A COMPARISON OF TEACHERS' AND SCHOOL PSYCHOLOGISTS' UNDERSTANDING OF THE COGNITIVE ABILITIES UNDERLYING BASIC ACADEMIC TASKS

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ABSTRACT

Title: A Comparison of Teachers' and School Psychologists' Understanding of the Cognitive Abilities Underlying Basic Academic Tasks
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The Cattell-Horn-Carroll Theory of cognitive functioning is a well-validated framework for intelligence. Cross-battery assessment is a means utilizing CHC theory in practice. School psychologists write recommendations with the assumption that teachers understand the cognitive abilities underlying basic academic tasks in the same way. Theoretically, the more similar the understanding of these two groups, the greater the likelihood of appropriate referrals and intervention fidelity. Teacher perceptions of their students' cognitive abilities impact the referrals that they make and intervention strategies that they implement. In this study, teachers and school psychologists were asked to sort basic academic tasks into the CHC broad abilities.

The central research questions being asked are as follows: Are school psychologists and teachers equally proficient at identifying the broad cognitive ability demands of a basic academic task? How do the responses of the participants compare to the theoretical model

presented? Do teachers and school psychologists become better at identifying the cognitive demands of a task with experience or higher levels of training?

In order to answer the first research question, MANOVAs were performed. There was a significant overall difference between groups on their responses. While teachers and school psychologists differed significantly on five of the eight CHC broad ability scales. School psychologists were only significantly better at consistently identifying the basic academic tasks that utilized Fluid Reasoning.

To answer the second research question, principal components factor analysis was performed. The factors created displayed limited similarity to the theoretical factors. Pearson correlations between the theoretical factors and the factors created through factor analysis revealed multiple positive correlations that accounted for more than 10% of the variance. The theoretical scales that were more significantly correlated were Fluid Reasoning, Auditory Processing, and Processing Speed.

To answer the third research question, Pearson correlations were calculated. This analysis revealed that neither group develops a better understanding of the cognitive abilities required to perform academic tasks with experience. Level of education is not related to accuracy for teachers on any of the items. Level of education is significantly correlated with accuracy in identifying tasks that require Fluid Reasoning and Visual Processing for school psychologists.

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This work is dedicated to my husband and the love of my life, Matthew Petruccelli. I owe him absolutely everything and I hope that I have made him proud.

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CHAPTER 1

THE PROBLEM

Introduction

When a student is struggling in school and interventions in place do not remediate the problems, school psychologists conduct psychological assessments to determine the cognitive profile of the student including strengths and weaknesses. This information is then used to make a diagnosis if one applies, make a placement decision and recommend interventions to support the learner. Before any of this happens, however, a teacher must notice that the student is struggling and make a referral. With approximately 10-12% of school-aged children (National Institute of Child Health and Human Development, 2000) being referred for evaluations and possible special education services due to moderate to serious learning problems (Gilman & Gabriel, 2004), it is crucial that educators and school psychologists have a common understanding of the specific cognitive abilities and deficits of the children with whom they work.

Historically, school psychologists have been interested primarily in some overall or general factor of intelligence or *g.* Advances in cognitive science have lead to a better understanding of the specific cognitive abilities that combine to form *g* and many practitioners have recently begun to rely less on g (or a full scale IQ score) and more on specific broad or narrow ability constructs that are measured by particular tests and subtests. This is due to the belief that performance on specific tests and subtests may provide more useful information for making diagnoses and providing treatment than full scale scores (McGrew, Flanagan, Keith, Vanderwood, 1997). In addition, many practitioners believe that traditional measures of intelligence have failed to provide information that is useful for instructional decision making (Flanagan, 2000).

One framework for understanding human cognitive abilities is Cattell-Horn-Carroll (CHC) theory. This theory is based on the work of Cattell, Horn and Carroll and posits three strata of abilities: general, broad and narrow. According to McGrew (2005), “CHC theory is the most comprehensive and empirically supported psychometric theory of the structure of cognitive and academic abilities” (p. 136). Translating theory into practice, CHC Cross-Battery Approach (Flanagan & Ortiz, 2001; Flanagan, Ortiz, & Alfonso, 2007; McGrew & Flanagan, 1998) gives guidelines to practitioners regarding test battery selection, subtest loadings and score interpretation following the CHC framework. As CHC theory has gained recognition as the most well-validated theory of cognition, it has also been the theoretical framework that has guided recent development of major cognitive assessment batteries such as the Woodcock Johnson III Tests of Cognitive Abilities, Kaufman Assessment Battery for Children, Second Edition, Stanford Binet Intelligence Scales, Fifth Edition, and the Differential Ability Scales, Second Edition (Eliott, 2007; Kaufman & Kaufman, 2004; Roid, 2003; Woodcock, McGrew, Mather, 2001).

Theoretically, if CHC theory can help practitioners to understand individuals' cognition, this understanding should improve the instructional decision making on behalf of children. McKenna, Jurgensen, and Thurman (2008) argue that "the extent to which we can understand the role and functions of cognitive processes in classrooms and other applied settings, it should logically follow that instruction and consequently learning will improve" (p. 4). The authors also point out that increasing Federal mandates for student performance and teacher accountability have created an environment in which evidence-based practices that have a solid foundation in cognitive science are extremely important. Applying research findings to practical settings, the authors acknowledge, is a challenging yet crucial undertaking.

There is a growing body of research that explores the different ways in which CHC cognitive abilities and other psychological processes have direct links to performance in the classroom in a variety of academic subjects (Fiorello et al., 2006; Hale & Fiorello, 2004). Fiorello et al. (2008) investigated the CHC broad abilities involved in academic skill development in early elementary schooling. The authors found that learning the complex set of skills that comprise reading ability involve a conglomerate of CHC abilities. These include: visual processing, crystallized ability, auditory processing, short-term memory, fluid reasoning, processing speed, and long-term storage and retrieval. Similarly, mathematics skills involve multiple CHC abilities including: quantitative reasoning, auditory processing, fluid reasoning, crystallized ability, short-term memory, long-term storage and retrieval, processing speed, and visual processing. In writing, the following CHC abilities are central to skill development: visual processing (early acquisition of alphabetic knowledge), crystallized ability, auditory processing, long-term storage and retrieval, fluid reasoning, short-term memory, and processing speed. Clearly, this information about how specific abilities impact distinct skill acquisition should inform the ways these skills are instructed and developed in our educational system.

With such a robust base of empirical support for the use of CHC theory for psychometrics and mounting evidence for the effects of CHC broad abilities on academic achievement, the next logical step is to continue research on the ecological validity of CHC theory. Some would argue that the importance of ecological validity for applied settings trumps other, more traditional forms of validity (Gioia & Isquith, 2004). Ecological validity is a vital construct for researchers creating interventions for use outside of the analog research setting. This construct is also of immediate relevance for practitioners attempting to apply a theory to practice. Unfortunately, little research has been done in education-related fields on ecological validity. This is especially true about the ecological validity of CHC theory. This study is a small-scale attempt to address this scarcity. Specifically, the current study looks at the perceptions of practitioners regarding the impact of CHC broad abilities in the classroom.

As CHC theory is finding utility in schools, it is essential to study its ecological validity. The present study is part of a line of research currently being conducted by individuals at Temple University who are interested in the ecological validity of Cattell-Horn-Carroll theory. While the utility of CHC theory has been demonstrated for interpretation of assessments and cross-battery assessment, more work must be done before it can be said with certainty that CHC has utility for communicating assessment findings to teachers. A second problem addressed by this study is the gap in the literature regarding teachers' and school psychologists' perceptions of the cognitive requirements of common academic tasks.

Purpose

The purpose of the current study is to add to the research literature on the ecological validity of CHC theory. While research exists on the direct link between CHC abilities and academic achievement, very little research exists to date on the way teachers and school psychologists understand the way that these abilities impact academic tasks. Increasing our knowledge in this area will help us to understand how these professionals can work together with greater efficacy in communication and collaboration.

The rationale for assessing teachers' and school psychologists' perceptions is rooted in the fact that communication between these two groups of professionals has consequences children in schools. As discussed in the introduction to this chapter, teachers make referrals to school psychologists when children are failing to make progress in the curriculum. This referral alone sets into motion the process of considering whether a child may have a disability. While approximately 40% of American school children struggle in school, teachers refer only 10-12% for special education services (National Institute of Child Health and Human Development, 2000). Thus, the teacher's perception of the child's ability has a major impact on the likelihood that they will be diagnosed with a disability and will begin to receive services.

If the evaluation performed by the school psychologist reveals the presence of a disability, the psychologist will then make recommendations regarding service provision. Research on aptitude treatment interactions (ATI) assumes that pairing specific interventions to specific cognitive deficits will lead to better outcomes (McGrew, 1993). However, prior to the emergence of CHC theory and cross-battery assessment, it was extremely difficult to reliably measure distinct cognitive ability. This made it almost impossible to design interventions based on a child's cognitive profile. The cross-battery approach to cognitive assessment was designed, in part, as a means of improving

ATI research (McGrew & Flanagan, 1998). Therefore, the promise of CHC cross-battery assessment for improving research on ATI may lead to better evidence based interventions, which may, in turn, lead to better outcomes, and increased compliance with federal mandates.

In the present study, teachers and school psychologists were asked to determine the cognitive requirements of 34 basic academic tasks. The cognitive requirements were based on the broad stratum abilities outlined by CHC theory: Fluid Reasoning (*Gf*), Crystallized Intelligence (*Gc*), Quantitative Knowledge (*Gq*), Short-Term Memory (*Gsm*), Visual Processing (*Gv*), Auditory Processing (*Ga*), Long-Term Retrieval (*Glr*), and Processing Speed (*Gs*). The goal is to increase our understanding of how teachers and school psychologists comprehend cognitive requirements of school activities. The hypothesis is that teachers and school psychologists perceive cognitive abilities very differently. Thus, this research is important to gain an understanding of *whether* and *how* school psychologists and teachers are similar and different in their understandings.

Research Questions

The research questions being asked in the present study are as follows.

1). Do school psychologists and teachers identify the broad cognitive ability demands of a basic academic task similarly? If not, how do they differ?

2). How do the responses of the participants to the research probes compare to the theoretical model presented (CHC Theory)?

3). Do teachers and school psychologists become better at identifying the cognitive demands of a task with experience in the field or higher levels of training?

Hypotheses

1). While there may be some similarity in the responses given by the participants and the theoretical model, the participants' responses are likely to be significantly different from the model. Responses in some broad ability categories may be more similar to the model than others (Crystallized Intelligence, Fluid Reasoning, Auditory Processing, Quantitative Reasoning).

2). Theoretically, school psychologists will have more experience with CHC theory and may be more familiar with the broad abilities. Due to training and familiarity, school psychologists will be more fluent and accurate with this task.

3). Level of experience will be a significant predictor of accuracy in identifying the cognitive requirements of the academic tasks presented. Similarly, level of training will be a significant predictor of accuracy in identifying the cognitive requirements of the academic tasks presented.

4). The null hypothesis is that teachers and school psychologists do not identify the cognitive requirements of basic academic tasks better than chance. There is no significant difference between groups.

Conclusion

The information provided by this study about the level of understanding of broad cognitive abilities as they relate to basic academic tasks can inform the way that school psychologists and teachers communicate with one another. The use of common language and recommendations that are feasible and acceptable to the teacher may help to increase treatment fidelity. Ultimately, this could lead to better intervention outcomes for children. Additionally, the information provided by the data collected here can help to understand whether better understanding of cognitive requirements is a function of experience, training, or level of education. These findings may help to inform preservice teacher and school psychologist education and practice in the field.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

Years of research have demonstrated that teachers are the single most significant factor for student learning (Darling-Hammond, 2000). Given that teachers have such a profound impact throughout the educational process, it is important to consider the ways in which their understandings and beliefs impact the way that they teach, interact with students and assess their students. Researchers have shown that teachers' beliefs influence how they structure tasks and interact with their students (Peterson, Fennema, Carpenter, & Loef, 1989; Richardson, 1996). Teachers' expectations for the performance of their students influence both their behavior toward their students and their students' learning (Jussim & Eccles, 1992; Jussim, Eccles, & Madon, 1996). Furthermore, teacher expectations for student performance are strongly linked to student ability in specific skill areas (Jussim & Eccles, 1992; Jussim, Eccles, & Madon, 1996).

When students are struggling in schools, teachers are often the professionals who make initial referrals to the school psychologists who are responsible for conducting psychoeducational evaluations. Clearly, teacher perceptions of their students' performance influence this process. When students are referred for assessment, the school psychologist must make important decisions regarding the tests that he or she will administer to measure the student's cognitive ability. These decisions are informed by a hundred years of research on human intelligence.

For years psychologists have attempted to define and quantify the construct of intelligence. Many psychologists have worked to deconstruct and more specifically define the components of intelligence that comprise *g*, or a general factor theory of intelligence. One of the most widely used factor models of intelligence is the Cattell-Horn-Carroll (CHC) theory (Flanagan & Ortiz (2001); Flanagan, Ortiz, Alfonso, 2007; McGrew & Flanagan, 1998; McGrew, Flanagan, Keith & Vanderwood, 1997). This model of cognitive functioning is based on the work of Cattell, Horn, and Carroll. The CHC cross battery assessment model stresses cross-battery interpretation of assessments in order to analyze data in a way that is empirically meaningful (Flanagan & Ortiz, 2001; Flanagan, Ortiz, & Alfonso, 2007). CHC cross-battery assessment, as originally conceptualized by Flanagan and Ortiz, provides practitioners a framework for cognitive assessment interpretation along a three-level hierarchy. While much work has been done on CHC theory in general, almost no empirical studies have been conducted to assess teachers' understanding of the cognitive abilities underlying basic academic tasks using a CHC framework.

This review provides an overview of the literature on CHC theory, teachers' perceptions of the cognitive requirements for specific academic tasks, and the utility of school psychologists' reports. The review also includes a brief history of conceptualizations of intelligence and the development of Cattell-Horn-Carroll (CHC) theory. This portion of the review is by no means exhaustive. The numerous studies that attempted to define the construct of intelligence were not included here because it would be impossible to fully represent the work. A discussion of the application of CHC theory follows. The referral of students for assessment is examined. Finally, the utility of assessment results and recommendations are also discussed.

Teacher Perceptions

Given the fact that teachers are the most significant factor for student learning (Darling-Hammond, 2000), assessing their perception of the cognitive requirements of the tasks that they assign is an important, if overlooked undertaking. Despite the recognition that teachers' role in the education process is central to student's learning, there is an absence of studies that have examined teacher's understandings of specific cognitive abilities in relation to basic academic tasks. This lack of research is surprising because understanding teacher perceptions may provide insight into the routine decisions that teachers make regarding curriculum, planning and task assignment on a day-to-day basis. Studies have been conducted to determine teachers' perceptions of alternative assessments (Flowers, Ahlgrim-Delzelll, Browder, & Spooner, 2005), the role of teachers' perspectives in decision making (Eckert & Arbolino, 2005), how ethnicity and language proficiency relate to teacher ratings (Edl, Jones, & Estell, 2008), and the role of teacher assessment in diagnosis (Sikora & Plapinger, 1997). Very little, if any, work has been done on what teachers know about the cognitive requirements of the tasks that they assign. The current study attempts to close this gap in the literature.

