
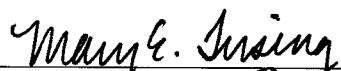



CONCURRENT VALIDITY OF THE WOODCOCK JOHNSON III TESTS OF COGNITIVE
ABILITY AND THE DIFFERENTIAL ABILITY SCALES

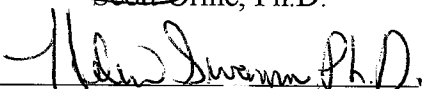
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ABSTRACT

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Concurrent validity of the Woodcock Johnson III Tests of Cognitive Abilities and
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The purpose of this study was to examine the concurrent validity of two contemporary intelligence tests, the Woodcock Johnson III Tests of Cognitive Abilities (WJ III COG) and the Differential Ability Scales (DAS). Studies of these instruments' validity examine how comparable the test batteries are in the cognitive abilities they are designed to assess. This study examined the comparability of the WJ III COG and the DAS in accordance with current intellectual theory. Specifically, this study was intended to add to the literature concerning the validity of the WJ III COG in assessing cognitive abilities according to the Cattell-Horn-Carroll (CHC) model of cognitive abilities. Thirty-one middle school students were administered the WJ III COG and the DAS. The results were compared through data analyses of scores obtained on each battery. Results of this study implied that the broad factors of the WJ III COG and the DAS are measuring similar cognitive constructs. With the exception of measures of visual-spatial reasoning, factors of the WJ III COG and the DAS are similar with one another. The results also support that the WJ III COG is measuring unique cognitive abilities in children. Examinees in

this study tended to score higher on the DAS than the WJ III COG, Therefore, practitioners need to be aware of differences in the abilities measured on each test battery that may impact individual test performance.

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Chapter I

Introduction

Intellectual assessment is one of the major functions associated with the role of a school psychologist in education today. Currently, school psychologists spend more time conducting intellectual assessments than in any other role within the schools (Braden, 1997). The use of cognitive assessments in schools increased due to changes in federal criteria, the Individuals with Disabilities Education Act (IDEA, 1991, 1997), which mandated specific guidelines for determining learning disabilities and other special education services. Hence, sound measures of a child's cognitive abilities and information processing skills became imperative to the assessment process in order to make decisions regarding a child's eligibility for special education (Esters, Ittenbach, & Han, 1997; Kranzler, 1997). Therefore, the need for practitioners to be current on research with new and revised assessment tools and with advances in the purposes of intellectual assessment is all the more prevalent (Sattler, 1992).

Traditionally, school psychologists have relied on empirically based assessment tools, such as the Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991) and the Stanford Binet Intelligence Scale-Fourth Edition (SB-IV; Thorndike, Hagan, & Sattler, 1986), to define cognitive abilities in children. Criticisms of these scales stem from the fact that little has changed in the way that they assess abilities in children since their development (Braden, 1997; Flanagan, 2000; Harrison, Flanagan, & Genshaft, 1997; Ittenbach, Esters, & Wainer, 1997). More specifically, most traditional intelligence batteries were not developed according to well-researched models of intelligence (Flanagan, Andrews, & Genshaft, 1997; Keith, 1997). As a result, the traditional intelligence batteries fail to provide a full picture of a child's cognitive functioning, bringing the validity of the instruments into question when

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information on a child's cognitive processing skills is needed (Ittenbach, Esters, & Wainer, 1997; Kamphaus, Petoskey, & Morgan, 1997; Snow, 1986). However, with advances in research on intellectual theory, some contemporary intellectual assessment tools have undergone major changes with regard to structure and development. As a result, more tests have been developed to match theoretical models of cognitive abilities that are believed to provide a more accurate picture of cognitive functioning and information processing in children (Braden, 1997; Harrison, Flanagan, & Genshaft, 1997; McGrew, 1997).

Most recently, two prominent psychometric theories of intelligence, namely *Gf-Gc* theory (Horn & Cattell, 1967) and Carroll's Three Stratum Theory of Intelligence (Carroll, 1993), have been merged by intellectual assessment researchers and used as the basis for a revision to the Woodcock Johnson-Revised Tests of Cognitive Abilities (WJ-R; Woodcock & Johnson, 1989; Woodcock, McGrew, & Mather, 2001). The merged theory is referred to as the Cattell-Horn-Carroll theory (CHC; McGrew, 1997; McGrew & Flanagan, 1998).

CHC theory delineates a broad-based hierarchical structure for interpreting cognitive abilities. Empirical support for CHC theory suggests that it is the most comprehensive framework for explaining the complexity of cognitive skills and information processing abilities to date (Carroll, 1993; McGrew, Flanagan, Keith, & Vanderwood, 1997; McGrew & Woodcock, 2001). The WJ-R was highly regarded as the best representation of contemporary intellectual theory as it operationalized Horn and Cattell's (1967) *Gf-Gc* theory (Bolen, 1998; McGrew & Flanagan, 1998; Woodcock, 1990; Ysseldyke, 1990), and similar support has been given to the WJ III COG as an operational definition of CHC theory (Woodcock, McGrew, & Mather, 2001).

Another intelligence test that has been reviewed favorably with regard to its consistency with contemporary intellectual theory is the Differential Ability Scales (DAS; Elliott, 1990;

McGrew & Flanagan, 1998). The DAS was not designed to conform to any specific theory of intelligence; however, the structure of the battery is reflective of Carroll's Three Stratum model, *Gf-Gc* theory, and Spearman's "g" (Elliott, 1990). Therefore, the DAS is designed to measure distinct cognitive abilities that contribute to broader definitions of intelligence, and thus is reflective of the hierarchical nature of the WJ III COG in its structure and orientation (Elliott, 1990b, 1997; McGrew & Flanagan, 1998). Previous research (Dumont, Willis, Farr, McCarthy, & Price, 2000; Gilman, Ford, Williams, Cantrell, Teague, Tusing, & Paolino, 1996; Ysseldyke, 1990) compared the structure of the DAS favorably with the theoretical structure of the WJ-R COG, indicating that certain subtests reflect factors supporting CHC theory.

