	(-.25)	.02	(-.01)
Working Memory						
Parent	-.08	(-.34)	-.07	(-.32)	-.53*	(-.51*)
Teacher	.06	(.07)	.09	(.11)	-.40	(-.40)
Plan/Organize						
Parent	-.05	(-.29)	-.06	(-.31)	-.42	(-.40)
Teacher	-.12	(.04)	-.14	(.01)	-.22	(-.26)
Monitor						
Parent	-.12	(-.26)	-.09	(-.22)	-.49*	(-.48*)
Teacher	.19	(.22)	.18	(.21)	-.19	(-.18)

Note. Items in Parentheses indicate the Partial Correlation controlling for Age.

*p<.05. **p<.01.

Table 9

Pearson Product-Moment Correlation between BRIEF and Visual Matching and Hand Movements (N=20)

BRIEF	WJ-III[a] Visual Matching		KABC-II[b] Hand Movements	
Inhibit				
Parent	-.28	(-.60**)	-.27	(-.53*)
Teacher	.39	(-.55*)	-.42	(-.55*)
Shift				
Parent	-.37	(-.74**)	-.33	(-.63**)
Teacher	-.18	(-.23)	-.25	(-.29)
Working Memory				
Parent	-.41	(-.63**)	-.38	(-.55*)
Teacher	-.38	(-.44)	.50*	(-.55*)
Plan/Organize				
Parent	-.44	(-.65**)	-.46*	(-.64**)
Teacher	.37	(-.32)	.27	(-.21)
Monitor				
Parent	-.55*	(-.69**)	-.48*	(-.59**)
Teacher	-.33	(-.39)	.34	(-.39)

Note. Items in Parentheses indicate the Partial Correlation controlling for Age.

[a]WJ-III = Woodcock Johnson – Third Edition;
[b]KABC-II = Kaufman Assessment Battery for Children –Second Edition

*p<.05. **p<.01.

Table 10

Pearson Product-Moment Correlation between BRIEF and Achievement Fluency Performance on WJ-III ACH (N=16)

BRIEF	Reading	Math	Writing
Inhibit			
Parent	-.40 (-.63*)	.38 (-.67**)	-.53* (-.77**)
Teacher	-.23 (-.33)	-.29 (-.42)	-.30 (-.40)
Shift			
Parent	-.36 (-.56*)	-.43 (-.68**)	-.47 (-.67**)
Teacher	-.27 (-.29)	-.39 (-.42)	-.56* (-.60*)
Working Memory			
Parent	-.27 (-.45)	-.28 (-.49)	-.44 (-.63*)
Teacher	-.48 (-.55*)	-.29 (-.37)	-.39 (-.45)
Plan/Organize			
Parent	.26 (-.41)	-.30 (-.49)	-.31 (-.45)
Teacher	-.10 (-.07)	-.09 (-.06)	-.28 (-.26)
Monitor			
Parent	-.41 (-.51*)	-.41 (-.53*)	.51* (-.61*)
Teacher	-.41 (-.45)	-.31 (-.37)	-.46 (-.51*)

Note: Items in Parentheses indicate the Partial Correlation controlling for Age

*p<.05. **p<.01.

Table 11

Three Stepwise Multiple Regression Analysis with Executive Functioning factors as the dependent variables (Parent BRIEF) and the student performance measures as the independent variables

Student Performance Factors	R	R^2 change	β	t
1				
WJ-III ACH Writing Fluency	.84	.70	-.53	-3.61**
WCST Total Errors			-.65	-4.42**
2				
WCST Total Errors	.82	.68	.67	-4.35**
WJ-III ACH Writing Fluency			-.47	-3.10**
3				
CCTT/CTT-2	.73	.53	-.73	-4.11**

Note: Student Performance Measures predicted the following Parent BRIEF composite and index scores:

1. Global Executive Composite (GEC)
2. Metacognition Index (MCI)
3. Behavioral Regulation Index (BRI)

*p<.05. **p<.01.