Impact of Teacher Beliefs on Instructional Decision-Making

Flowerday and Schraw (2000) conducted a phenomenological study examining how teacher beliefs impact their offering of choice to their students. The authors justify their use of a phenomenological design by pointing out that there is no existing theory of teachers' choice offering and the necessity to explore a phenomenon about which little has been written. Participants in the study were 36 classroom teachers attending classes at a Midwestern university. All participants were interviewed as the primary mode of data collection. Interviews followed a seven question protocol and were tape recorded and transcribed before being analyzed. Age, subject knowledge, and achievement were three factors most teachers in the study considered when designing instruction and offering choice. Flowerday and Schraw found that teachers offer choice of activities to students who are older and whom they perceive as higher achievers. Therefore, their perception of their students' cognitive abilities impacts the instructional decisions that they make. Again, the importance of studying teachers' perceptions of the cognitive requirements of tasks that they assign is necessary to better understand the instructional decisions that teachers make based on their beliefs.

Torff (2005) studied teachers' beliefs about critical-thinking activities. Four hundred and eight preservice, prospective and inservice teachers participated in this cross-sectional study. The teachers completed a survey instrument entitled the Critical Thinking Belief Appraisal (CTBA), which was designed by the researcher. Analysis revealed that despite increases in teaching experience and inservice training, teachers tend not to change their beliefs regarding critical-thinking activities. Obviously, these findings are somewhat limited by the fact that cross-sectional research does not allow for causal attributions or the tracking of individuals or groups over time. Thus, the finding that teachers tend not to change their beliefs despite additional inservice training or professional experience may not be entirely accurate. With the limitations in mind, however, these data suggest that teachers are unlikely to change their beliefs about some instructional techniques or activities after they begin teaching. Presumably, these fairly static beliefs about instruction impact the instructional decisions that are made. Teachers' beliefs about their students' abilities also have a strong impact on their students' education.

Teacher Ratings of Students' Academic Ability

In a meta-analytic review, Hoge and Coladarci (1989) synthesized 16 empirical studies of the correspondence between teachers' estimates of students' achievement and students' achievement on concurrent standardized measures of academic ability. The researchers found that the median correlation between the ratings and actual measures was .66. They also noted that a stronger relationship existed between direct teacher judgments ($r = .48$ to $.92$) and indirect teacher judgments ($r = .29$ to .86). Based on these data, it appears as though standardized teacher estimates are more reliable than general teacher estimates. This may have to do with the fact that direct teacher judgments are more specific than indirect. The authors also found that in several of the studies that they reviewed variability among teachers ranged from within-class correlations of 0.44 to 0.88 in one study to .03 to .90 in another. Hoge and Coladarci suggest that the accuracy of teacher judgments is a topic for future research.

Demaray and Elliott (1998) analyzed the relationship between two different standardized teacher ratings and a standardized measure of student achievement. In their study, twelve teachers rated the academic ability of 47 students. The Academic Competence Scale of the SSRS (Gresham & Elliott, 1990) and the Kaufman Test of Educational Achievement Brief Form (K-TEA; Kaufman & Kaufman, 1985) were used. On the K-TEA, the teachers predicted students' performance on each item. The correlation between the Academic Competence Scale of the Social Skills Rating Systems and the K-TEA was found (.70) and the predictions of student performance (.79). This finding suggests that predictions made by teachers regarding the academic abilities of their students can be slightly enhanced by giving teachers information regarding specific cognitive tasks.

Kenny and Chekaluk (1993) used a battery of standardized reading measures with a sample of 312 elementary-age students in Kindergarten through second grade and teacher ratings of students' reading skills to measure the strength of the relationship between the two. Their findings were that the strength of the relationships between ratings and students' performance becomes more reliable as the students get older. Additionally, teacher ratings of student performance may become more reliable as the grade level that they teach increases. Thus teacher ratings of student students' skills may be more accurate in the later grades.

Bennett, Gottesman, Rock and Cerullo (1993) studied the effects of students' gender and perceived behavior on teachers' judgments of academic skill. A diverse (55% minority) and large (N= 794) sample of Kindergarten through second grade aged students was recruited from three urban elementary schools in Cleveland and one in the Bronx. Students took the Einstein Assessment of School-Related Skills, a standardized achievement test. Behavior perceptions of the students' teachers were obtained through a record review of behavior grades on report cards.

Academic judgments were gathered through the use of report card grades structured ratings in each subject area. Significant effect sizes were found for the correlation between behavior judgments and academic ratings. One standard deviation increase in behavior grade was associated with increases in teacher academic ratings of .49 SD in the Bronx and .34 SD in Cleveland. This was compared to academic grade values of .41 SD and .31 SD. Thus, teachers' perceptions of students' behaviors were a significant predictor of their academic judgments. These results suggest that teachers' perceptions of their students' academic skill are not based solely on their perceived intelligence or academic performance but are confounded by other variables such as student behavior.

Teacher Ratings of the Importance of Specific Skills

Fiorello and Thurman's (2001) work on teacher rating scales using CHC theory is the first attempt to link teachers' perceptions and the CHC framework. In Fiorello and Thurman's (2001) study, a teacher rating scale of Cattell-Horn-Carroll cognitive abilities was developed. Items for their scale were developed by the researchers for each of the broad CHC abilities. The researchers then solicited feedback on their items from an expert panel of school psychologists and cognitive assessment researchers.

Those participants rated each item as to its perceived validity and items with low ratings were discarded as invalid measures of the construct. The items were subjected to two rounds of similar ratings and were pared down to a final list of 35 items that were considered valid measures of the construct. Ninety-two teachers were solicited to complete the scale and preliminary information show that the total scale has a reliability of .94 and the subscales have a mean reliability of .74 (Fiorello and Thurman, 2001). The information regarding teacher understanding that is gained through the use of rating scales such as Fiorello and Thurman's (2001) may also help to clarify the factors that predict teachers' referrals of students for assessment.

In a second set of studies, Fiorello, Thurman, Zavertnik, and Sher (2006) and Sher, Fiorello, Thurman, and Flanagan (2004), the authors sought to assess the ecological validity of CHC theory by determining whether teachers perceived CHC broad abilities as important in the classroom. The authors again created a rating scale to assess teacher perceptions of the importance of CHC abilities to school performance. Items for the scale were developed by the researchers and then evaluated by an expert panel of researchers in the field of cognitive assessment and CHC theory. Items that were rated less than excellent examples of the construct were discarded. The remaining items were used in the study scale. The researchers then mailed the scale to a random nation-wide sample of teachers and school psychologists. The response rate was 17% for school psychologists and 11% for teachers.

The authors found that school psychologists and teachers both perceive Quantitative Reasoning, Crystallized Intelligence and Fluid Reasoning as the most important predictors of school success. Auditory Processing, Short-Term Memory, and Quantitative Reasoning were rated as significantly more important by school psychologists than by teachers. Other abilities showed no significant differences. An interesting finding of this study is that higher-level reasoning abilities and academic abilities were rated significantly higher than lower-level automatic processing abilities. As lower-level processing abilities like Short-Term Memory, Processing Speed, and Long-Term Retrieval are important for both reading and mathematics achievement in school (Flanagan & Ortiz, 2001), it is important to ensure that teachers understand what these abilities are and how they impact their students' performance in school.

Fiorello and Thurman further indicate that there is a relative lack of empirical studies of the direct links between CHC cognitive abilities and classroom applications. The present study addresses this need by providing information regarding the way that teachers and school psychologists understand which cognitive abilities are required for students to perform classroom-based tasks. Higher-level cognitive abilities, lower-level processing and academic abilities will all be considered in the current study.

Ecological Validity

Ecological validity is a crucially important construct when researchers seek to create interventions for use outside the analog research setting and for practitioners attempting to apply a theory to practice. In the field of education, ecological validity manifests itself in the idea that theory derived in academia or in research settings have utility in naturalistic classroom environments. A key assumption is that theories of cognitive development will help to explain the cognitive abilities employed by individuals. In the field of school psychology, an important assumption is that assessments used to measure various abilities will provide valuable information about how the individual being assessed will function in activities of daily living.

An ecologically valid assessment instrument should have characteristics similar to naturally occurring behavior and should be able to predict everyday function (Franzen & Wilhelm, 1996). Franzen & Wilhelm (1996) outlined two requirements for ecological validity. The first requirement is for verisimilitude, or topographical similarity between the way that data is collected and the skills and behaviors required in the natural environment. Secondly, veridicality is the degree to which performance on an assessment predicts the child's everyday functioning. A test with high ecological validity should provide some information about how the child would perform on the construct being measured in daily life. Poor performance on assessments would then suggest that the individual would perform poorly on tasks requiring the skills that the test sought to measure. If an individual performed poorly on a test and was observed to be able to perform well outside of the testing situation, the test itself may have poor ecological validity. Having poor ecological validity decreases the expediency of assessments and theory for predicting behavior or ability outside the analog setting. Poor ecological validity may also decrease the ability of the assessor to use assessments results to make valid recommendations. Unfortunately, little research has been done in education-related fields on ecological validity. One area in which much ecological validity research has been conducted is in the domain of neuropsychology.

In their study on the ecological validity of executive functioning assessment, Chaytor, Schmitter-Edgecombe, and Burr (2006) sought to improve ecological validity of such assessments. The extra-test variables environmental cognitive demand and compensatory strategies were examined. When additional assessments of these two variables were added, more of the variance was accounted for than was accounted for by tests of executive functioning in isolation. The authors found that ecological validity of executive functioning assessment could be increased by controlling for the variance accounted for by environmental cognitive demand and compensatory strategies. However, even when those factors were controlled, when four executive functioning tests (Wisconsin Card Sorting Test, Trail Making Test, Stroop Color and Word Test and Controlled Oral Word Association Test) were taken in combination, only 18-20% of the variance in everyday executive ability was accounted for. The authors point out that adequate ecological validity of neuropsychological assessments is not the standard and is highly variable from test to test. This study, however, is limited by its small sample size (N=46) and limited number of neuropsychological assessments included. Despite these limitations, the findings demonstrate a need for additional efforts to increase the ecological validity of the tests used to measure executive functioning and predict executive functioning in the natural setting.

Gioia and Isquith's (2004) research on ecological assessment of executive functioning in children with traumatic brain injury is largely in response to the shift over time from concern with medical descriptions of brain damage to interest in identifying strengths and weaknesses, forecasting daily functioning and predicting the need for specific types of supports within the community. This shift necessitates the prioritization of ecological validity over what the authors consider to be "traditional" types of validity. These authors have attempted to increase the ecological validity of executive functioning assessment through the development of the Behavior Rating Inventory of Executive Function (BRIEF) (Gioia, Isquith, Guy & Kenworthy, 2000). They assert that the BRIEF can provide information to the neuropsychologist that will help the practitioner to "make predictions about a child's functioning in the everyday environment and to recommend interventions and accommodations" (Gioia & Isquith, 2004, p. 144). When students are referred for assessment, it is important that the test battery used to make predictions about everyday behavior has adequate, demonstrable ecological validity.

Referral of Students for Assessment

According to the National Institute of Child Health and Human Development (2000), approximately 40% of school-age children have difficulties in schooling. A smaller percentage (10-12%) of school-age children are referred for special education services because the problems that they are experiencing are profoundly affecting their ability to learn (National Institute of Child Health and Human Development, 2000). Regular education teachers are typically the primary source of referral of students for psychoeducational evaluations. In fact, the teachers who work with the student being assessed can contribute valuable information regarding the child that comes from multiple observations over a longer period of time than is typically spent with the student by the school psychologist. Teachers' input can provide information about the student's academic functioning in terms of specific skills as well as information about the student's level of functioning as compared to expected levels (Eckert & Arbolino, 2005).

Teachers are typically the school professionals who are most likely to identify learning difficulties and make referrals for evaluation (Eckert & Arbolino, 2005; Fagan & Wise, 1994). The first step in the assessment process is to receive and review referral information (Sattler, 2008). Therefore, in most school-based service delivery models, the teacher's referral sets the assessment process into motion. Teacher's perceptions of a student's cognitive abilities and academic achievement have been shown to be one of the primary factors related to positive outcomes for students in the classroom. Teachers often make day-to-day decisions regarding curriculum, instructional grouping and instructional strategies based on their perception of student's classroom performance (Eckert & Arbolino, 2005). Due to the fact that in almost any present service delivery model the teacher is ultimately the instruction and intervention provider, their perceptions about the student's cognitive abilities are central to service provision.

Based on the referrals made by teachers and other school professionals, school psychologists are left with the task of designing a test battery that will simultaneously answer referral questions and measure the cognitive abilities of the student. It is important to understand the historical context in which cognitive assessment developed to gain a sense of the field's present status. The following section of this review will discuss the historical context of cognitive assessment and will trace the development of the theoretical model being used in the current study, Cattell-Horn-Carroll Theory.

Historical Context of Cognitive Assessment

While Galton first proposed that individuals have a general intelligence and specific aptitudes, other prominent psychologists, Thorndike (1927) and Thurstone (1938), argued that intelligence is actually comprised of several different factors (Sattler, 2008). In 1927 Spearman conducted a factor analysis of the data from intelligence tests of individuals and asserted that intelligence is actually composed of two factors, a general factor (*g*) and specific factors (*s*) (Spearman, 1927). Spearman argued that *g* or general mental energy represented the intelligence required to perform more complex mental tasks. However many have argued that while a general factor of intelligence is important, "we can accept the evidence for Spearman's g without accepting Spearman's explanation of g… that suggests a unitary something underlying the behavioral phenomena" (Sattler, 2001, p. 138).

Sternberg has argued that conventional theories of intelligence that focus on a single factor, g, are incomplete and inadequate (Sternberg, 2002). In fact, "the identification of a general factor of human intelligence may tell us more about how abilities interact with patterns of schooling and especially Western patterns of schooling than it does about the structure of human abilities" (Sternberg, 2002, p. 451). Sternberg further asserts that in Western schools, students learn in a variety of subject areas which prepares them to perform on an ability test in multiple skill areas. Overall, "the general factor is an artifact of limitations in populations of individuals tested, types of materials with which they are tested, and types of methods used in testing" (Sternberg, 2002, p. 473).

Many models have been offered in recent years to explain the structure of intelligence. Most models are based on multiple factors, as a monolithic structure of intelligence is no longer widely accepted by the psychological community. Popular models of intelligence include the Cattell-Horn Fluid Intelligence- Crystallized Intelligence (*Gf-Gc*) theory and Carroll's Three-Stratum

Theory of Cognitive Abilities among many others. These models form the basis for CHC theory.