More recently, McIntosh and Dunham (2001) examined specific clusters measured by the WJ III COG and the DAS. With the exception of the *Gv* cluster of the WJ III COG and the Spatial Ability cluster of the DAS, a moderate to strong relationship was found between similar factors on each test, adding to the initial support for the validity of the WJ III COG. However, the full breadth of abilities encompassed by CHC theory was not examined in the McIntosh & Dunham study. Hence, there is little published research comparing all of the CHC clusters of the WJ III COG with the cluster scores and diagnostic subtests of the DAS. More validity research is needed to support the concurrent validity between the two tests and to further examine the consistency of the WJ III COG battery with constructs related to CHC theory.

Purpose of the Study

The purpose of this study was to add to research on the validity of the Woodcock Johnson III Tests of Cognitive Abilities (WJ III COG; Woodcock, McGrew, & Mather, 2001) in assessing cognitive abilities in children according to current intellectual theory. Specifically, this study was designed to examine the level of concurrent validity between the WJ III COG and the

Differential Ability Scales (DAS; Elliott, 1990). The study provides information pertaining to the broad and cluster scores of each battery. Strong correlations were expected between the broad general scores of each battery, while moderate to high correlations were expected between similar cluster scores of each battery. Lower correlations were expected between clusters on each battery that are purported to measure different cognitive abilities.

Research Questions

1. The first question addressed in this study was the strength of the relationship between the broad ability scores of the WJ III COG and the DAS. The General Intellectual Ability-Ext. score of the WJ III COG was compared to the General Conceptual Ability (GCA) score of the DAS. This study also examined how comparable the mean overall composite scores were between the two batteries for the current sample.
2. The second question addressed in this study was the level of concurrent validity across the CHC cluster scores of the WJ III COG and the cluster scores and diagnostic subtests of the DAS. Specifically, the strength of correlations across measures of similarly defined clusters and dissimilar clusters were examined.

Definition of Terms

Concurrent Validity.

Concurrent validity is defined in this study as the comparison of scores that are obtained in approximately the same time frame in order to compare their similarities and differences (Anastasi & Urbina, 1997). Examination of the broad and cluster scores and diagnostic subtests of the WJ III COG and the DAS established the convergent and discriminant validity of abilities measured by each battery.

Intelligence Assessment/ Test/ Instrument/Battery.

Intelligence Assessment/ Test/ Instrument/Battery is defined in this study as an instrument that determines individual cognitive ability scores and characterizes unique cognitive processes (Elliott, 1990a). For the purposes of this study, these terms were used interchangeably.

Intelligence.

Intelligence is defined in this study as the unique cognitive processes, abilities, and characteristics that comprise individual cognitive functioning as measured by a given intelligence test (Kamphaus, Petoskey, & Morgan, 1997).

Assumptions of the Study

An assumption of the study was that the WJ III COG and the DAS batteries were administered according to standardized practices and scored appropriately. It is assumed that administration of the tests in counterbalanced order eradicated practice effects. It is assumed that the students who participated had no previous exposure to the test batteries used in this study. Since regular education students were targeted to participate in testing, it is assumed that the results of this study are based on the cognitive ability of students who are not receiving special education services, or who have a learning disability.

Chapter II

Review of Relevant Literature

The purpose of the chapter is to review literature relevant to the concurrent validity of the Woodcock Johnson III Tests of Cognitive Ability (WJ III COG; Woodcock, McGrew, & Mather, 2001) and the Differential Ability Scales (DAS; Elliott, 1990). The first part of this chapter is a discussion the concept of validity as it relates to test construction. Current intellectual theory is also discussed. The next part of the chapter will review the construction of the WJ III COG and the DAS. Current research concerning concurrent validity studies of each of these batteries is also reviewed.

Validity

In its broadest sense, validity refers to the notion that “a test is measuring what it is intended to measure” (Flanagan, 2000, p. 300). With the information gathered from studies of an instrument’s validity, conclusions can be made about the suitability, meaningfulness, and value of a specific test score. Validation of an intelligence instrument involves gathering evidence from three specific sources: construct, content, and criterion-related validity. Construct validity refers to whether test constructs match the proposed structure of a test; this is the broadest type of validity, as it encompasses both content and criterion-related validity in its overall orientation (Anastasi & Urbina, 1997). Content validity studies assist in determining the accuracy of test items in measuring a proposed construct (Scherich & Hanna, 1977). The focus of the current study is on validation of intelligence tests according to criterion-related validity, or how scores are related to specific outcome criteria (Ittenbach, Esters, & Wainer, 1997).

Criterion-related validity studies are comprised of two types of validity, predictive and concurrent. Studies of predictive validity are designed to determine if performance on a specific

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test can estimate future performance in a specific area. Studies of an instrument's concurrent validity provides further support for the content and construct validity of a particular instrument by making comparisons with other instruments that are designed to measure similar cognitive constructs (American Educational Research Association, American Psychological Association & National Council on Measurement in Education, 1999). Concurrent validity focuses on obtaining information from two or more intelligence tests that are administered at approximately the same time (Anastasi & Urbina, 1997).

Concurrent validity of intelligence tests is established through examination of the correlations between broad overall scores and subtest scores of each respective test battery. This establishes whether intelligence tests that are designed to measure similar cognitive abilities will be comparable in their outcomes of scores, or whether scores will differentiate from one another between tests measuring dissimilar abilities. This is also known as an instrument's convergent and discriminant validity (American Educational Research Association, American Psychological Association & National Council on Measurement in Education, 1999; Anastasi & Urbina, 1997).