Table 12

Three Stepwise Multiple Regression Analysis with Executive Functioning factors as the dependent variables (Teacher BRIEF) and the student performance measures as the independent variables

Student Performance Factors	R	R^2 change	β	t
1				
WCST Total Errors	.81	.65	-.64	-4.05**
WJ-III ACH Writing Fluency			-.49	-3.09**
2				
WCST Total Errors	.49	.24	-.49	-.2.20*
3				
WCST Perseverative Responses	.56	.31	-.56	-2.61*

Note: Student Performance Measures predicted the following Teacher BRIEF composite and index scores:

1. Global Executive Composite (GEC)
2. Metacognition Index (MCI)
3. Behavioral Regulation Index (BRI)

*p<.05. **p<.01.

Table 13

Mean Performance Scores of the BRIEF scores separated by etiology classification (Genetic vs. Non-genetic and Unknown)

	Genetic (n= 4-5)		Non-Genetic/Unknown (n = 15-16)		
BRIEF Scales	Mean	SD	Mean	SD	t
Inhibit					
Parent	46.1	5.8	62.9	10.2	4.625**
Teacher	50.2	9.4	61.3	11.6	2.159
Shift					
Parent	47.2	8.4	64.5	10.5	3.766**
Teacher	52.8	10.0	60.3	16.5	1.232
Emotional Control					
Parent	45.6	7.2	57.6	10.8	2.843*
Teacher	57.2	11.4	59.0	16.2	.272
Initiate					
Parent	46.7	6.6	61.8	10.3	3.856**
Teacher	52.8	7.3	67.0	15.5	2.805*
Working Memory					
Parent	49.6	5.7	63.1	12.0	3.426**
Teacher	47.8	5.9	64.1	14.3	3.658**
Plan/Organize					
Parent	46.8	11.4	66.5	12.1	3.021*
Teacher	53.0	9.3	63.0	14.7	1.799
Organ. of Materials					
Parent	46.9	3.9	54.8	12.4	2.202*
Teacher	47.0	6.7	61.9	23.6	2.248*
Monitor					
Parent	40.0	7.8	59.8	12.3	4.243**
Teacher	51.8	8.6	61.8	11.7	2.080
BRI					
Parent	45.6	8.1	62.9	10.5	3.867**
Teacher	53.0	9.2	61.4	14.9	1.514
MCI					
Parent	46.3	9.0	63.4	12.5	3.095*
Teacher	50.8	7.2	63.6	15.7	2.512*
GEC					
Parent	45.4	9.5	64.6	11.8	3.394*
Teacher	52.0	8.3	65.2	14.2	2.567*

*p<.05. **p<.01.

Table 14

Mean Performance Scores of the performance scores separated by etiology classification (Genetic vs. Non-genetic and Unknown)

	Genetic (n= 4-5)		Non-Genetic/Unknown (n = 12-16)		
Performance Scales	Mean	SD	Mean	SD	t
Scaled Scores (SS)					
WJ-III Tests of Cognitive Abilities					
Visual Matching	98.2	4.1	81.8	11.5	-4.799**
Visual.-Auditory Learning	106.4	18.3	94.5	10.4	-.1374
VAL Delayed	95.2	11.1	81.4	18.2	-2.043
WJ-III Tests of Achievement					
Reading Fluency	102.3	8.0	81.1	14.0	-3.714**
Math Fluency	95.3	6.2	76.8	11.9	-4.166**
Writing Fluency	95.8	18.9	76.6	15.8	-1.842
WCST					
Total Errors	104.5	18.7	89.7	15.0	-1.459
Perseverative Reponses	110.5	10.9	94.2	14.3	-2.479*
Perseverative Errors	108.8	11.8	93.5	13.7	-2.219
Non-Perseverative Errors	100.0	22.2	88.7	15.1	-.963
% of Concept. level Resp.	104.0	17.5	91.9	15.2	-1.269
CCTT/CTT					
Trail 1	95.3	14.8	83.3	24.0	-1.220
Trail 2	103. 8	8.3	82.4	16.1	-3.588**
Scaled Scores (ScS)					
Leiter-R					
Full Scale	9.4	1.1	8.3	2.4	-1.395
Correct Responses	9.2	1.3	8.2	2.7	-1.144
Errors	12.2	0.5	8.8	2.5	-5.177**
SB-V					
Proc. Know./ Picture Abs.	9.4	2.1	8.2	2.3	-1.109
KABC-II					
Hand Movements	11.6	1.1	7.6	2.9	-4.466*
WCST: Categories Completed	5.3	1.5	4.2	1.8	-1.179

*p<.05. **p<.01.