Raymond Cattell and John Horn (Cattell, 1963; Horn, 1967, 1968, 1978a, 1978b, 1985, 1998; Horn and Cattell, 1967) hypothesized that there were two forms of intelligence, crystallized intelligence (*Gc*) and fluid intelligence (*Gf*). Horn later expanded the theory to 55 primary abilities and 9 second stratum abilities (Horn, 1998).

John Carroll's theory (1993, 1997) builds on the Cattell-Horn *Gf-Gc* theory. Carroll categorizes human abilities into three strata including narrow (stratum I), broad (stratum II), and general (stratum III). The three-stratum theory of intelligence suggests that there are 65 narrow abilities that can be grouped together into eight broad categories. These eight broad categories comprise a general factor of intelligence or *g*. According to Carroll, "The three stratum theory reflects advances in cognitive psychology because these advances make it easier to interpret findings from factor analysis in terms of the properties of cognitive tasks" (Carroll, 1997, p. 128). Thus, these factors relate directly to the cognitive abilities required to perform specific tasks. Carroll's theory attempts to explain the entirety of human cognitive ability and performance.

Cattell-Horn-Carroll Theory & Cross-Battery Approach

Developed from Cattell and Horn as well as Carroll's theories, Flanagan and McGrew's CHC theory consists of the following eight broad abilities: Fluid Reasoning (*Gf*), Crystallized Intelligence (*Gc*), Quantitative Knowledge (*Gq*), Short-Term Memory (*Gsm*), Visual Processing (*Gv*), Auditory Processing (*Ga*), Long-Term Retrieval (*Glr*), and Processing Speed (*Gs*). CHC theory also emphasizes 69 narrow abilities that can be measured and interpreted to create a strengths and weaknesses-based profile of cognitive ability. For a graphic representation, see Table 2.1. According to McGrew et al. (1997), support for Gf-Gc (now known as CHC) theory has been demonstrated in five types of validity evidence: structural, developmental, neuroscience, achievement, and heritability. Structural validity has been shown through factor analysis. Developmental validity has been expressed through changes in individuals' cognitive profile across time. The evidence for neuroscientific validity comes from the relation of different broad and narrow abilities to physiological and neurological functioning. CHC also helps to predict academic success, hence achievement validity.

Additionally, there is some suggestion that biological relatives may have similar CHC profiles (McGrew, et al., 1997).

According to Sherman (2001), the validity of CHC theory has its basis in three pillars. The first is its basis in a theoretical model of intelligence. CHC's combination of the work of Cattell, Horn and Carroll makes it the most empirically supported model of the structure of intelligence (Sherman, 2001). This empirical evidence is that which was discussed above.

Additionally, CHC theory avoids "construct irrelevance" (McGrew & Flanagan, 1998). The concept of construct irrelevance means that an assessment is too broad and performance reflects the multiple influences of variables that confound the pure measure of the intended construct (Fletcher et al., 1995). For example, a subtest may be intended to measure fluid intelligence or novel problem solving but may also require that the test taker respond quickly. This may contaminate the measure of fluid intelligence with reaction speed. Thus, the subtest is not a pure measure of fluid intelligence. CHC guards against this construct irrelevance by interpreting each subtest on the basis of what it most clearly loads on.

Thirdly, CHC theory guards against construct underrepresentation. Construct underrepresentation refers to the occurrence when a construct is not fully represented by the item or subtest intended to measure it (Fletcher et al., 1995). Tests which may claim to measure a broad CHC ability may actually only measure one of the narrow stratum abilities subsumed under the broad abilities. Thus, that test underrepresents the construct. McGrew and Flanagan suggest that to protect from construct underrepresentation, two measures of separate narrow stratum abilities should be conducted (1998).

There are no standardized tests of intelligence available today that measure all cognitive abilities described by CHC theory. Thus, a cross-battery approach within the CHC framework is necessary to attain a comprehensive understanding of an individual's cognitive functioning (Flanagan & Ortiz, 2001; Flanagan, Ortiz, & Alfonso, 2007; McGrew & Flanagan, 1998;). "The CHC Cross-Battery approach… provides a systematic means for clinicians to make valid, up-to-date interpretations of current intelligence batteries… and to augment them in a way that is consistent with the empirically supported CHC theory of cognitive abilities" (Flanagan & Ortiz, 2001, p. 33). CHC theory can be used by practitioners with any tests or subtests if it is clear which broad or narrow ability the measure loads on.

Flanagan, Ortiz & Alfonso (2007) argue that one of the major benefits of the CHC Cross-Battery Assessment approach is that it can facilitate communication between professionals by providing a common language with which to discuss cognitive abilities (p. 11). The authors point out that this method of assessment has already had a positive impact in this way. The current study will help to determine whether teachers and school psychologists even understand these common terms in the same way. If they do not, simply having a common set of terms and definitions may not improve communication in actuality.

CHC Broad Stratum Abilities and the Narrow Stratum Abilities Subsumed Under Each

In the current study, the 8 broad abilities will be utilized as the underlying cognitive abilities. Fluid Reasoning (*Gf*), Crystallized Intelligence (*Gc*), Quantitative Knowledge (*Gq*), Short-Term Memory (*Gsm*), Visual Processing (*Gv*), Auditory Processing (*Ga*), Long-Term Retrieval (*Glr*), and Processing Speed (*Gs*) are the abilities included in this study. Those broad abilities will be discussed in detail here. Considerably less work has been completed on the narrow stratum abilities. The work of McGrew (1997) to define select narrow stratum abilities will be discussed. In order to better understand these narrow abilities, we will examine concrete task examples for select narrow stratum abilities (Flanagan, McGrew, and Ortiz, 2001).

Fluid Reasoning

Fluid Reasoning (Gf) involves the cognitive process employed when one approaches a novel task that cannot be performed without conscious effort (Flanagan & Ortiz, 2001). Tasks that demand fluid reasoning cannot rely on previously learned information. Narrow stratum abilities assumed under the broad stratum ability Fluid Reasoning are General Sequential Reasoning, Induction, and Quantitative Reasoning. McGrew (1997) defines select narrow stratum abilities subsumed under Fluid Intelligence. In order to more fully illustrate these narrow cognitive abilities, task examples will be provided. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Fluid Intelligence. General Sequential Reasoning involves the ability to solve a novel problem given a set of conditions. An example of a task requiring the use of General Sequential Reasoning is the completion of a logic puzzle. Induction involves the ability to identify the characteristic, commonality or governing rule of a problem or group of items. An example of a task requiring the use of Induction is the completion of a pattern using the rule governing the pattern. Quantitative Reasoning involves the ability to use deductive and inductive reasoning with mathematical concepts. An example of a task requiring the use of Quantitative Reasoning is filling in the blanks in an incomplete series of numbers.

Crystallized Intelligence

Crystallized Intelligence (Gc) consists of the full range of an individuals' acquired knowledge and their ability to use that knowledge (Flanagan & Ortiz, 2001). Gc is influenced by culture, experience, and education. Gc is composed of the following narrow stratum abilities: Language Development, Lexical Knowledge, Listening Ability, General (Verbal) Information and Information About Culture. McGrew (1997) defines select narrow stratum abilities subsumed under Crystallized Intelligence (Gc). For a more concrete illustration of the aforementioned abilities, task examples are useful. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Crystallized Intelligence. Language Development involves the overall development of language skills in the native language, especially the comprehension of units of the language. An example of a task requiring the use of Language Development is an oral response to a problem of everyday living that includes appropriate social norms and conceptions. Lexical Knowledge involves the knowledge of vocabulary. An example of a task requiring the use of Lexical Knowledge is defining words in the individual’s native language without the use of reference materials. Listening Ability involves the ability to listen to and understand oral language. An example of a task requiring the use of Listening Ability is an orally presented cloze activity wherein the individual is required to fill in the missing words. General (Verbal) Information involves the extent of general knowledge possessed by the individual. An example of a task requiring the use of General (Verbal) Information is answering a general factual question. Information About Culture involves the extent of cultural knowledge possessed by the individual. An example of a task requiring the use of Information About Culture is identifying famous historical people given photographs of those people.

Quantitative Knowledge

Quantitative Knowledge (Gq) “encompasses an individual’s store of accumulated quantitative, declarative, and procedural knowledge” (Flanagan & Ortiz, 2001, p. 9). This base of knowledge is a necessary prerequisite to working with numbers and information about quantities. Subsumed under Gq are two narrow stratum abilities, Mathematical Achievement and Mathematical Knowledge. McGrew (1997) defines the narrow stratum abilities subsumed under Quantitative Knowledge. Flanagan, McGrew and Ortiz (2000) provide task examples for the narrow abilities subsumed under Quantitative Knowledge. Mathematical Achievement involves mathematical abilities that can be measured through the use of academic assessments. An example of a task requiring Mathematical Achievement abilities is the solving of mathematical calculations. Mathematical Knowledge involves an individual's scope of knowledge about mathematical concepts. An example of a task requiring Mathematical Knowledge is knowing the meaning of mathematical symbols (+, -, +, %, etc.).

Table 2.1

Cattell Horn Carroll (CHC) Broad and Narrow Stratum Abilities[1]

Broad Abilities	Narrow Abilities
Fluid Intelligence *(Gf)*	General Sequential Reasoning Induction Quantitative Reasoning Piagetian Reasoning Speed of Reasoning
Quantitative Knowledge *(Gq)*	Mathematical Knowledge Mathematical Achievement
Crystallized Intelligence *(Gc)*	Language Development Lexical Knowledge Listening Ability General Information Information About Culture General Science Information Geography Achievement Communicative Ability Oral Production and Fluency Grammatical Sensitivity Foreign Language Proficiency Foreign Language Aptitude
Short-Term Memory *(Gsm)*	Memory Span Learning Abilities Working Memory
Visual Processing *(Gv)*	Visualization Spatial Relations Visual Memory Closure Speed Flexibility of Closure Spatial Scanning Serial Perceptual Integration Length Estimation Perceptual Illusions Perceptual Alternations Imagery

Table 2.1 (continued)

Broad Abilities	**Narrow Abilities**
Auditory Processing *(Ga)*	Phonetic Coding: Analysis Phonetic Coding: Synthesis Speech Sound Discrimination Resistance to Auditory Stimulus Distortion Memory for Sound Patterns General Sound Discrimination Temporal Tracking Musical Discrimination and Judgment Maintaining & Judging Rhythm Sound-Intensity Duration Discrimination Sound-Frequency Discrimination Hearing & Speech Threshold Absolute Pitch Sound Localization
Long-Term Storage and Retrieval *(Glr)*	Associative Memory Meaningful Memory Free Recall Memory Ideational Fluency Associational Fluency Expressional Fluency Naming Facility Word Fluency Figural Fluency Figural Flexibility Sensitivity to Problems Originality/Creativity Learning Abilities
Processing Speed (*Gs*)	Perceptual Speed Rate-of-test-taking Number Facility

Note. Adapted from *Essentials of cross battery assessment*, by D. P. Flanagan and S. O. Ortiz, 2001, New York: Wiley.

Short-Term Memory

Short-Term Memory (Gsm) refers to the retention of information in immediate consciousness and the use of this information within seconds. Short-Term Memory has limited capacity and most individuals are able to hold only seven plus or minus two pieces of information. Included in Gsm are Memory Span, Learning Abilities and Working Memory.

McGrew (1997) defines select narrow stratum abilities subsumed under Short-Term Memory. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Short-Term Memory. Memory Span is the ability to pay attention to and recall ordered items of information in the correct order after they are presented on a single occasion. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Short-Term Memory. Working Memory includes the ability to hold information in temporary storage for long enough to work on the information cognitively. An example of a task requiring Working Memory is being provided orally a disorganized list of numbers and letters and having to hold them in the short-term memory long enough to reorder them in the correct order.

Visual Processing

Visual Processing (Gv) refers to the "generation, perception, analysis, synthesis, storage, retrieval, manipulation, and transformation of visual patterns and stimuli" (Flanagan & Ortiz, 2001, p. 14). Visual Processing capabilities enable individuals to use, cognitively manipulate and work with visual information. Subsumed under Visual Processing are the narrow stratum abilities, Visualization, Spatial Relations, Visual Memory, Closure Speed, Flexibility of Closure, Spatial Scanning, Serial Perceptual Integration, Length Estimation, Perceptual Illusions, Perceptual Alternations, and Imagery. McGrew (1997) defines select narrow stratum abilities subsumed under Visual Processing. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Visual Processing.

Spatial Relations involves the ability to quickly distinguish visual stimuli or to orient items in a spatial plane. An example of a task requiring the use of Spatial Relations is being provided a visual example of a pattern and being required to reproduce it using manipulatives. Visual Memory involves the ability to create and store a visual depiction of a given stimulus and remember it later. An example of a task requiring Visual Memory is one in which an individual is required to identify or recreate a visual stimulus that is presented then removed. Closure Speed involves the ability to combine meaningless parts of visual stimuli into a cohesive whole without prior knowledge of the whole stimuli or pattern. Visualization refers to the ability to imagine how an object or visual pattern would look if changed in some way. Flexibility of Closure is the ability to find a known pattern or visual stimulus hidden within a visual field. An example of a task requiring Flexibility of Closure is identifying a certain number of specified visual stimuli (i.e. flowers) in a multifarious visual field. Spatial Scanning involves the ability to quickly scan a visual plane and find a trail through the plane. An example of a task requiring Spatial Scanning is completing a succession of puzzles that heighten in difficulty within a set period of time. Serial Perceptual Integration is the ability to identify a visual pattern when parts of the pattern are presented quickly in order. A task requiring Serial Perceptual Integration would require an individual to correctly recognize a stimulus when parts of the stimulus are shown in order.

Auditory Processing

Auditory Processing (Ga) is defined as the ability to hear auditory information and distinguish between sounds and patterns of sound while blending or separating the sounds for various purposes (Flanagan & Ortiz, 2001). Auditory Processing is not reliant on the comprehension of oral language but does play a role in growth of language skills that are related to Crystallized Intelligence (Gc) (Flanagan & Ortiz, 2001). The narrow abilities subsumed under Auditory Processing are Phonetic Coding: Analysis, Phonetic Coding: Synthesis, Speech Sound Discrimination, Resistance to Auditory Stimulation Distortion, Memory for Sound Patterns, General Sound Discrimination, Temporal Tracking, Musical Discrimination and Judgment, Maintaining and Judging Rhythm, Sound-Intensity Duration Discrimination, Sound-Frequency Discrimination, Hearing and Speech Threshold, Absolute Pitch, and Sound Localization.