Convergent validity involves substantiating that variables that were designed to measure similar constructs demonstrate strong relationships with one another. This is evidenced through the size of correlations between constructs measured on each test. According to Bracken (1987), convergent validity of broad factors between test batteries is best demonstrated through a correlation coefficient of .90 or higher, and a correlation coefficient of .80 between subtests of different test batteries. Conversely, discriminant validity distinguishes a weaker relationship among variables that are purported to measure dissimilar constructs. The patterns of correlations among similar and dissimilar constructs of an instrument provide evidence that a test is measuring what it is designed to measure, and also allows for analysis of the inferences that can

be made about a test (American Educational Research Association, American Psychological Association & National Council on Measurement in Education, 1999).

In addition to examining the correlations between ability measures of different test batteries, studying the difference of mean scores between instruments helps to determine if the tests have comparable performance outcomes for examinees, and helps to distinguish if there are differences in scores that may help to explain correlations among factors (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999). Hence, studies of an instrument's concurrent validity are imperative to determining the degree of similarity between intelligence tests, as well as expected differences. This in turn potentially affects diagnostic and placement decisions based on test scores in the educational arena (Dumont, Willis, Farr, McCarthy & Price, 2000).

Contemporary Intellectual Theory

Contemporary psychometric research supports a hierarchical structure of cognitive abilities known as the Cattell-Horn-Carroll model (CHC; McGrew, 1997; McGrew & Flanagan, 1998), as the best representation of the structure of human intelligence. CHC theory evolved from the psychometric research tradition that involved numerous factor analytic studies (Horn & Noll, 1997). In addition to psychometric research, support for the CHC model has been validated through several research paradigms; namely, developmental evidence, neurocognitive evidence, heritability evidence, and outcome-criterion evidence (McGrew & Flanagan, 1998). The following section provides a basic overview of the evolution of psychometric theories of cognitive ability and information processing skills that underlie current intellectual theory, namely Spearman's "g" theory (Spearman, 1927), Thurstone's Theory of Primary Mental

Abilities (Thurstone, 1938), Vernon's Verbal/Spatial Theory (Vernon, 1950), *Gf-Gc* theory (Horn & Cattell, 1967), and Carroll's Three Stratum Theory (Carroll, 1993).

Early Theories of Intelligence.

An early theory of cognitive ability that had particular influence on the psychometric tradition was Spearman's theory of general intelligence. Spearman's work on the nature of human cognitive ability in the 1920s posited that different abilities could be explained by a single function (Ittenbach, Esters, & Wainer, 1997). This general factor, or *g*, was hypothesized as a an "overlying mental ability that was necessary for all intelligent behavior." (Bolen, 1998, p. 163). That is, according to the theory, all abilities were directly related to a general factor of intelligence. This theory has been used to explain the general finding of intercorrelations across all subtests within an intelligence battery, and provides support for an overall general ability factor or full scale intelligence score (Bickley, Keith, & Wolfe, 1995).

While Spearman's work introduced the concept of intelligence as a unitary trait, Thurstone's work laid the foundation for the multidimensional interpretation of abilities from factor-analytic research (Horn & Noll, 1997). Thurstone's work departed substantially from Spearman's in that it stated that intelligence was multidimensional and comprised of nine distinct "primary mental abilities", or PMAs, that constituted the variance in individual cognitive functioning. Each primary ability, according to this theory, had equal weight in its overall contribution to individual ability (Bolen, 1998).

Gf-Gc Theory.

Subsequent studies completed by Vernon (1950) on the nature of primary mental abilities found that the abilities hypothesized by Thurstone were not independent of one another, but that they correlated positively and yielded two higher order factors or abilities, a verbal factor and a

spatial factor. Vernon proposed that the covariance of these factors produced a general factor similar to that discussed in Spearman's theory (Elliott, 1990a). Cattell (1941) also reanalyzed the primary mental abilities and replaced the factors proposed by Vernon with a two-factor structure of intelligence, namely fluid intelligence (*Gf*), which is purported to be a measure of reasoning and thought flexibility, and crystallized intelligence (*Gc*), which is conceptualized as a measure of acquired knowledge.

Horn and Cattell (1967) further developed the structure of *Gf-Gc* theory to encompass a wider range of cognitive abilities through additional research studies. Horn originally expanded the dichotomous structure of the theory to include four additional cognitive factors that accounted for distinctly different primary abilities. These included visual perception/processing (*Gv*), short-term memory (*Gsm*), long-term storage and retrieval (*Glr*), and speed of processing (*Gs*) (McGrew & Flanagan, 1998). The definitions of these abilities were gradually modified, which caused another reconfiguration of the model to include an auditory processing component (*Ga*) in order to provide a more comprehensive framework of cognitive abilities (Horn, 1968). Within the past decade, the Horn-Cattell model has been reformulated to include factors representing quantitative ability (*Gq*), and reading and writing ability (*Grw*) (Horn, 1988).

Carroll's Three Stratum Model.

Intellectual theory was further reconceptualized within the past decade in the work of John B. Carroll, who factor analyzed 461 sets of intelligence data, and concluded that a hierarchical model similar to *Gf-Gc* theory is the most viable empirical structure for conceptualizing human intelligence (Carroll, 1993). He proposed three levels to the hierarchical structure of his theory, which he described as stratum. At the first stratum, abilities similar to Thurstone's PMA's and the narrow abilities in *Gf-Gc* theory are described. These abilities form

the basis of mental operations; currently, approximately seventy narrow abilities have been identified (Carroll, 1997).

Similar to *Gf-Gc* theory, Carroll's theory includes eight clusters or factors at the second stratum that capture the shared variance among narrow stratum I abilities. Notwithstanding similarities with *Gf-Gc* theory, Carroll's model differs in his treatment of certain broad and narrow abilities, most notably that of quantitative knowledge and quantitative reasoning. Carroll classified these abilities at the Stratum I level due to their reliance on other abilities to characterize their functioning within the cognitive ability structure. This was also Carroll's contention of reading and writing abilities, which he classified at the Stratum I level in contrast to the *Gf-Gc* model, which identifies quantitative reasoning and reading/writing abilities as independent factors. Carroll further regrouped certain ability factors represented in *Gf-Gc* theory across stratum II, namely the associative, meaningful, and free-memory recall, or *Glr* abilities in *Gf-Gc* theory, and the short-term memory ability (*Gsm*). He grouped all of these memory abilities under a single factor known as General Memory and Learning (*Gy*) (Flanagan, McGrew, & Ortiz, 2000). The broad abilities encompassed in Stratum II include fluid intelligence, crystallized intelligence, general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness, and decision speed (Cole & Randall, 2003, p. 162). Lastly, unlike *Gf-Gc* theory, Carroll accounted for the interrelationships among stratum II factors with a unitary higher order factor at stratum III, which he described as general intelligence or "g." (Carroll, 1993; Bickley, Keith, & Wolfe, 1995; McGrew, 1997).

The Cattell-Horn-Carroll Model of Cognitive Abilities.

The Cattell-Horn-Carroll (CHC; McGrew, 1997) model of cognitive abilities is an attempt to integrate the structure of cognitive abilities proposed by *Gf-Gc* theory and Carroll's

Three Stratum Theory into a useful framework for the purpose of evaluating and interpreting intelligence batteries (McGrew & Flanagan, 1998). CHC theory synthesized portions of *Gf-Gc* theory and Carroll's Three Stratum Theory according to the results of factor-analytic research. CHC theory retains a quantitative reasoning/knowledge factor (*Gq*), while regrouping reading and writing (*Grw*), storage and retrieval (*Gltr*), and short-term memory (*Gsm*) abilities under separate broad factors (McGrew, 1997). The higher order stratum III "g" factor that is characteristic of Carroll's theory was also retained, according to CHC theory (Carroll, 1997). A description of the clusters included in the structure of CHC theory is outlined in Table 2.1.

Table 2.1

CHC Broad Ability Factors

Cluster	Description of Ability
Fluid Reasoning (<i>Gf</i>)	The ability to reason and/or problem-solve given novel or unfamiliar information.
Crystallized Intelligence (<i>Gc</i>)	Knowledge acquired through verbal communication, and/or factual information.
Short-Term Memory (<i>Gsm</i>)	The ability to hold information in immediate memory and manipulate it for a task.
Quantitative Knowledge (<i>Gq</i>)	Ability to reason using numbers and applying numerical concepts.
Visual-Spatial Reasoning (<i>Gv</i>)	Ability to organize and synthesize visual stimuli.
Long-Term Retrieval (<i>Glr</i>)	Ability to store information in memory and retrieve it at a later time.
Auditory Processing (<i>Ga</i>)	Ability to organize and synthesize information that is presented auditorily.
Reading and Writing Ability (<i>Grw</i>)	Ability to decode and synthesize lexical information and apply this information in written form.

Confirmation of the validity of CHC theory in psychometric research has been outlined in various factor-analytic studies of numerous intelligence batteries (Bickley, Keith, & Wolfe, 1995; Cole & Randall, 2003; Flanagan & McGrew, 1998; Keith, 1997). In these studies, a three-factor structure that parallels the structure of CHC theory was found to be the best fit for explaining the relationship between cognitive abilities, as well as to explain the covariance among broad factors (McGrew, 1997). However, research in this area has been limited by the fact that the intelligence batteries examined were not designed to provide measures of the abilities encompassed within CHC theory in their structure and orientation, with the exception of the Woodcock Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001), making the need for further research into the nature of abilities encompassed by CHC theory all the more salient.

The Woodcock Johnson III Tests of Cognitive Abilities

The Woodcock Johnson III Tests of Cognitive Ability (WJ III COG; Woodcock, McGrew, & Mather, 2001) is a revised and updated version of the Woodcock Johnson Tests of Cognitive Abilities (WJ COG; Woodcock & Johnson, 1977) and the Woodcock Johnson-Revised Tests of Cognitive Ability (WJ-R COG; Woodcock & Johnson, 1989). The current version of the Woodcock Johnson battery is designed to provide an operational definition of CHC theory for purposes of providing greater diagnostic information according to this framework (Woodcock, McGrew, & Mather, 2001). The following section provides a brief overview of the WJ COG and the WJ-R COG as it relates to the development of the present battery regarding the framework and theoretical foundations of each battery. The WJ III COG battery is discussed next in terms of its structure and orientation, followed by support for the construct and concurrent validity of the battery.

The Woodcock Johnson Tests of Cognitive Abilities.

The original WJ COG (Woodcock & Johnson, 1977) was developed to provide a wide measure of cognitive functioning that was not available within other intelligence batteries at that time (Harrison, Flanagan, & Genshaft, 1997; Woodcock, 1997). The framework of the original WJ COG was not based on any specific theory of intelligence, as it was felt at that time that there was no theory comprehensive enough on which to base the objectives of the battery. Rather, the structure of the battery was allowed to emerge through factor analysis of the standardization data. The model of intelligence that emerged from the twelve tests of the battery was a structure of four broad areas of functioning, namely Reasoning-Thinking, Memory-Learning, Discrimination-Perception, and Knowledge-Comprehension abilities. Individual cognitive ability was interpreted according to the quality of performance within these four broad areas (Woodcock, 1997).

The Woodcock Johnson-Revised Tests of Cognitive Abilities.