McGrew (1997) defines select narrow stratum abilities subsumed under Auditory Processing. Task examples help to illustrate these narrow abilities. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Auditory Processing. Phonetic Coding: Analysis is defined as the ability to separate bigger chunks of speech sounds into smaller chunks of speech sounds. A task requiring the use of Phonetic Coding: Analysis, is the requirement to separate onset and rime in an orally presented whole word. Phonetic Coding:

Synthesis is defined as the ability to merge small units of speech with other small units of speech to form bigger units of speech sound. A task requiring the use of Phonetic Coding: Synthesis is the requirement to combine isolated phonemes into a word by blending the sounds together. Speech/General Sound Discrimination is defined as the ability to notice distinctions in speech sounds without distractions. An example of a task requiring the use of Speech/General Sound Discrimination is the presentation of nonsense sounds to an individual who must determine whether the sounds are the same. Resistance to Auditory Stimulus Distortion is the ability to recognize and comprehend speech that is difficult to understand because of distortion or imprecision. An example of a task requiring the use of Resistance to Auditory Stimulus Distortion is identifying words despite increasing levels of distracting noise. Memory for Sound Patterns is defined as the ability to hold auditory information in the short-term memory. A task requiring the use of Memory for Sound Patterns is being presented with sounds and being required to state whether they were previously heard in a series of tones presented.

Long-Term Storage and Retrieval

Long-Term Storage and Retrieval (Glr) is the ability to "store new or previously acquired information (e.g., concepts, ideas, items, names) in long-term memory and to retrieve it fluently later through association" (Flanagan & Ortiz, 2001, p. 18). It is important to distinguish between the information that a person knows (Gc or Gq) and how efficiently they store and retrieve that information from their long-term memory (Glr). Long-term retrieval is also different from Short-Term Memory (Gsm). While Long-Term Retrieval can happen anywhere from several minutes to hours after performing a task, the defining feature of Long-Term Retrieval is that a task requiring Short-Term Memory must occur in the time between storage of the information and attempted retrieval of the information (Flanagan & Ortiz, 2001). The narrow stratum abilities subsumed under Glr are Associative Memory, Meaningful Memory, Free Recall Memory, Ideational Fluency, Associational Fluency, Expressional Fluency, Naming Facility, Word Fluency, Figural Fluency, Sensitivity to Problems, Originality/Creativity, and Learning Abilities.

McGrew (1997) defines select narrow stratum abilities subsumed under Long-Term Storage and Retrieval. Flanagan, McGrew and Ortiz (2000) provide task examples for some of the narrow abilities subsumed under Long-Term Storage and Retrieval. Associative Memory is defined as the ability to remember one part of a pair of previously learned items when the other part is presented. A task requiring the use of Associative Memory is when an individual is presented with a series of objects paired with nonmeaningful words and is expected to remember which word goes with which object. Meaningful Memory is defined as the ability to remember a group of items when there is a significant relationship between the items. An example of a task requiring the use of Meaningful Memory is when a story is read and then retold with as much detail as possible afterwards. Free-recall Memory is defined as the ability to remember as many items as possible from a presented set of items that are not related. An example of a task requiring the use of Free-recall Memory is when an individual is shown a group of objects and then must recall the objects in any order once they are removed from sight. Ideational Fluency is defined as the ability to quickly produce words or concepts related to a specific prompt. With Ideational Fluency, the number of words or concepts recalled is more important than the quality of those words or concepts. A task requiring Ideational Fluency is when an individual is required to rapidly name all of the items

needed to complete a familiar task. Associational Fluency is defined as the ability to quickly recall words related in meaning to the concept provided. Associational Fluency is required to name as many items as possible within a given category. Expressional Fluency is defined as the ability to quickly create meaningful, higher order ideas based on cues given. A task requiring Expressional Fluency is when a category is quickly assigned to a group of words or objects (e.g., ingredients for making cookies). Naming Facility is the ability to quickly recall names for given visual or auditory cues. Naming Facility is used when a general categorical name is assigned based on one visual stimulus (e.g. horse-animal). Word Fluency is defined as the ability to quickly recall words with specific characteristics. Figural Fluency is defined as the ability to quickly draw examples after being given a visual cue. An example of a task requiring Figural Fluency is the presentation of a nonsense visual stimulus and then drawing as many things a possible based on that stimulus.
Word Fluency is required to name as many words as possible that end with –ing.

Processing Speed

Processing Speed (Gs) involves the ability to rapidly, effortlessly, and naturally perform tasks requiring cognitive effort. Processing Speed is especially salient in situations where the individual is required to maintain mental focus and freedom from distractions. The narrow stratum abilities subsumed under Gs are Perceptual Speed, Rate-of-Test-Taking, and Number Facility.

McGrew (1997) defines the narrow stratum abilities subsumed under Processing Speed. Flanagan, McGrew and Ortiz (2000) provide task examples for the narrow abilities subsumed under Processing Speed. Perceptual Speed is defined as the ability to quickly find and compare visual stimuli that are presented in parallel planes. An example of a task requiring Perceptual Speed is viewing a row of visual stimuli and quickly crossing out the one that is different from the others. Rate-of-Test-Taking is defined as the ability to quickly complete tests that are simple or easy. A task that requires Rate-of-Test-Taking is quickly matching numbers to visual symbols according to a key that is provided. Number Facility is defined as the ability to automatically and fluently mentally work with numbers from basic to advanced mental mathematical skills. Number Facility is required to complete rote mathematical problems.

Application of CHC Cross-Battery Approach

CHC is finding utility in schools through Flanagan, McGrew, and Ortiz's CHC Cross-Battery Approach (Flanagan, Ortiz, & Alfonso, 2007; Flanagan & Ortiz, 2001; McGrew & Flanagan, 1998). There are two primary methods for approaching CHC assessments of intelligence. The first is to administer the Woodcock-Johnson III (WJ-III; Phelps, McGrew, Knopik & Ford, 2005). The WJ-III is a battery of cognitive and achievement tests designed to measure all of the broad abilities in the CHC framework (Mc Grew & Woodcock, 2001). The second approach to CHC evaluation is the use of the CHC Cross-Battery Approach for test battery selection. Flanagan and Ortiz (2001) and Flanagan, Ortiz, and Alfonso (2007) offer three guiding principles for choosing tests or subtests in this approach. Their first guiding principle is that tests should be chosen for each broad ability that strongly or moderately loads on that ability. Secondly, two or more distinct narrow abilities should be measured for each broad ability. Subtests should be chosen from the fewest number of cognitive tests possible to decrease the effect of confounds from different norming samples between tests. Practitioners are encouraged to see McGrew and Flanagan's 1998 publication, *The Intelligence Test Desk Reference (ITDR)* for further information on selecting a test battery for CHC Cross-Battery interpretation. The utility of psychoeducational assessments can be judged by the interventions that they inform. After all, just as excellent teachers use assessments to drive instruction, school psychologists must utilize assessments to tailor their recommendations to the individual needs of the student.

The validity of CHC cross battery approach to test interpretation and the WJ-III was evaluated by a succession of research studies using joint confirmatory factor analysis (CFA). These empirically based studies have focused on broad and narrow CHC abilities separately. The broad CFAs analyzed individual tests of cognitive ability and classified each subtest at the broad stratum level (Flanagan, McGrew & Ortiz, 2000; McGrew & Flanagan, 1998). Narrow CFAs have focused on content validity (Flanagan et al., 2000, McGrew & Flanagan, 1998; McGrew & Woodcock, 2001). At this time, a major gap in the research literature is the lack of studies examining both the broad and narrow stratum classifications of existing intelligence tests and their subtests using exploratory or confirmatory factor analysis (Phelps et al. 2005).

The authors of the WJ-III have contributed to the literature in an attempt to fill this gap with an illustrative hierarchical three-stratum factor model in their norm sample (McGrew & Woodcock, 2001). McGrew and Woodcock (2001) concluded that CFA methods might be unable to differentiate between highly correlated narrow abilities even though these narrow abilities are distinct. The authors further point out that looking at the construct, content, and developmental validity for some highly correlated narrow abilities (i.e. Listening Ability) may be more appropriate than CFA methods. Further research is clearly indicated.

The recent study by Phelps et al. (2005) is the first ever three-stratum confirmatory factor analysis based on the CHC framework to look at a data set consisting of intelligence test data from the WJ-III and the Wechsler Intelligence Scales for Children- III (WISC-III; Phelps et al., 2005). The researchers tested 148 children, ages 8 to 12, who were part of the original sample for the norming of the WJ-III (2005). Their findings confirmed the validity of the classifications devised by Flanagan et al. (2000) (Phelps et al., 2005). The presentation of a *g*+broad+narrow CHC model based on empirical information is a second contribution of this study. The plausibility of their model is supported by the goodness of fit statistics used. The authors recognize, however that while the plausibility is confirmed, there is not concrete proof that their model is the correct model. Limitations of sample homogeneity and small sample limit the generalizability of the study's results. This study is also limited in the fact that it used test data from the WISC-III, which has since been revised and renormed in the WISC-IV (Wechsler, 2003).

Recently, Fiorello, Hale, Holdnack, Kavanagh, Terrell, and Long (2007) used regression commonality analysis to determine whether assessment of distinct cognitive abilities was more appropriate than assessment of global cognitive ability, *g*. The authors found that interpretation of clusters of scores from assessment batteries revealed important information about the cognitive profiles of children with disabilities. Further, Fiorello et. al. point out that interpretation of the full scale IQ for children with disabilities does not adequately illustrate the complexity of their cognitive profile and should rarely, if every be interpreted. Rather than interpret FSIQ, the authors indicate that Index scores may be interpreted depending on the CHC broad ability that they represent.

Utility of Assessment Results and Recommendations

While CHC theory itself has demonstrated many types of validity (McGrew et. al., 1997), ecological validity has not yet been established. Thus, despite the assertion of Flanagan, Ortiz, and Alfonso (2007) that CHC has positively impacted communication between professions, reports written based on CHC theory may not provide information to teachers that is easily utilized. It is important to consider what we know about the utility of assessment results and recommendations in order to increase productive communication between teachers and school psychologists.

In a recent study by Gilman and Gabriel (2004), the authors sought to gain information regarding teachers' and administrators' perception of school psychological services. In their study, teachers were asked to rate their perceived knowledge of school psychology, satisfaction with school psychological services, helpfulness of services to children, helpfulness of services to educators, and seriousness of problems prior to referral on a four and five point Likert-type scales. The teachers indicated that they perceive themselves as somewhat knowledgeable about school psychology. They reported that they were somewhat satisfied with school psychological services and that the services were moderately helpful to both them and their students. Teachers also reported that a child must be experiencing problems that are moderate to serious before they would refer them to a school psychologist.

In a study conducted by Gomez (2006), teachers were asked to read psychoeducational reports written using different theoretical models to determine whether the format of the report impacted their comprehension and whether the teachers preferred one report style over the other. In one report, the results were organized according to CHC theory. The other report organized results in a test-by-test format. Results of this study indicated that teachers did not prefer or better comprehend one report over the other. This study was limited by its very small (n=40) sample size. However, it is interesting to note that participants in this study did not have improved satisfaction or comprehension when test results were organized in a CHC format.

According to Brown-Chidsey and Steege (2005), “no assessment is likely to be useful until, or unless, the findings are communicated to those in a position to implement solutions” (p. 267). Several researchers have looked at the utility of different report formats. Hoy and Retish (1984) presented participants with two types of reports, one according to a traditional report format and one that focused on students' strengths. Neither type of report was preferred. In fact, both were considered rather useless by the participants (Hoy & Retish, 1984). In a related study, Ownby found that reports organized by abilities, that included a strengths and weaknesses profile and that provided clear recommendations were preferred by teachers (1987). Lichtenberger et al. point out that consumer satisfaction is of utmost importance in report writing (2004). One way to increase consumer satisfaction with reports is by tying recommendations to the referral question, thereby providing potential solutions to the referral problem (Lichtenberger et al., 2004).

Linking Assessments to Interventions

Many researchers have attempted to increase the utility of their assessment results by tying those results to ensuing treatments or interventions. This effort comes as a result of the shift in school psychology from a medical model of disability diagnosis (focusing on within child pathologies) to an ecological model that considers ecological variables as influential to children's cognitive, social, and emotional development. Sheridan and McCurdy (2005) point out that ecological assessment may be superior than other forms of assessment for devising interventions and monitoring those interventions. In their ecological assessment model, microsystemic factors (environmental factors in the classroom or home) are considered because these factors have heavy influence on a child's ability to learn within those environments. This ecological approach provides information about the way that a child learns that can help a teacher to tailor their instruction to meet the individual needs of the learner.

Similarly, Hale and Fiorello (2004) promote a ecologically valid cognitive hypothesis testing (CHT) model wherein IQ scores from standardized intelligence tests are used primarily as a screening tool, a rudimentary road map for further assessment. Linking assessment to intervention is a major priority for these authors; and CHT emphasizes ecological and treatment validity. They argue that as a school psychologist, the most effective assessment and intervention model is one where you "intervene to assess" (Hale & Fiorello, 2004, p. 128). The authors agree that CHC theory is a useful framework for assessment. Using cross-battery assessment, the authors suggest that practitioners conduct a demands analysis to determine the neuropsychological and cognitive processes necessary for task completion (Hale & Fiorello, 2004). Similar to the recommendations made by Flanagan and Ortiz (2001) and

McGrew and Flanagan (1998) regarding cross-battery test interpretation, Hale and Fiorello (2004) suggest that a pattern of low scores on subtests with comparable demands would indicate a possible weakness in that area of neurological processing.

The CHT model follows 13 steps in four categories: theory, hypothesis, data collection, and interpretation (Hale & Fiorello, 2004). Step one of the CHT model involves the examination of the referral question and history to develop a theory of the presenting problem. In step two, a determination is made as to whether the hypothesized problem is caused by cognitive functioning. If so, step three is administration of an intelligence test. In step four, the practitioner interprets the results of the IQ test by conducting a demands analysis. A profile of possible cognitive strengths and weaknesses is then created in step five. In step six, the school psychologist chooses tests to measure the related constructs as defined by the cognitive strengths and weaknesses of the child. Those tests are then administered (step seven) compared, and interpreted (step eight). At this point, in step nine the practitioner consults with the teacher to design interventions. Step ten is where the intervention plan is chosen. Then, the intervention is systematically implemented (step 11). In step 12, data are collected to evaluate the efficacy of the intervention. Finally, the intervention is either revised or continued until desired results are obtained (step 13). Clearly, the guidelines provided in the Cognitive Hypothesis Testing Model give practitioners a comprehensive approach for implementation of CHC cross-battery approach, tailored intervention, teacher involvement and progress monitoring.

Lidz (2003) offers "Guidelines for Pain Reduction in Report Writing and for Generating Meaningful Reports." Several of these guidelines offer information regarding recommendations. These guidelines include basing recommendations on what has been learned about the child through assessment in combination with what is known about evidence-based practices as well as what is feasible for the teacher to implement (Lidz, 2003). Good recommendations flow logically from the assessment information. Further, "if there is good problem clarification at the start of the assessment, and if the process proceeds in good hypothesis-generating, problem-solving fashion, then a repertory of interventions naturally unfolds" (Lidz, 2003, p. 229). Along with using evidence-based interventions, it is crucial that school psychologists are not lulled into using "cookbook style" interventions. With children, one size most certainly does not fit all.