The WJ-R COG was developed in response to criticisms of the lack of theoretical orientation of the original WJ COG (Woodcock & Johnson, 1989; Ysseldyke, 1990). The structure of the battery departed substantially from that of the original WJ COG, in that it was based primarily on the *Gf-Gc* theory of cognitive abilities (Woodcock, 1990; Bolen, 1998). Seven of the eight cluster areas of *Gf-Gc* theory were included in the cognitive battery, namely Fluid Reasoning (*Gf*), Comprehension-Knowledge (*Gc*), Visual Processing (*Gv*), Auditory Processing (*Ga*), Processing Speed (*Gs*), Short-Term Memory (*Gsm*), and Long-Term Retrieval (*Glr*) (Woodcock & Johnson, 1989; Woodcock, 1990; Reschly, 1990). The WJ-R COG was unique in this orientation, as it was the first intelligence battery designed to operationalize the cluster areas of *Gf-Gc*. The battery also provided a more comprehensive assessment of abilities

than any other intelligence battery at the time of the test's publication (Reschly, 1990; Horn & Noll, 1997).

However, research conducted since the publication of the WJ-R COG indicated that a wider range of broad cognitive abilities exists than what was measured within the WJ-R COG battery. As a result, the authors realized that the WJ-R COG could not provide adequate breadth and depth of coverage of each *Gf-Gc* ability assessed within the battery (McGrew & Flanagan, 1998; Woodcock, McGrew, & Mather, 2001). Along with this, the range of cognitive functioning measured by the WJ-R COG was considered inadequate given current contributions to psychometric tradition including Carroll's work and advances in *Gf-Gc* theory (Carroll, 1993; Carroll, 1997; McGrew, 1997; Rizza, McIntosh, & McCunn, 2001).

Structure of the WJ III COG.

The latest version to the Woodcock Johnson Tests of Cognitive Abilities attempted to address the concerns cited above by maintaining an intelligence test based on contemporary intellectual theory (McGrew & Woodcock, 2001). The WJ III COG (Woodcock, McGrew, & Mather, 2001) includes a wider range of content in the cluster areas of the battery. This includes measures of intellectual functioning that are consistent with CHC theory. Specific changes to the format of the WJ III COG that differ from that of the WJ-R COG includes the addition of new subtests that measure narrow abilities consistent with CHC theory, and the addition of clinical tests measuring clinically useful constructs. Further, the CHC clusters are grouped into three areas: Verbal Ability, Thinking Ability, and Cognitive Efficiency, which are represented as unique clusters on the test. This representation is intended to provide a framework for understanding how the CHC clusters are related to one another and to overall cognitive

performance or information processing, referred to as the Cognitive Performance Model (Mather & Woodcock, 2001).

The WJ III COG is comprised of two batteries, a Standard and an Extended Battery encompassing twenty tests measuring individual cognitive ability. Each test measures a unique narrow ability (or Stratum I ability) that is related to a broader CHC cluster (or Stratum II ability). Thus, abilities (*Gc*, *Glr*, *Gv*, *Ga*, *Gf*, *Gs*, and *Gsm*) are represented as broad cluster scores. Individual tests also contribute to the broader Cognitive Performance Clusters: Verbal Ability, Thinking Ability, and Cognitive Efficiency, which again are intended to be measures of information processing abilities. The first seven tests of the Standard Battery are differentially weighted and clusters of the WJ III COG contribute to the overall General Intellectual Ability (GIA) score. These tests were found to load most strongly on the overall general factor in factor analysis (Mather & Woodcock, 2001). Similarly, the first seven tests of the Standard Battery are combined with the first seven tests of the Extended Battery to determine the GIA-Extended score, a second broad ability score derived from those tests that are most strongly related to an overall general ability factor. The structure of the WJ III COG, namely the tests that are utilized in this study, are outlined in Table 2.2.

Table 2.2

Structure of the WJ III COG

Cluster	Standard Battery Test	Extended Battery Test
Comprehension-Knowledge (<i>Gc</i>)	Test 1: Verbal Comprehension	Test 11: General Information
Long-Term Retrieval (<i>Glr</i>)	Test 2: Visual-Auditory Learning	Test 12: Retrieval Fluency
Visual-Spatial Thinking (<i>Gv</i>)	Test 3: Spatial Relations	Test 13: Picture Recognition
Auditory Processing (<i>Ga</i>)	Test 4: Sound Blending	Test 14: Auditory Attention
Fluid Reasoning (<i>Gf</i>)	Test 5: Concept Formation	Test 15: Analysis-Synthesis
Processing Speed (<i>Gs</i>)	Test 6: Visual Matching	Test 16: Decision Speed
Short-Term Memory (<i>Gsm</i>)	Test 7: Numbers Reversed	Test 17: Memory for Words

Note. Adapted from *Woodcock Johnson III Examiner's Manual* (2001). N. Mather & R. Woodcock. Itasca, IL. Riverside Publishing Company, p. 76

Construct Validity.

Studies of the structure of the WJ III COG reported in the technical manual (McGrew & Woodcock, 2001) support the construct validity of the instrument. Confirmatory factor analyses suggest that the test is best represented as a hierarchical-multidimensional model similar to that defined by CHC theory that accounts for narrow abilities, broad abilities, and an overall ability factor. Further, the relationship among tests provides evidence for seven broad abilities, or clusters (*Gf*, *Gc*, *Gv*, *Gs*, *Gsm*, *Ga*, and *Glr*) that are similar to the broad factors outlined in CHC theory. The seven clusters also have a moderate to high degree of relationship with one another, suggesting the existence of a general factor, which is represented by the WJ III COG's General

Intellectual Ability (GIA) score. Thus, like the WJ-R COG (Woodcock & Johnson, 1989), the WJ III COG (Woodcock, McGrew, & Mather, 2000) is well matched to contemporary theories of intelligence.

Concurrent Validity.

Evidence for the concurrent validity of the WJ III COG for school aged children is supported through special studies (Phelps, 2001; McIntosh & Dunham, 2001; Flanagan, Kranzler, & Keith, 2001) cited in the Technical Manual of the test battery (McGrew & Woodcock, 2001). In these studies, the broad ability and CHC clusters of the WJ III COG were compared with the broad ability and clusters of the Cognitive Assessment System (CAS; Naglieri & Das, 1997; Flanagan, Kranzler, & Keith, 2001) the Differential Ability Scales (DAS; Elliott, 1990; McIntosh & Dunham, 2001) and the Wechsler Intelligence Scale for Children-Third Edition (WISC III; Wechsler, 1991; Phelps, 2001). The following section reviews the studies involving the WISC-III and CAS. Relationships between the DAS and WJ III COG are discussed later in this chapter.

Evidence of the WJ III COG General Intellectual Ability-Extended (GIA-Ext.) score's validity was supported through concurrent studies with the WISC-III and the CAS. The strongest correlation was with the Full-Scale score of the CAS ($r=.70$), although the correlation of the GIA-Ext. with the Full Scale Intelligence Quotient (FSIQ) of the WISC-III was very similar to that of the CAS ($r=.69$). This suggests that the broad constructs measured by the WJ III COG are similar to those of other intelligence instruments. However, the level of correlation also suggests that the WJ III COG measures unique features of intelligence not captured by other tests. Mean scores were similar between the WJ III COG and those of the WISC-III and the CAS, though

scores on the WJ III COG were an average of 3-5 points lower than those obtained on other instruments (McGrew & Woodcock, 2001).

Correlations of the CHC clusters of the WJ III COG with cluster scores of the WISC-III support the convergent and discriminant validity of the battery, while also supporting the construct of the test as measuring distinct cognitive abilities. Correlations were strongest between the *Gc* cluster of the WJ III COG and the Verbal Intelligence Quotient (VIQ) and Verbal Comprehension Index (VCI) of the WISC-III ($r = .79$ and $.78$), providing support that the *Gc* cluster of the WJ III COG measures verbal reasoning and comprehension abilities similar to the WISC-III.

Specific indices of fluid reasoning abilities are not contained within either the CAS or the WISC-III. Thus, as expected, correlations of the *Gf* cluster of the WJ III COG with the clusters of the CAS and the WISC-III were moderate to weak. The strongest relationship was found between the *Gf* cluster of the WJ III COG and the Simultaneous Processing cluster of the CAS ($r = .54$), which is described as a measure of fluid reasoning and visual-spatial abilities (Keith, Kranzler, & Flanagan, 2001). As expected, the WJ III COG *Gf* cluster was not strongly related to the Processing Speed Index (PSI) ($r = .26$); however, relationships between *Gf* and all other WISC III factors were in the moderate range ($r = .45$, PIQ; to $r = .53$, VIQ) and similar in size to the factor's correlation with the CAS Simultaneous Processing cluster. The moderate degree of relationship between the WJ III COG *Gf* cluster and clusters from other batteries supports the notion that the *Gf* cluster measures specific fluid reasoning abilities, while cluster scores of the CAS and the WISC-III likely provide a mixed measure of several cognitive abilities (Keith, Kranzler, & Flanagan, 2001; McGrew & Woodcock, 2001).

Similar to *Gf*, neither the CAS nor the WISC-III provide specific visual-spatial cluster scores that corresponding to the *Gv* cluster of the WJ III COG; however, research has suggested that the PIQ and POI indexes of the WISC-III contain measures of visual-spatial abilities (Flanagan, 2000). However, weak correlations were found among the comparisons of each of the WISC-III clusters ($r=.10-.23$) with the WJ III COG. This may be due in part to differences in the specific abilities measured within each cluster; measures of visual-spatial reasoning within the WISC-III center on visual-motor integration, while tests contributing to *Gv* within the WJ III COG focus on visualization and spatial relations. Thus, the nature of tests within each battery may account for differences in scores obtained between the two test batteries. Despite this, the correlations are still lower than expected. Further research examining the relationship between the *Gv* factor of the WJ III COG with other measures is needed.

Interpretation of specific patterns of convergent and discriminant validity of the *Glr* and *Gsm* clusters of the WJ III COG is also difficult, given that the other intelligence batteries analyzed do not provide specific cluster scores for these memory abilities. Of the CHC factors, the Short-Term Memory (*Gsm*) cluster of the WJ III COG was most strongly related to the Freedom From Distractibility Index (FFD) of the WISC-III ($r=.58$). Thus, the two clusters appear to share some similarities in terms of memory abilities being measured. However, the degree of relationship suggests that each cluster also measures abilities not shared with the other cluster. This is likely due to the fact that the FFD factor of the WISC III also contains a measure of quantitative reasoning (Arithmetic subtest). Weaker correlations with the Processing Speed Index and Perceptual Organization Index of the WISC-III ($r=.18-.24$) supports the discriminant validity of the *Gsm* cluster.

The *Glr* cluster of the WJ III COG was most strongly related to the VIQ and Verbal Comprehension Index (VCI) and Perceptual Organization Index (POI) indices of the WISC-III ($r=.50$, $.45$, and $.40$, respectfully). Similarly, moderate correlations were found between the *Glr* cluster and the Planning and Simultaneous Processing clusters of the CAS ($r=.46$ and $.50$), suggesting some influence of comprehension and visual-spatial reasoning within the *Glr* cluster. As expected, the discriminant validity of the *Glr* cluster was evidenced through a weak correlation with the Processing Speed Index of the WISC-III ($r = .12$), which is reflective of a child's abilities with regard to speed of information processing as well as attention.

The *Gs* cluster of the WJ III COG was most strongly related to the Processing Speed Index (PSI) of the WISC-III ($r=.59$), indicating that both likely assess aspects of speed of information processing. A similar relationship was also found between the *Gs* cluster and the Planning and Attention clusters of the CAS ($r=.57$ and $.54$), which are also defined as being strongly influenced by speed of cognitive functioning (Keith, Kranzler, & Flanagan, 2001). Low correlations with verbal measures of the WISC-III ($r=.20-.29$) support the discriminant validity of the *Gs* cluster from those abilities influenced by comprehension and knowledge.