Summary

The present study could assist in determining the ecological validity of CHC Theory by narrowing the gap between the research base on teacher and school psychologist perceptions and the research base on cognitive abilities and cognitive assessment. As teachers are the most significant factor in student learning (Darling-Hammond, 2000) and their perceptions influence the ways that they teach (Peterson, Fennema, Carpenter, & Loef, 1989; Richardson, 1996), it is crucially important to know how they understand their students' cognitive abilities. As teachers are usually the first professionals to notice that a student is struggling in schools and are typically the referrers of students for special education evaluations (Eckert & Arbolino, 2005; Fagan & Wise, 1994), their perceptions of student ability merit important consideration.

The paradigm shift in the field of cognitive assessment (and neuropsychological) of children from a medical model to an ecological model (Gioia & Isquith, 2004) has practitioners focusing less on individual pathology and more on the ecological variables that impact a child's learning and behavior. In this framework, teachers are important agents of change and instructional variables become targets of intervention. Thus, the field must evaluate the utility of the assessments performed in light of the interventions they inform. CHC theory, as a relatively new framework for cross-battery assessment must provide the information needed about an individual's strengths and needs that can be translated into interventions.

CHC theory has demonstrated several important forms of validity: structural, developmental, neuroscientific, achievement and heritability (McGrew et. al., 1997). As researchers in neuroscience have demonstrated, ecological validity is a vital component of any assessment or theory that may have direct applicability with children (Gioia & Isquith, 2004). The ecological validity of CHC theory has not been as clearly demonstrated although select researchers are actively pursuing data to determine the level of ecological validity (Fiorello & Thurman, 2001; Fiorello et. al., 2006; Sher et. al. 2004). These researchers are primarily working on rating scales of CHC broad abilities to be completed by teachers which may provide valuable information to school psychologists engaged in assessment activities. The current study is unique among current CHC ecological validity research in that it seeks to understand how teachers comprehend the broad abilities defined by CHC theory.

Research Questions

There are several research questions being posed in this study.

1). Are school psychologists and teachers equally proficient at identifying the broad cognitive ability demands of a basic academic task? If not, which group is more proficient?

2). How do the responses of the participants compare to the theoretical model presented (CHC Theory)?

3). Do teachers and school psychologists become better at identifying the cognitive demands of a task with experience in the field or higher levels of training?

Hypotheses

1). While there may be some similarity in the responses given by the participants and the theoretical model, the participants' responses are likely to be significantly different from the model. Responses in some broad ability categories may be more similar to the model than others (Crystallized Intelligence, Fluid Reasoning, Auditory Processing, Quantitative Reasoning).

2). Theoretically, school psychologists will have more experience with CHC theory and may be more familiar with the broad abilities. Due to training and familiarity, school psychologists will be more fluent and accurate with this task.

3). Level of experience will be a significant predictor of accuracy in identifying the cognitive requirements of the academic tasks presented. Similarly, level of training will be a significant predictor of accuracy in identifying the cognitive requirements of the academic tasks presented.

4). The null hypotheses are that

a). teachers and school psychologists do not identify the cognitive requirements of basic academic tasks better than chance.

b). There is no significant difference between groups.

CHAPTER 3

METHOD

Participants

Participants in this study were 70 teachers (Kindergarten through 12th grade) and 79 school psychologists. A power analysis using an alpha of .05, 80% power and with a large effect size indicated that the required sample size was 60 per group. Therefore, the current sample was sufficient to run all of the statistical procedures necessary for this study. Thus minimizing the risk of making a Type I or Type II error.

These teachers and school psychologists were recruited nationally via the listservs of teacher and school psychologist organizations. The teachers were recruited through the Elementary Lesson Share listserv, which had 3,118 members nationally at the time of recruitment. The school psychologists were recruited through the general listserv of the National Association of School Psychologists (NASP), the NASP Multicultural Interest Group listserv, and the NASP Social Justice Interest Group Listserv. These listservs had combined membership of 2,516 school psychologists at the time of recruitment. The recruitment letters posted to these listservs are presented in Appendices A and B.

Participants' demographic information was collected through the use of an anonymous, researcher-created demographic questionnaire. This questionnaire provided information about the gender, ethnicity, years teaching, level of education, grade taught, type of school taught in (urban, suburban, rural) and whether or not the teacher was a special education teacher. While a participant's gender and ethnicity were not theorized to significantly impact their responses to the items presented, this information was collected to ensure the demographic representativeness of the sample. The information collected was in no way personally identifiable so that confidentiality was not compromised. No personally identifying information accompanied the data.

Teachers

The teachers who participated in this study were generally representative of the population of teachers in the United States. This was determined by comparing the teachers in the sample to national teacher demographics as compiled by the National Center for Education Statistics (2007) and the National Education Association (2003). There were 11 male and 59 female teachers. Sixty-seven of the teachers were Caucasian, 1 was African American and 2 self-identified as "Other." All of the teachers in the study had at least a bachelor’s degree (n=9) while some had a bachelor’s degree plus some graduate credits (n=11). The other 68% of the teacher participants had graduate degrees: 20 had master’s degrees, 23 had master’s degrees plus 30 graduate credits, and 5 had doctoral degrees. The teacher participants ranged in experience from first year teachers to veterans with more than 25 years of experience. Nineteen teachers had been teaching for 0-5 years, 9 had 6-10 years of experience, 10 had 11-15 years of experience, 7 teachers had 16-20 years of experience, 6 had 21-25 years, and 19 had over 25 years of teaching experience. The teachers were fairly evenly divided between early elementary (n=30), elementary (n=28), middle (n=20), and high school (n=25). The majority of teacher participants were regular education teachers. Thirty participants identified as special education teachers. These data are presented in Table 3.1.

Table 3.1

Demographic Representation of Teacher Participants Compared to National Teacher Demographics

Profession		Teachers		National (NCES/NEA)
		N	%	
Total		70	N/A	N/A
Gender				
	Male	11	15.71	24.8
	Female	59	84.29	75.2
Ethnicity				
	American Indian/Alaska Native	0	0.00	0.6
	Asian	0	0.00	1.4
	Native Hawaiian or Other Pacific Islander	0	0.00	0.2
	Black/ African American	1	1.43	7.4
	White (non-Hispanic)	67	95.71	83.7
	Hispanic	0	0.00	6.0
	Other	2	2.86	0.7
Years Teaching/ Practicing				Mean Total
	0-5	19	27.14	15
	6-10	9	12.86	
	11-15	10	14.29	
	16-20	7	10.00	
	21-25	6	8.57	
	Over 25	19	27.14	
Level of Education				

Table 3.1 (continued)

	Bachelor's Degree	9	12.86	51.4
	Bachelor's Degree + some graduate credits	11	15.71	Not Available
	Master's Degree	20	28.57	39.5
	Master's Degree + 30 credits	23	32.86	Not Available
	Doctoral Degree	5	7.14	7.0

Note: National Percentages based on: (National Center for Education Statistics, 2007; National Education Association, 2003)

The teacher participants were geographically representative as well. Teachers from 20 states responded to the survey. Twenty-three teachers were from the Northeast Census Region of the U.S., 3 were from the Midwest, 40 were from the South Census Region, and 4 were from the West Census Region. For a specific breakdown of participants by census division, see Table 3.2. The majority of the teachers teach in suburban schools (n=35) with the other half of the teachers split between urban (n=16) and rural schools (n=19).

Table 3.2

Geographic Location of Teacher Participants

School Location		N	%	NCES/ NEA
	Urban	16	22.86	30.0
	Suburban	35	50.00	30.0
	Rural	19	27.14	40.0
Census Division				
	Northeast Region Total	23	32.85	
	New England Division (CT, ME, MA, NH, RI, VT)	6	08.57	
	Middle Atlantic Division (NJ, NY, PA)	17	24.28	
	Midwest Region Total	3	04.28	
	East North Division (IN, IL, MI, OH, WI)	3	04.28	
	West North Division (IA, KS, MN, MO, NE, ND, SD)	0	0	
	South Region Total	40	57.14	
	South Atlantic Division (DE, DC, FL, GA, MD, NC, SC, VA, WV)	32	45.71	
	East South Central Division (AL, KY, MS, TN)	5	07.14	
	West South Central Division (AR, LA, OK, TX)	3	04.28	
	West Region Total	4	05.71	
	Mountain Division (AZ, CO, ID, MT, NM, NV, UT, WY)	2	02.86	
	Pacific Division (AK, CA, HI, OR, WA)	2	02.86	

School Psychologists

School psychologist participants were also generally representative of the demographics of the profession. This was determined by comparing the school psychologists in the sample to demographic information collected by the National Association of School Psychologists (Curtis, Lopez, Batsche, & Smith, 2006). Twenty-two of the school psychologists were male and 57 were female. The participants were predominantly Caucasian, which is the case for the profession as a whole. Seventy-four of the participants identified as Caucasian, three were Hispanic, and three self-identified as “Other.” Necessarily, all of the school psychologists had at least a master’s degree (n= 7). The majority of the school psychologists had a master’s degree plus 30 graduate credits (n=31). Finally, 25 of the school psychologists had doctoral degrees. The school psychologist participants varied in level of experience. Twenty-six school psychologists had 0-5 years of experience, 18 had 6-10 years, 10 had 11-15 years of experience, 6 had 16-20 years, 6 had 21-25 years, and 13 had over 25 years of experience. As many school psychologists work in multiple grade levels, visual inspection of the data revealed significant overlap between grade levels. The following numbers indicate how many school psychologists spend at least part of the time working with students in the following grade levels. Thirty-four of the school psychologists worked with preschool aged students. Sixty-two school psychologists worked with early elementary aged students (grades K-3). Sixty-five of the participants worked with elementary aged students (grades 4-6). Fifty of the school psychologists who responded worked with middle school students (grades 7-8). Finally, 35 of the school psychologists worked with high school aged students (grades 9-12).

Table 3.3

Demographic Representation of School Psychologist Participants Compared to National Representation

Profession		School Psychologists		National (NASP)
		N	%	%
Total		79	N/A	N/A
Gender				
	Male	22	27.85	26.00
	Female	57	72.15	74.00
Ethnicity				
	American Indian/Alaska Native	0	0.00	0.8
	Asian	0	0.00	0.9
	Native Hawaiian or Other Pacific Islander	0	0.00	
	Black/ African American	0	0.00	1.9
	White (non-Hispanic)	74	93.67	92.6
	Hispanic	2	2.53	3.0
	Other	3	3.80	0.8
Years Teaching/ Practicing				
	0-5	26	32.91	
	6-10	18	22.78	
	11-15	10	12.66	
	16-20	6	7.59	
	21-25	6	7.59	
	Over 25	13	16.46	

Table 3.3 (continued)

Level of Education				
	Bachelor's Degree	0	0.00	N/A
	Bachelor's Degree + some graduate credits	0	0.00	N/A
	Master's Degree	8	10.12	33.0
	Master's Degree + 30 credits	45	58.22	35.0
	Doctoral Degree	25	31.65	32.0

Note: NASP Percentiles Based On: (Curtis, Lopez, Batsche, & Smith 2006)

The school psychologists were also geographically representative. Respondents were located in 25 states. Like the teacher participants, the majority of the school psychologist participants were located in the Northeast Census Region (n=38). The Midwest Region was represented by 9 participants. Twenty-nine participants were located in the South Census Region. Only 3 participants were located in the West Census Region.

Table 3.4

Geographic Location of School Psychologist Participants

School Location		N	%
	Urban	24	30.38
	Suburban	44	55.70
	Rural	11	13.92
Census Division			
	Northeast Region Total	38	48.10
	New England Division (CT, ME, MA, NH, RI, VT)	9	11.39
	Middle Atlantic Division (NJ, NY, PA)	29	36.70
	Midwest Region Total	9	11.39
	East North Division (IN, IL, MI, OH, WI)	6	07.59
	West North Division (IA, KS, MN, MO, NE, ND, SD)	3	03.79
	South Region Total	29	36.70
	South Atlantic Division (DE, DC, FL, GA, MD, NC, SC, VA, WV)	20	25.31
	East South Central Division (AL, KY, MS, TN)	8	10.12
	West South Central Division (AR, LA, OK, TX)	1	01.26
	West Region Total	3	03.79
	Mountain Division (AZ, CO, ID, MT, NM, NV, UT, WY)	0	0
	Pacific Division (AK, CA, HI, OR, WA)	3	03.79

Measures

The researcher developed a web page (www.schoolpsych-teachersurvey.com) to gather data. Volunteer participants visited the web page at their leisure and completed the following task. The researcher developed a sorting procedure to assess how teachers and school psychologists conceptualize the cognitive abilities underlying basic academic tasks, thereby answering the research questions. The sorting procedure was modified from Q-sort methodology. In the sorting activity, teachers and school psychologists were presented with the same 34 basic academic tasks to sort by their underlying cognitive ability. The participants were given a forced choice between one of eight CHC broad stratum cognitive abilities for each task.

Items for the sort were developed by Fiorello and Thurman (2001) based on written descriptions of the abilities subsumed under each broad cognitive ability from CHC theory (Carroll, 1993; McGrew & Flanagan, 1998). Several items describing everyday skills or abilities were created to represent each broad cognitive ability. An expert panel of researchers published in the area of cognitive assessment and CHC theory was solicited through a CHC listserv (Fiorello & Thurman, 2001). Each expert was provided the description of each ability and the items that were developed to assess that ability. They were asked to rate each item. Based on those ratings, items with only average ratings were discarded. Those items that were considered to be the most pure representations of the construct were retained in the final list of 37. The 37 items retained in the scale were then administered to a group of 92 teachers. Results of this study indicated that the total scale had an internal consistency reliability of .94 and the subscales had a median reliability of .74. The individual items in the scale were significantly positively correlated with their respective subscale scores at the .01 level. The authors indicated that the items on the scale were appropriate for grades 1-12.

Sher et al. (2004) expanded on this questionnaire by adding eight overall descriptors of the broad abilities. The researchers sent this questionnaire to a national random selection of teachers and school psychologists and asked them to complete the survey and rate the eight overall descriptors regarding their importance for the success of students in their classroom/school. In analyzing their data, Sher et al. correlated each item with the broad ability scale it was intended to represent. They also calculated Cronbach alphas for each scale with and without each item. Items were dropped from the scale if they had low correlations to the theoretical scale they purported to represent and if the scale yielded higher alphas without them. Cronbach alphas for the remaining 34 items were calculated to evaluate internal consistency.

The alphas for each scale were as follows: .736 for Fluid Reasoning, .691 for Crystallized Intelligence, .829 for Visual Processing, .885 for Auditory Processing, .739 for Short-term Memory, .639 for Long-term Storage and Retrieval, .656 for Processing Speed, and .935 for Quantitative Reasoning (Sher et. al. 2004). Thus, the Visual Processing, Auditory Processing, and Quantitative Reasoning scales met the .8 requirement for internal consistency. Fluid Reasoning and Short-term Memory were very close to .8, which is considered highly consistent.