Finally, given a lack of similar measures on other intelligence batteries, the *Ga* cluster on the WJ III COG was not expected to be strongly related to clusters from the CAS or WISC-III. Patterns of correlations support its discriminant validity and imply that the measurement of *Ga* abilities is unique to the WJ III COG battery.

The Differential Ability Scales

The following section discusses the historical and theoretical foundations of the Differential Ability Scales (DAS; Elliott, 1990), followed by a description of the nature of the

abilities assessed by the battery from a theoretical standpoint. This is followed by a discussion of support for the construct and concurrent validity of the instrument.

The British Ability Scales.

The DAS is a revised and restandardized version of the British Ability Scales (BAS; Elliott, Murray, & Peterson, 1979), hence the structure and orientation of the DAS closely resembles that of the BAS. The BAS was designed as an individually administered scale and was developed within the context of British culture. It was standardized on a population of British school children. The developers of the BAS intended to design subtests that were based on a wide range of abilities, rather than conforming to any specific theoretical orientation. Thus, abilities measured by the BAS allow for an overall cognitive profile of children as well as the interpretation of specific abilities for the purpose of differential diagnosis (Byrd & Buckhalt, 1991; Elliott, 1990).

Structure of the DAS.

The development of the DAS was guided by goals that were similar to those of the BAS, though the shortcomings of the BAS were taken into account during the initial development of the battery. The BAS had been criticized mainly for not providing distinct cognitive profiles in children; to achieve this goal, developers of the DAS deleted or modified six subtests and subsequently added four new subtests to the battery. New content was added to the subtests of the DAS to make them more reliable indicators of cognitive ability. Lastly, the DAS differed from the BAS in the fact that the battery was developed within the context of United States culture and standardized on a sample of United States school children (Elliott, 1990a).

The DAS is comprised of two separate levels, a preschool and a school-age battery. Thirteen subtests comprise the school-age battery, which are differentiated into three distinct

areas, a core, diagnostic, and achievement battery. The core battery consists of those six subtests that loaded most strongly on a general factor when factor analyzed. Thus, they are thought to measure complex cognitive functioning (Elliott, 1997). The diagnostic subtests of the DAS are those that do not load highly on the general factor, thus they do not contribute to the overall General Conceptual Ability (GCA) score. The diagnostic subtests are thought to be measures of less complex cognitive ability, which lends credence to the GCA score as being a measure of complex cognitive functioning. Specific abilities measured by the diagnostic battery include short-term memory and processing speed (Elliott, 1990b).

Similar to the WJ III COG, the subtests are organized according to a hierarchical format ranging from specific to general ability. At the subtest level, each subtest was designed to represent a specific or unique type of cognitive ability, such as visual perception, numerical concepts, and receptive or expressive language. The subtests then group together to form the basis of broader clusters including Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability factors. A broad factor, or General Conceptual Ability (GCA) score at the highest level encompasses the narrow and broad abilities measured by the core battery (Elliott, 1990b, 1997).

Like its predecessor the BAS, the theoretical framework of the DAS is considered to be eclectic in nature. That is, it does not conform to a specific theory of cognitive abilities. However, independent studies have suggested notable similarities between the hierarchical structure of the battery with several well-known factor-analytic theories of intelligence. For example, the test is consistent with Thurstone's Theory of Primary Mental Abilities (PMAs) in that the individual subtests provide narrow, distinct indicators of multiple cognitive abilities (Carroll & Maxwell, 1979; Elliott, 1990). Similarities between the Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability clusters with the Crystallized (*Gc*), Fluid (*Gf*), and

Spatial-Visualization (*Gv*) factors of *Gf-Gc* theory have also been supported in research (Elliott, 1990b; McGrew & Flanagan, 1998).

Lastly, the composition of the DAS's GCA is strongly reflective of Spearman's theory of general intellectual ability. The nature of the GCA of the DAS is based on the premise that cognitive abilities are interrelated and share variance that indicates the existence of a general factor (Elliott, 1990b, p. 378). Therefore, Elliott included only those subtests in the core battery that were thought to be a measure of mental complexity as measured by their high factor loadings in factor analyses, specifically those subtests that loaded most strongly on the first unrotated factor when all DAS subtests are analyzed together (Elliott, 1990, 1990b; Keith, 1990). The structure of the DAS is outlined in Table 2.3.

Table 2.3

Structure of the DAS

Subtest	Cluster	Proposed CHC Factor
Word Definitions	Verbal Ability	<i>Gc</i>
Similarities	Verbal Ability	<i>Gc</i>
Matrices	Nonverbal Reasoning Ability	<i>Gf</i>
Sequential and Quantitative Reasoning	Nonverbal Reasoning Ability	<i>Gf</i>
Recall of Designs	Spatial Ability	<i>Gv</i>
Recall of Objects-Delayed		<i>Glr</i>
Recall of Digits		<i>Gsm</i>
Speed of Information Processing		<i>Gs</i>

Construct Validity.

Studies cited in the technical manual of the DAS (Elliott, 1990a) and a review of the technical characteristics of the DAS (Platt, Kamphaus, Keltgen, & Gilliland, 1991) support the construct validity of the instrument. Confirmatory factor analysis supports a hierarchical, three-factor model to explain the structure of abilities measured by the core battery of the DAS. According to the author, differences in performance across age ranges also supports the hypothesis that abilities become more differentiated with increasing age. Further, weaknesses in the correlation coefficients of the diagnostic subtests with the general factor confirmed the

distinction between abilities that contribute to general intelligence with less complex cognitive functioning abilities (Elliott, 1990a).