In the current study, the 34 items retained by Sher et. al. were employed. The items representing each cognitive ability according to the theoretical model are presented in Table 3.5.

Table 3.5

Items Representing Each Broad Cognitive Ability

Fluid Reasoning (Gf)
figure out what comes next in a series
derive rules explaining why objects or pictures are in different categories
select the correct missing piece to complete a logical puzzle
figure out which objects go together logically
Crystallized Ability (Gc)
show good language development
know a great deal of general information
have a well-developed vocabulary
complete crossword puzzles
Visual Processing (Gv)
pick out visual item among other distracting items
build a model with blocks or Legos from a picture of the completed model
visualize how an object would look from another perspective
identify a picture that is distorted or has parts missing
know what jigsaw puzzle piece will fit
Auditory Processing (Ga)
tell when two sounds are subtly different

Table 3.5 (continued)

tell when two words are subtly different
recognize a word when only parts of it are pronounced
say how a word would sound with one sound deleted ("blend without the /l/)
figure out missing sounds in incomplete words
blend sounds together into meaningful words
Short-Term Memory (Gsm)
remember a phone number briefly before calling it
remember a series of related words
remember the details of a phone message long enough to write them down after hanging up
remember a series of unrelated words
Long-Term Storage and Retrieval (Glr)
recall the name of a new acquaintance when you meet again
remember a series of related words when one word is given after a long delay
recall information related to a particular topic quickly
Processing Speed (Gs)
work quickly and accurately on tasks that are already mastered and automatic
quickly and accurately check work against an answer key
quickly copy routine information from the chalkboard
quickly find all the e's on a page

Table 3.5 (continued)

Quantitative Reasoning (Gq)

figure out oral or written math word problems (not just rote memory of "math facts")
know mathematical concepts and terms
learn and carry out math procedures, such as solving algebraic equations
easily and efficiently work through mathematical problems

Procedure

Informed consent was obtained from the research participants as they read a brief statement regarding the study, their participation therein, and confidentiality (see Appendix C). The informed consent was collected upon visiting the web page and participants were not able to move forward with the activity until they selected "I Accept" at the bottom of the informed consent page. There was no risk of harm to the participants. There was no deception involved in the study. Compensation was not offered for participation in the study, however, participants were offered the opportunity to enter a drawing for a gift card. It was unlikely that participation in the study interfered with the participants' typical functioning, as they were given the opportunity to complete the activity at their leisure. The participants were made aware, through the informed consent statement, of the fact that their participation is voluntary and they could choose to discontinue participation at any time. The participants were also informed of whom they could contact with questions. At the end of the activity, participants were provided with an opportunity to leave comments for the researcher.

After informed consent was obtained from the participants, an anonymous demographic survey was presented (see Appendix D for survey). The participants completed the brief demographic survey consisting of 7 questions. Then they viewed the instructions for the task. Due to the fact that the researcher was not present while participants completed the task, the list of instructions were explicit and appeared at the top of each screen (see Appendix E for instructions). After reading the instructions for the task, the participants indicated that they were ready to begin and the first basic academic task appeared on the web page (see Appendix F for a list of the basic academic tasks to be presented). At the bottom of the page were the definitions of each CHC broad ability (see Appendix G for a list of CHC broad abilities). The participant then clicked the radio button (circle) corresponding to the broad ability for each item. Once each item was completed, the next item appeared on the screen until all items were completed. Once all items were sorted, the participants viewed each of the items with their choices. They had the opportunity at that time to change any selection before finalizing their answers. At the conclusion of the activity, participants viewed a screen thanking them for their participation and offering them the opportunity to share comments with the researcher regarding the study. They also had an opportunity to enter a drawing for a gift certificate in appreciation for their participation.

The participants' responses were electronically gathered and compiled into a spreadsheet for ease of analysis. The identifying information gathered (email addresses) was stored separately from their responses to the demographic questionnaire and to the items. By so doing, the participants remained anonymous.

CHAPTER 4

RESULTS

Data Analysis Procedures

The main questions being asked in this study were: 1.) Are school psychologists and teachers equally proficient at identifying the broad cognitive ability demands of a basic academic task? If not, which group is more proficient?, 2.) How do the responses of the participants compare to the theoretical model presented (CHC Theory), and 3.) Do teachers and school psychologists become better at identifying the cognitive demands of a task with experience in the field or higher levels of training?

In order to answer the first question, the responses of the participants were visually inspected. The percentage of respondents who sorted each item correctly was calculated and those percentages were compared. Next, a multivariate analysis of variance (MANOVA) was used to determine whether a significant difference existed between the responses of the teachers and the responses of the school psychologists. A MANOVA was used because it can handle several dependent variables. The dependent variables were created by transforming the data for each item to represent correctness or incorrectness according to the theoretical model. Thus, a participant who selected the correct broad ability for the academic task as determined by Fiorello and Thurman in creating the items would be considered correct, any other answer was considered incorrect. These transformations created 34 new variables, which were used as the dependent variables for the MANOVA. The independent variable for the MANOVA was profession. Additional MANOVAs were calculated with each theoretical scale as the dependent variables and with the items by theoretical scale as the dependent variables.

To analyze the multivariate effects of the MANOVA, Wilks' Lambda statistics were computed. This multivariate test statistic was selected to express the proportion of unexplained variance (Tatsuoka, 1971). Each Wilks' Lambda was transformed into an F statistic and compared to a critical F value to obtain a significance level. A predetermined criterion for significance was set at $p<.05$.

To answer the second main research question posed in this study, a factor analysis was conducted. A principal components factor analysis, followed by a varimax rotation, was computed on the 34 items from the sort activity. This analysis produced thirteen factors with eigenvalues over 1. The results of this analysis were not useful in answering the research question, therefore a second principal components factor analysis was run. Again, this factor analysis was followed by a varimax rotation. The varimax rotation was used to achieve a more interpretable solution (simple structure) to the factor analysis. In the second principal components factor analysis, an a priori criterion stopping rule was employed in the principal-components analysis. This approach has been recognized as useful when the researcher has an idea about the number of eigenvectors (factors) to extract based on a theoretical model (Hair, Anderson, Tatham, & Black, 1992). The analysis was limited to eight factors.

To further respond to question 2, the eight factors created by the principal components factor analysis were correlated with the eight theoretical factors using Pearson correlations. Pearson correlations allowed for determination of significant correlations between theoretical factors and the results of the factor analysis.

In addition, Cronbach alphas were calculated for each of the theoretical factors to determine whether the items themselves were internally consistent. Cronbach alpha also helped to determine whether the items that are supposed to cluster together according to the theoretical model actually group together as a construct.

Finally, to answer question 3, Pearson correlations were calculated to determine the relationship between years practicing and "correctness" of responses for the theoretical factors. Also correlated were level of education and "correctness" of responses for the theoretical factors.

To expand on question 3, independent samples t-tests were calculated to determine whether significant differences existed between regular education and special education teachers on the items from the sort activity. Differences in means were used to determine which group was more correct in their responses when compared to the theoretical model.

Results of Data Analysis

The first research question asked whether school psychologists and teachers are equally proficient at identifying the broad cognitive ability demands of a basic academic task. The question also asked which group was more proficient. The responses are presented in Table 4.1. In order to determine whether a significant difference existed between the two groups, a MANOVA was used. The overall Wilks' Lambda for the between groups differences was significant ($p=.000$). Thus, the null hypothesis can be rejected. There is a significant difference between teachers and school psychologists in the way that they perceive the cognitive abilities required to perform basic academic tasks. Of the 34 items, the two groups of participants differed significantly on 16 items. The results of the MANOVA with sort items as the dependent variables are presented in Table 4.2.

Table 4.1

Participants' Choices for Sort Activity

	School Psychologists' Choices								% Correct	Teachers' Choices								% Correct
Item	Gf	Gc	Gv	Ga	Gsm	Glr	Gs	Gq		Gf	Gc	Gv	Ga	Gsm	Glr	Gs	Gq	
1	**55**	0	11	0	3	4	3	3	69.62	**37**	0	13	0	8	7	5	0	52.85
2	**51**	15	6	0	1	6	0	0	64.55	**27**	11	20	0	0	12	0	0	38.57
3	0	0	1	0	**75**	2	1	0	94.93	0	1	1	0	**58**	8	2	0	82.85
4	0	**57**	1	18	0	3	0	0	72.15	0	**41**	0	24	0	5	0	0	58.57
5	0	0	**54**	0	0	1	24	0	68.35	1	0	**56**	0	0	0	13	0	80.00
6	0	**53**	0	1	0	25	0	0	67.08	2	**35**	1	0	0	31	0	1	50.00
7	0	1	0	0	0	4	**74**	0	93.67	1	1	0	1	0	3	**64**	0	91.42
8	4	0	**74**	0	0	0	0	1	93.67	0	0	**63**	0	4	0	1	2	90.00
9	**44**	0	34	0	0	1	0	0	55.69	**26**	0	36	1	0	2	2	3	37.14
10	3	0	**75**	0	0	1	0	0	94.93	9	0	**57**	0	0	3	0	1	81.42
11	0	**67**	0	0	1	11	0	0	84.81	2	**52**	0	5	0	11	0	0	74.28
12	9	1	**67**	0	0	1	1	0	84.81	12	1	**51**	0	0	3	1	2	72.85
13	0	2	0	**76**	1	0	0	0	96.20	0	0	0	**69**	1	0	0	0	98.57

Item	School Psychologists' Choices Gf	Gc	Gv	Ga	Gsm	Glr	Gs	Gq	% Correct	Teachers' Choices Gf	Gc	Gv	Ga	Gsm	Glr	Gs	Gq	% Correct
14	**66**	4	8	0	0	0	1	0	83.54	**43**	0	17	0	0	2	3	5	61.42
15	9	0	0	0	0	3	0	**67**	84.81	13	3	0	1	0	1	1	**51**	72.85
16	1	2	0	**76**	0	0	0	0	96.20	0	2	1	**66**	1	0	0	0	94.28
17	0	0	0	1	**53**	25	0	0	67.08	0	0	0	2	**47**	18	3	0	67.14
18	1	0	4	0	4	1	**68**	1	86.07	0	0	6	0	3	0	**60**	1	85.71
19	3	**65**	1	0	0	9	0	1	82.27	3	**43**	3	0	0	18	3	0	61.42
20	1	2	0	**76**	0	0	0	0	96.20	2	4	1	**57**	1	3	2	0	81.42
21	1	1	0	0	**72**	4	1	0	91.13	0	0	0	1	**66**	0	3	0	94.28
22	0	2	0	0	0	6	0	**71**	89.87	3	4	1	0	0	11	0	**51**	72.85
23	1	1	0	1	**58**	18	0	0	73.41	0	5	0	0	**51**	11	3	0	72.85
24	0	2	0	0	5	**72**	0	0	91.13	0	0	0	0	5	**65**	0	0	92.85
25	2	1	0	**76**	0	0	0	0	96.20	1	11	0	**57**	0	1	0	0	81.42
26	0	1	0	0	11	**67**	0	0	84.81	0	6	0	1	16	**44**	3	0	62.85
27	3	0	**75**	0	0	0	1	0	94.93	2	0	**65**	0	0	0	3	0	92.85
28	1	17	0	0	4	**52**	5	0	65.82	0	15	0	1	4	**43**	7	0	61.42
29	0	0	8	1	6	0	**64**	0	81.01	0	0	13	0	5	0	**52**	0	74.28

Item	School Psychologists' Choices Gf	Gc	Gv	Ga	Gsm	Glr	Gs	Gq	% Correct	Teachers' Choices Gf	Gc	Gv	Ga	Gsm	Glr	Gs	Gq	% Correct
30	0	1	0	**77**	0	1	0	0	97.46	4	5	1	**59**	0	1	0	0	84.28
31	0	1	14	0	0	0	**64**	0	81.01	0	0	33	0	1	0	**36**	0	51.42
32	1	2	0	**75**	1	0	0	0	94.93	0	8	2	**58**	0	2	0	0	82.85
33	1	0	0	0	0	0	0	**78**	98.73	6	0	0	0	0	2	1	**61**	87.14
34	3	0	0	0	0	0	12	**64**	81.01	5	0	0	0	0	1	10	**54**	77.14

* Correct choice is bold faced.

Table 4.2

MANOVA for Items

Test of Between-Subjects Effects			
Dependent Variable	Type III Sum of Squares	F	Significance
Item 1	1.043	4.489	.036
Item 2	2.506	10.628	.001
Item 3	.542	5.794	.017
Item 4	.684	3.062	.082
Item 5	.503	2.616	.108
Item 6	1.084	4.559	.034
Item 7	.019	.270	.604
Item 8	.050	.669	.415
Item 9	1.278	5.241	.023
Item 10	.677	6.921	.009
Item 11	.411	2.566	.111
Item 12	.530	3.245	.074
Item 13	.021	.791	.375
Item 14	1.815	9.722	.002
Item 15	.530	3.245	.074
Item 16	.014	.301	.584
Item 17	-.005	.000	.994
Item 18	.000	.004	.950
Item 19	1.613	8.439	.004

Table 4.2 (continued)

Dependent Variable	Type III Sum of Squares	F	Significance
Item 20	.810	8.839	.003
Item 21	.037	.532	.467
Item 22	1.075	7.511	.007
Item 23	.001	.006	.939
Item 24	.011	.146	.703
Item 25	.810	8.839	.003
Item 26	1.789	9.914	.002
Item 27	.016	.280	.598
Item 28	.072	.307	.581
Item 29	.168	.967	.327
Item 30	.645	8.450	.004
Item 31	3.248	16.111	.000
Item 32	.542	5.794	.017
Item 33	.499	8.301	.005
Item 34	.056	.334	.564

On the items for which there was a significant between-groups difference, the school psychologists were consistently more correct in choosing the broad ability as indicated by the theoretical model. Thus, school psychologists are better at selecting the correct answer for 16 of the 34 individual items.

A separate MANOVA was run to determine whether teachers and school psychologists differed significantly in their responses to groups of items based on the theoretical model's scales. The two groups were found to differ significantly on five of the eight scales: Fluid Reasoning, Crystallized Intelligence, Auditory Processing, Processing Speed, and Quantitative Reasoning. However, the Partial Etas Squared revealed that only one of the theoretical factors exceeds the 10% criteria for effect size. The overall Partial Etas Squared equaled .267. With recognition that school psychologists generally have higher levels of education, an additional MANOVA was calculated with level of education covaried. The overall Partial Etas Squared when level of education was covaried decrease slightly to .205. Thus, the significance of the difference between the two groups is slightly reduced when level of education is accounted for. The results of the second MANOVA are presented in Table 4.3.

Table 4.3

MANOVA for Theoretical Scales

Tests of Between-Subjects Effects				
Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Gf	25.826	18.102	.000	.110
Gc	14.287	14.589	.000	.090
Gv	1.421	1.579	.211	.011
Ga	10.966	13.188	.000	.082
Gsm	.331	.339	.561	.002
Glr	2.251	3.886	.051	.026
Gs	5.620	6.397	.012	.042
Gq	7.327	9.135	.003	.059

To determine whether school psychologists were significantly better at selecting the correct broad ability for any of the eight scales, separate MANOVAs were run on the items for each of the eight scales. The results of these MANOVAs are presented in Tables 4.4-4.11.

Table 4.4

MANOVA for Fluid Reasoning

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 1	1.043	4.489	.036	.030
Item 2	2.506	10.682	.001	.067
Item 9	1.278	5.241	.023	.038
Item 14	1.815	9.722	.002	.020

Table 4.5

MANOVA for Crystallized Intelligence

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 4	.684	3.062	.082	.020
Item 6	1.084	4.559	.034	.030
Item 11	.411	2.566	.111	.017
Item 19	1.613	8.439	.004	.054

Table 4.6

MANOVA for Visual Processing

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 5	81.685	2.616	.108	.017
Item 8	.050	.669	.415	.005
Item 10	.677	6.921	.009	.045
Item 12	.530	3.245	.074	.022
Item 27	.016	.280	.598	.002

Table 4.7

MANOVA for Auditory Processing

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 13	.021	.791	.375	.005
Item 16	.014	.301	.584	.002
Item 20	.810	8.839	.003	.057
Item 25	.810	8.839	.003	.057
Item 30	.645	8.450	.004	.054
Item 32	.542	5.794	.017	.038

Table 4.8

MANOVA for Short-term Memory

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 3	.542	5.794	.017	.038
Item 17	1.09E-005	.000	.994	.000
Item 21	.037	.532	.467	.004
Item 23	.001	.006	.939	.000

Table 4.9

MANOVA for Long-term Storage and Retrieval

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 24	.011	.146	.703	.001
Item 26	1.789	9.914	.002	.063
Item 28	.072	.307	.581	.002

Table 4.10

MANOVA for Processing Speed

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 7	.019	.270	.604	.002
Item 18	.000	.004	.950	.000
Item 29	.168	.967	.327	.007
Item 31	3.248	16.111	.000	.099

Table 4.11

MANOVA for Quantitative Reasoning

Dependent Variable	Type III Sum of Squares	F	Significance	Partial Eta Squared
Item 15	.530	3.245	.074	.022
Item 22	1.075	7.511	.007	.049
Item 33	.499	8.301	.005	.053
Item 34	.056	.334	.564	.002

The second research question asked how the responses of the participants compare to the theoretical model (CHC theory). In order to answer this question, a principal-components analysis was conducted to determine whether the items clustered in the same way as theorized by the creators of the items. Initially, a factor analysis with no a priori stopping criteria was run. This analysis extracted thirteen factors, few of which displayed meaningful similarity to the theoretical factors. For the current analysis, the principal-components analysis was limited to eight factor extractions to align with the eight broad abilities proposed by CHC theory. The eight factors produced are presented in Table 4.12.

Table 4.12

Factors Extracted by Principal Components Analysis

Factor	Items	Theoretical Designation
1	know what jigsaw puzzle will fit	Gv
	build a model with blocks or Legos from a picture of the completed model	Gv
	remember the details of a phone message long enough to write them down after hanging up	Gsm
	recognize a word when only parts of it are pronounced	Ga
2	figure out what objects go together logically	Gf
	derive rules explaining why objects or pictures are in different categories	Gf
	select the correct missing piece to complete a logical puzzle	Gf
	visualize how an object would look from another perspective	Gv
	figure out what comes next in a series	Gf
	complete crossword puzzles	Gc
3	blend sounds together into meaningful words	Ga
	say how a word would sound with one sound deleted ("blend without the /l/)	Ga
	tell when two words sound subtly different	Ga
	tell when two sounds are subtly different	Ga
4	quickly copy routine information from the chalkboard	Gs
	quickly find all the e's on a page	Gs
	quickly and accurately check work against an answer key	Gs
	figure out missing sounds in incomplete words	Ga

Table 4.12 (continued)

Factor	Items	Theoretical Designation
	pick out visual item among other distracting items	Gv
5	figure out oral or written math word problems (not just rote memory of "math facts")	Gq
	easily and efficiently work through mathematical problems	Gq
	remember a series of unrelated words	Gsm
	remember a series of related words	Gsm
	learn and carry out math procedures, such as solving algebraic equations	Gq
6	have a well-developed vocabulary	Gc
	show good language development	Gc
	remember a series of related words when one word is given after a long delay	Glr
7	identify a picture that is distorted or has parts missing	Gv
	know mathematical concepts and terms	Gq
8	work quickly and accurately on tasks that are already mastered and automatic	Gs
	remember a phone number briefly before dialing it	Gsm
	recall information related to a particular topic quickly	Glr

After completing the factor analysis, the factors produced were correlated with the theoretical factors using Pearson correlations. This was done to determine how closely the items in the sort activity resemble the theoretical model. These data are presented in Table 4.13.

Table 4.13

Pearson Correlations between Factor Analysis Factors and Theoretical Factors

Theoretical Clusters	Factors 1	2	3	4	5	6	7	8
Gf	.114	.897*	.085	.078	-.030	.135	.007	.180
	.167	.000	.304	.343	.718	.101	.935	.028
Gc	-.014	.263	-.052	.293*	.114	.650*	.119	.034
	.869	.001	.527	.000	.167	.000	.147	.681
Gv	.583*	.223	.138	-.027	.150	.054	.565*	-.107
	.000	.006	.092	.746	.067	.514	.000	.193
Ga	.238*	.075	.871*	.175	-.052	.136	.158	.120
	.003	.360	.000	.033	.525	.098	.054	.146
Gsm	.407*	.318*	.154	.083	.518*	-.270	.086	.281
	.000	.000	.061	.314	.000	.011	.300	.001
Glr	.328*	.270	.205	.211	.084	.443*	.101	-.052
	.000	.001	.012	.010	.310	.000	.222	.525
Gs	.137	.064	.017	.847*	.013	.057	-.043	.153
	.096	.437	.841	.000	.875	.487	.605	.063
Gq	-.060	.068	-.021	.082	-.727*	-.122	.406*	.069
	.467	.412	.799	.322	.000	.140	.000	.404

* Correlation is significant at the 0.01 level (2-tailed)

This analysis revealed that seven of the factors produced by the principal components analysis (Factors 1-8) were significantly correlated with the theoretical factors, though not always in the manner anticipated.

The Auditory Processing (Ga) factor was highly correlated (.871) with Factor 3. This correlation is strongly positive because all four of the items that clustered to create Factor 3 are items representing Ga. However, two of the other items representing Ga clustered with other items to create unrelated factors.

The Fluid Reasoning (Gf) factor was highly correlated (.897) with Factor 2. This correlation makes sense as 4 of the six items clustered to create this factor are the four items that theoretically represent Gf.

The Crystallized Intelligence (Gc) factor was moderately correlated (.650) with Factor 6. Factor 6 included two of the four items theoretically representing Gc.

The Visual Processing (Gv) factor was moderately correlated with two of the factors created through principal components analysis, Factors 1 and 7. Factor 1 consisted of two items representing Gv, one item representing Ga and one item representing Gsm. The Short-term Memory factor was also significantly correlated with Factor 1, even though there was only one Gsm item in Factor 1. Factor 7 consisted of only two items, one representing Gv and one representing Gq. The Gv items do not cluster in the manner anticipated. In fact, they are scattered between four of the factors created through factor analysis.

The Short-term Memory (Gsm) factor was significantly correlated with two of the factors created through the factor analysis. Gsm was correlated with Factor 5, with two of the Gsm items clustering with other items that theoretically represent Quantitative Reasoning. Gsm also correlated significantly with Factor 1, despite only one Gsm item clustering there.

The Long-term Storage and Retrieval (Glr) factor was significantly correlated with Factor 6. As previously discussed, Factor 6 included one item representing Glr and two items representing Gc. The three items representing Glr did not cluster together whatsoever in the factor analysis which suggests that the items do not actually group together to represent Long-term Storage and Retrieval.

Processing Speed (Gs) was significantly correlated with Factor 4 with three of the four items representing Gs clustering together in this factor. The other items that clustered with the Gs items were one item representing Ga and one item representing Gv.

Finally, Quantitative Reasoning (Gq) was significantly correlated with Factors 5 and 7. Three of the four items representing Gq clustered with two items representing Gsm to create Factor 5. The other item representing Gq clustered with an item representing Gv to form Factor 7.

Due to the fact that the items did not cluster as anticipated by the theoretical model, Cronbach alphas were calculated for each of the eight theoretical factors to determine the internal consistency of the items representing each factor (see Table 4.14). Cronbach alphas of .80 are considered acceptable. Thus, when the responses of teachers and school psychologists are taken together and are analyzed for internal consistency, none of the theoretical scales have acceptable reliability.

Table 4.14

Cronbach Alphas for Theoretical Scales

	Cronbach Alpha		
Scale	All Participants	Teachers	School Psychologists
Gf	.548	.493	.494
Gc	.295	.249	.199
Gv	.428	.463	.403
Ga	.612	.430	.800
Gsm	.530	.464	.592
Glr	.234	.089	.361
Gs	.475	.367	.570
Gq	.476	.538	.251

The data set was then split by profession and Cronbach alphas were calculated for each scale. This revealed that only one scale (Ga) has adequate internal consistency and only when the responses of only the school psychologists are analyzed.

The third research question in this study asked whether teachers and school psychologists become better at identifying the cognitive demands of a task with experience in the field or higher levels of training. In order to answer this question Pearson correlations were calculated. First, Pearson correlations for the two groups combined were calculated for level of experience and level of education. Next, in recognition that most school psychologists have a higher level of education than most teachers, the data set was split by profession and separate Pearson correlations were calculated. The results of the Pearson correlations are as follows:

Combined groups:

- No gender effects
- No effect of years of experience
- Significant, positive effect of higher level of education on responses to items representing Gf and Gv

School Psychologists only:

- No gender effects
- No effect of years of experience
- Significant, positive effect of higher level of education on responses to items representing Gv

Teachers only:

- Significant, negative effect of gender on responses to items representing Gf (Male teachers were significantly more correct)
- No effect of years of experience
- No effect of level of education

To examine if differences existed between regular education and special education teachers, independent samples t-tests were conducted. Levene's test of homogeneity of variance was performed to assess whether the null hypothesis that regular education teachers and special education teachers were the same. For five of the thirty four items, Levene's test of homogeneity of variance found that equal variances between the two groups could not be assumed. The results of this independent samples t-test can be found in Table 4.15.

Table 4.15

T-tests, Means, and Standard Deviations for Significant Items

			Special Education		Regular Education	
Items	t-statistic	Significance (2-tailed)	M	SD	M	SD
9	-2.747	.008	.2000	.40684	.5000	.50637
10	-2.047	.046	.7000	.46609	.9000	.30382
19	-2.748	.008	.4333	.50401	.7500	.43853
21	-2.112	.043	.8667	.34575	1.000	.00000
24	-2.408	.023	.8333	.37905	1.000	.00000

Summary of Findings

The statistical procedures utilized to answer the research questions included MANOVAs, principal components factor analyses, and Pearson correlations. These statistics were used to determine whether the research hypotheses could be confirmed or disproven. Conclusions can be drawn on the basis of this information and will be discussed in chapter 5.

Differences Between Teachers and School Psychologists

- Significant overall difference ($p=.000$)
- Null hypothesis rejected
- Significant difference on 16/34 items
- School Psychologists better on all of the significant items
- Significant difference on 5/8 scales
- Significance of difference decreases slightly when level of education is covaried in MANOVA

Comparison of Responses to Theoretical Model

- principal components factor analysis with a priori stopping criteria of 8 factors was employed
- factors produced have multiple significant positive and negative correlations with theoretical factors
- internal consistency was evaluated using the Cronbach alpha statistic
- when taken together, none of the scales have adequate internal consistency
- when split by profession, only Ga for school psychologists ($\alpha=.80$)

Effect of Experience and Training

- Pearson correlations revealed no significant correlation between correctness of responses and years of experience

- significant positive correlation between level of education and Gf, Gv for combined groups
- significant positive correlation between level of education and Gv for school psychologists
- no significant correlation between correctness of responses and level of education for teachers
- male teachers were significantly better compared to the theoretical model on items representing Gf than were female teachers
- special education teachers were significantly less accurate on 5/34 items

CHAPTER 5

DISCUSSION

Review of Research Questions and Interpretation of Results

The present study investigated the perceptions of school psychologists and teachers regarding the cognitive abilities required to perform basic academic tasks. This study is part of a line of research currently being conducted by individuals at Temple University who are interested in the ecological validity of Cattell-Horn-Carroll theory. CHC theory has been proven to be useful in the interpretation of assessments and cross-battery assessment. However, more research is required to determine whether CHC theory has utility in communicating assessment results to teachers. This study also addresses a substantial gap in the literature on teachers' perceptions of cognitive requirements. The purpose of the current study was to add to the research literature on the ecological validity of CHC theory.

The first research question examined whether school psychologists and teachers were equally proficient at identifying the broad cognitive demands of a basic academic task. The question also asked which group was more proficient. It was hypothesized that school psychologists would be more accurate with the task in general due to the increased likelihood that they would have previous knowledge of CHC theory. In examining the multivariate analysis of variance (MANOVA) data, this hypothesis was partially supported. The overall Wilk's Lambda for the between groups differences was significant (.000). Thus, there is a significant difference between the groups on their responses to the sort activity. Therefore, the null hypothesis can be rejected and further analysis of the differences can be completed.

The MANOVA revealed that there were significant differences between the groups on sixteen individual items from the sort activity. For each of these items a greater percentage of school psychologists selected the correct broad ability for the basic academic task. Thus, school psychologists were better at identifying the cognitive requirement for those items in which there was a significant difference. It is important to note, however, that there were 18 items for which there was no significant difference between teachers and school psychologists.

To further examine these differences, additional MANOVAs were computed for each of the theoretical scales. Overall partial etas squared equaled .267. School psychologists and teachers differed significantly on five of the eight scales. However, further inspection of the items on each scale revealed that these overall differences on scales did not indicate that school psychologists were generally better than teachers at understanding the cognitive abilities represented by each scale. That is, while there may have been a significant difference on the scale, school psychologists did not necessarily perform better on every item on the scale. Moreover, school psychologists were only significantly better at consistently identifying the basic academic tasks that utilized Fluid Reasoning. They were significantly better at answering each of the four items in the fluid reasoning scale. Furthermore, the Fluid Reasoning scale was the only scale that exceeded the 10% criteria for effect size (Partial Eta Squared= .110).

The second research question posed in this study asked how the responses of the participants compare to the theoretical model presented (CHC Theory). This researcher hypothesized that there may be some similarity in the responses given by the participants to the theoretical model but that the responses were likely to be significantly different from the model. This hypothesis was supported by the data. The principal components factor analysis originally revealed that the items for the sort clustered together into thirteen different factors. When an a priori stopping criterion of eight was used in an attempt to create parallel factors to the eight factors present in CHC theory's broad abilities, the factors created displayed limited similarity to the theoretical factors. Pearson correlations between the theoretical factors and the factors created through factor analysis revealed multiple positive correlations that accounted for more than 10% of the variance. The three theoretical scales that were more significantly correlated with the factors created through factor analysis were Fluid Reasoning, Auditory Processing, and Processing Speed. Therefore, the responses of the participants were most closely aligned with the theoretical model on these three scales. The research hypotheses anticipated that the respondents would be most similar to the theoretical model on the Crystallized Intelligence, Fluid Reasoning, Auditory Processing, and Quantitative Reasoning scales. Two of the four hypotheses were correct.

The third research question asked whether teachers and school psychologists become better at identifying the cognitive demands of a task with experience in the field or with higher levels of training. The hypothesis was that level of experience and training would be significant predictors of accuracy. These hypotheses were disproven by the data. Years of experience was not significantly correlated with any of the theoretical constructs. Thus, according to this study, neither teachers nor school psychologists develop a better understanding of the cognitive abilities required to perform academic tasks, according to CHC theory, with experience. Similarly, level of education is not related to accuracy for teachers on any of the items. Level of education is significantly correlated with accuracy in identifying tasks that require Visual Processing for school psychologists. Thus, school psychologists may receive some more training in this broad ability than teachers do.

Also assessed were gender effects and the effects of being a special education teacher on the responses. When split by profession, only one significant gender effect was found. Male teachers were found to be significantly more correct on items measuring Gv. Special education teachers were found to be significantly less asccurate at identifying the broad ability required to complete five of the 34 tasks. These five tasks represented five different cognitive abilities: Gc, Gsm, Glr, Gv, and Gf. Thus, the special education teachers did not perform significantly worse (or any better) than the general education teachers on any one of the broad ability scales. Further, the regular education teachers did not perform significantly better than the special education teachers on any of the scales.

Limitations

Any conclusions drawn based on the results of this study must be considered with respect to the study's limitations. Both measurement and design limitations exist in the current study. One design limitation is the sample. While the sample includes teachers from 20 states and school psychologists from 25 states, the majority of the respondents in both groups represented the Northeast and South census regions (89.9% of teachers, 84.8% of school psychologists). Thus, the sample is not truly nationally representative and the results may not generalize nationally.

In addition, the sample for both groups was not ethnically representative. While both professions are dominated by Caucasian professionals, this study failed to include even the small percentage of ethnic minority professionals included in each group's national demographics. Specifically, this study failed to recruit any Native American, Alaskan Native, Asian, Native Hawaiian, or Pacific Islander participants. Only one African American participant was included in the sample and

Hispanic participants were similarly underrepresented (N=2). Individuals who self-identified as representing an “Other” ethnic group were slightly overrepresented in the current sample. This sample restriction further limits the external validity of the current study.

Two additional design limitations can be attributed to the measure used in the study. The validity of the scale used for the sort items in the current study is questionable according to the statistical procedures performed on the data collected. First, if the items in the sort had construct validity, they would cluster along theoretical lines to create the scales that the researchers intended. In this case, when principal components analysis was performed, 13 factors were created, few of which related to the theoretical model in any meaningful way. When the principal components factor analysis was redone with an a priori criterion stopping rule of eight factors, only some of the items clustered in the manner anticipated and none of the theoretical scales survived as factors in the factor analysis. When the factors created were correlated with the theoretical factors using Pearson correlations, several of the theoretical scales were correlated with multiple factors.

To assess the scale's reliability, the 34 items were assessed for internal consistency. The internal consistency of the items representing each theoretical scale was found to be insufficient for each scale. The only instance in which a scale demonstrated acceptable internal consistency was when the data were split by profession. Items representing Auditory Processing were found to be internally consistent according to the Cronbach alpha (α=.8) for school psychologist participants. Cronbach alpha of 0 indicates that participants are guessing on the item. The lowest alpha in the data set was for Long-term Storage and Retrieval for teachers (α=.089), which was very close to random guessing. The implications of this are that the items in the scale may not actually measure what they purport to measure which clearly limits the conclusions that can be drawn based on the data.

The second type of limitation in the current study is a measurement limitation. In the research on statistical analysis, there are many opinions regarding the minimum sample size for a factor analysis. There is general agreement that a factor analysis should never be performed with fewer than 100 subjects (Gorsuch, 1983). Additionally, the number of variables to be factor analyzed affects minimum sample size. This concept is represented by the subjects-to-variables ratio. Bryant and Yarnold (1995) state that for the results of a principal-components factor analysis to be reliable, the minimum number of observations (participants) must be at least five times the number of variables. Thus, in the current study, with 34 variables, there should be a minimum of 170 participants. With the current n of 149 participants, the reliability of the factor analysis may be somewhat compromised. Thus, results of this analysis should be interpreted with caution.

Implications

In light of its limitations, the results of this study can inform future CHC ecological validity research. To improve on the current study, the survey (sort) could be used with a larger, more diverse, nationally representative sample. If the same issues with reliability and validity of the survey are found, work should be done on the items included to ensure internal consistency and external validity.

The findings of the study have interesting implications for school psychology and teacher training. In general, the data show that teachers do not get better at identifying the cognitive demands of academic tasks with training. Even with “specialized” special education training, special education teachers are no better (and possibly slightly worse) than regular education teachers at understanding cognitive requirements.

School psychologists only get significantly better at understanding Visual Processing with higher levels of training. This is concerning as the prevailing presumption would be that with higher levels of training for both groups, would come better ability to understand the basic elements of cognition. For teachers, this knowledge should drive instructional practices as teachers understand the cognitive abilities being employed to build academic skill. For school psychologists, understanding cognitive requirements could aid in interpreting referral questions ("Johnny can't copy from the board quickly.") and understanding of the impact of cognitive strengths and deficits on classroom performance. Even teachers and school psychologists with less experience (and thus, more recent training) are not better at the tasks presented in the current study. This may indicate that in the training experiences of the current sample, there was inadequate instruction in this area. It appears as though both undergraduate and graduate programs need to increase instruction in the structure of cognitive ability and the effects of cognitive ability on performance. CHC theory is a logical choice for teacher and school psychologist training as it is widely recognized as the most empirically supported theory of intelligence (McGrew, 2005).

Flanagan, Ortiz, and Alfonso (2007) point out that, “Given its impressive level of empirical support and contemporary representation of cognitive abilities… CHC theory should serve as a foundation for the selection and interpretation of both intelligence and achievement batteries” (p. 269). Fiorello and Primerano (2005) agree that school psychologists should use CHC theory when conducting psychoeducational assessments because of its utility for communicating recommendations. However, the results of this study indicate that school psychologists who use CHC theory in their test battery design, interpretation and communication of results must be cautious to not assume that teachers understand these broad abilities and their impact on classroom performance. The current finding that teachers and school psychologists differ significantly in their understanding of five of eight broad CHC abilities suggests that merely having common terms and definitions will not necessarily improve communication or comprehension.

Overall, while researchers have demonstrated many types of reliability and validity for CHC theory, continued research is needed regarding the ecological validity of this theory. The current study indicates that teachers and school psychologists lack knowledge about how CHC broad cognitive abilities impact students' performance on basic academic tasks and that they perceive cognitive requirements differently. Thus, additional training in the practical applications of this theory may be necessary. Future research in this area could have positive effects on teacher-school psychologist communication thereby increasing the accuracy of referrals, understanding of psychoeducational evaluations, and selection of interventions.

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APPENDIX A
SCHOOL PSYCHOLOGIST RECRUITMENT LETTER

www.schoolpsych-teachersurvey.com

Dear School Psychologists,

You are invited to participate in a research study examining the perceptions of teachers and school psychologists regarding the cognitive abilities required for students to complete academic tasks. Your perceptions are valuable to our research. Your participation in this important study will contribute to the research literature on the ecological validity of an important cognitive theory (Cattell-Horn-Carroll Theory). This research will have implications for communication between teachers and school psychologists.

Your participation in this study is VOLUNTARY and CONFIDENTIAL. The survey is online and should take NO LONGER THAN 10 MINUTES to complete. After completing the survey, you can choose to enter a drawing for one of several $20 gift certificates to Barnes and Noble. You may also leave comments for the researcher.

www.schoolpsych-teachersurvey.com

Thank you in advance for your participation. Please feel free to forward this link to other teachers and school psychologists who may be interested in participating.

--
Meredith Petruccelli, Ed.M.
School Psychology Doctoral Candidate
Temple University
Studying under the supervision of Dr. Catherine Fiorello

APPENDIX B
TEACHER RECRUITMENT LETTER

www.schoolpsych-teachersurvey.com

Dear Teachers,

You are invited to participate in a research study examining the perceptions of teachers and school psychologists regarding the cognitive abilities required for students to complete academic tasks. Your perceptions are valuable to our research. Your participation in this important study will contribute to the research literature on the ecological validity of an important cognitive theory (Cattell-Horn- Carroll Theory). This research will have implications for communication between teachers and school psychologists.

Your participation in this study is VOLUNTARY and CONFIDENTIAL. The survey is online and should take NO LONGER THAN 10 MINUTES to complete. After completing the survey, you can choose to enter a drawing for one of several $20 gift certificates to Barnes and Noble. You may also leave comments for the researcher.

www.schoolpsych-teachersurvey.com

Thank you in advance for your participation. Please feel free to forward this link to other teachers and school psychologists who may be interested in participating.

Meredith Petruccelli, Ed.M.
School Psychology Doctoral Candidate
Temple University
Studying under the supervision of Dr. Catherine Fiorello

APPENDIX C
INTRODUCTORY LETTER

Dear Teacher or School Psychologist,

Thank you for agreeing to participate in this important research study. Your participation is voluntary. You have the freedom to decline to participate. Your responses are confidential. No identifying information will be collected or recorded. To show our appreciation for your participation, at the end of the activity, you will be offered the opportunity to provide your name and email address. You will then be entered into a drawing for a Barnes and Noble Gift Certificate valued at $20. Should your name be drawn at the conclusion of the study, you will be contacted via email.

This study seeks to gather information regarding teachers' and school psychologists' perceptions of the cognitive abilities underlying typical academic tasks. Thank you for your time and effort. Your willingness to participate has contributed to our understanding of the cognitive abilities associated with common academic tasks.

If you should have any questions or comments, please feel free to share them with me.

Sincerely,

Meredith Petruccelli, Ed.M.
School Psychology Doctoral Student
Under the Supervision of Dr. Catherine Fiorello
Temple University

APPENDIX D
ANONYMOUS DEMOGRAPHIC QUESTIONNAIRE

Confidential Demographic Questionnaire

Please complete the following questionnaire. Your responses will be held in the strictest confidence.

Gender : Male Female

Ethnicity:

_____American Indian or Alaska Native
_____Asian
_____Black or African American
_____Native Hawaiian or Other Pacific Islander
_____White (non Hispanic)
_____Hispanic
_____Other: ____________________________

Years teaching: _______________________

Level of Education:

_____ Bachelor's Degree
_____ Bachelor's Degree + some graduate credits
_____ Master's Degree
_____ Master's Degree + 30 credits
_____ Doctoral Degree
_____ Other:_____________________________

The school(s) where I work is considered:

_____ Urban
_____ Suburban
_____ Rural

State:
Select One

I work with students in the following grade levels:

_____ Preschool
_____ Early Elementary (K-3)
_____ Elementary (4-6)
_____ Middle (7-8)
_____ High (9-12)

I am a Special Education Teacher:
_____ Yes _____ No

APPENDIX E
INSTRUCTIONS

Instructions:

On each page, you will see a basic academic task at the top of the page and a list of eight cognitive abilities.

For each task, please choose the cognitive ability required to complete it by clicking on the circle next to the cognitive ability.

After you have made your selection, click SUBMIT.

The next common academic task will appear with the same list of eight cognitive abilities.

Repeat this process until you have completed all of the common academic tasks.

Once you are finished, you will have the opportunity to review your selections.

After submitting your answers, you will be given the opportunity to leave comments for the researchers and to submit your name for the gift card drawing.

Thank you for your time!

APPENDIX F
SORT ITEMS: ACADEMIC TASKS

Common Academic Tasks

The following 34 common tasks will be sorted into 8 cognitive ability categories.

1. figure out what comes next in a series
2. derive rules explaining why objects or pictures are in different categories
3. remember a phone number briefly before calling it
4. show good language development
5. pick out visual item among other distracting items
6. know a great deal of general information
7. work quickly and accurately on tasks that are already mastered and automatic
8. build a model with blocks or Legos from a picture of the completed model
9. select the correct missing piece to complete a logical puzzle
10. visualize how an object would look from another perspective
11. have a well-developed vocabulary
12. identify a picture that is distorted or has parts missing
13. tell when two sounds are subtly different
14. figure out which objects go together logically
15. figure out oral or written math word problems (not just rote memory of "math facts")
16. tell when two words sound subtly different
17. remember a series of related words
18. quickly and accurately check work against an answer key
19. complete crossword puzzles
20. recognize a word when only parts of it are pronounced
21. remember the details of a phone message long enough to write them down after hanging up
22. know mathematical concepts and terms
23. remember a series of unrelated words
24. recall the name of a new acquaintance when you meet again
25. say how a word would sound with one sound deleted ("blend" without the /l/)
26. remember a series of related words when one word is given after a long delay
27. know what jigsaw puzzle piece will fit
28. recall information related to a particular topic quickly
29. quickly copy routine information from the chalkboard
30. figure out missing sounds in incomplete words
31. quickly find all the e's on a page
32. blend sounds together into meaningful words
33. learn and carry out math procedures, such as solving algebraic equations
34. easily and efficiently work through mathematical problems

APPENDIX G
CHC BROAD ABILITIES

CHC Broad Abilities

The 34 common academic tasks were sorted into the following 8 cognitive ability categories.

1. To solve novel problems, be able to reason, be able to form and recognize concepts, and be able to draw inferences.
2. To have a large amount of acquired knowledge and language ability, and be able to effectively use that knowledge.
3. To effectively process visual information, including perceiving and manipulating visual shapes and forms, and understanding and manipulating spatial orientation.
4. To effectively process auditory information, especially to perceive and manipulate patterns of the sounds that make up speech.
5. To have a good short-term memory, especially the ability to remember a sequence of spoken items or directions just long enough to use the information immediately.
6. To easily store and retrieve information in long-term memory, including being able to learn new associations and to fluently recall previously learned material.
7. To quickly perform automatic cognitive tasks accurately, while maintaining focused attention and concentration.
8. To have a large amount of mathematical knowledge, and the ability to effectively apply that information to solve quantitative problems.