An independent study conducted by Keith (1990) also showed strong support for the construct validity of the DAS. Results from this study were consistent with those discussed in the technical manual (Elliott, 1990a), and supported a three-factor hierarchical model of abilities of the core subtests. Keith's description of the clusters of the DAS were consistent with those of Elliott, although he described the Verbal Ability factor as an indicator of verbal abilities, the Nonverbal Reasoning Ability factor as an indicator of fluid reasoning abilities, and he renamed the Spatial Ability factor 'Nonverbal Reasoning' (Elliott, 1997). The core subtests in Keith's study loaded highly on the general factor, supporting the results of Elliott's (1990) analysis. Keith also grouped those subtests that did not load highly on the general factor into a separate cluster independent of the core battery, which is consistent with the structure of the diagnostic battery of the DAS (Keith, 1990).

A joint confirmatory factor analytic study conducted by Byrd and Buckhalt (1991), including the DAS and the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974), also supported a three-factor, hierarchical structure of the DAS. However, the results suggested that while the DAS measures broad constructs that are similar to other intelligence batteries, the specific abilities measured by each subtest tend to diverge from those of other intelligence batteries. More specifically, the narrow abilities measured by each subtest tend to be unique from those of other intelligence batteries, providing support for the broad and narrow abilities measured by the DAS.

Additional independent studies conducted by Dunham, McIntosh, and Gridley (2002) with a sample of regular-education students and by Keith, Quirk, Schartzler, and Elliott (1999)

with a sample of African-American, Latino, and Caucasian students found similar results supporting the construct validity of the DAS. When a narrow ability range is considered, however, the three-factor hierarchical structure of the battery was not supported in research (Parker, 1996). Parker analyzed the factor structure of the DAS with a sample of children with cognitive disabilities, and only a one-factor model was supported. This suggests that the structure of cognitive abilities presented in the technical manual of the DAS (1990) may not be generalized to populations of children with below average cognitive ability. That is, the Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability may not be distinguishable from one another among low-functioning children.

Concurrent Validity.

Evidence for the concurrent validity of the DAS is supported through studies reported in the technical manual (Elliott, 1990a), where the DAS is compared to the Stanford-Binet-Fourth Edition (SB-IV; Thorndike, Hagan, & Sattler, 1986), and the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1985). Further evidence for the concurrent validity of the instrument was provided in a study reported in the technical manual of the Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991).

Findings support the concurrent validity of the GCA score of the DAS with the broad scores of other intelligence batteries. A strong relationship was found between the GCA of the DAS with the broad scores of other intelligence batteries ($r=.75-.92$), suggesting that the broad abilities measured by each battery are similar. Mean scores between the DAS, the WISC-III, and the SB-IV were comparable, although scores were more differentiated within the sample of gifted children. Mean scores between the DAS and the K-ABC differed by nine points in this study (Elliott, 1990a).

Correlations between the cluster scores of the DAS with those of other intelligence instruments also support the convergent and discriminant properties of the battery. The Verbal Ability cluster of the DAS correlated highly with indices of verbal ability on the SB-IV and the WISC-III ($r=.79-.87$), supporting the convergent validity of the Verbal Ability cluster among regular and gifted students (Elliott, 1990a). A moderate correlation was found between the Verbal Ability cluster of the DAS and the Achievement cluster of the K-ABC ($r=.64$), implying some overlap in the abilities measured within each cluster. Conversely, the Simultaneous and Sequential clusters of the K-ABC were weakly correlated with the Verbal Ability cluster of the DAS ($r=.18$ and $.35$, respectfully). According to Elliott (1990a), this supports interpretation of the Verbal Ability cluster as a measure of crystallized abilities, or *Gc*.

The Nonverbal Reasoning cluster of the DAS correlated most strongly with the Performance Intelligence Quotient (PIQ) scale of the WISC-III ($r=.78$), which implies that the WISC III PIQ may measure aspects of reasoning abilities. As expected, given the overlap of the PIQ and POI factors, a similar relationship was found between the Nonverbal Reasoning Ability cluster and the Perceptual Organization Index of the WISC-III ($r=.75$). Lower correlations were found between the Nonverbal Reasoning Ability cluster of the DAS and the VIQ and VCI of the WISC-III ($r=.58$ and $.54$), suggesting that the DAS Nonverbal Reasoning Ability cluster is less influenced by verbal abilities.

Similar to findings with the WISC-III, a strong relationship was found between the Nonverbal Reasoning cluster of the DAS and the Abstract-Visual Reasoning and Quantitative Reasoning clusters of the SB-IV ($r=.75-.76$) with a sample of regular education students (Elliott, 1990a). As expected, correlations were weaker between the Nonverbal Reasoning Ability cluster of the DAS and the Verbal Reasoning cluster ($r=.58$), and the Short-Term Memory cluster of the

SB-IV ($r=.55$). Similarly, the Nonverbal Reasoning cluster was moderately to strongly related to the Simultaneous Processing and Achievement clusters of the K-ABC ($r=.68$ and $.72$), and much less related to the Sequential Processing cluster ($r=.24$). This suggests that the Nonverbal Reasoning Ability cluster also may be influenced by information/knowledge and simultaneous processing abilities.

Although strong relationships between the DAS Nonverbal Reasoning Ability cluster and the WISC-III Performance IQ were evident, the Spatial Ability cluster of the DAS correlated most strongly with the PIQ of the WISC-III ($r=.82$), as well as the Simultaneous Processing cluster of the K-ABC ($r=.74$). This strongly suggests that visual abilities are being measured by the DAS Spatial Ability cluster. Moderate correlations were also found between the DAS Spatial Ability cluster and the Abstract-Visual Reasoning cluster of the SB-IV ($r=.67$), and the Sequential Processing cluster of the K-ABC ($r=.62$). Given that these clusters tend to be mixed measures of abilities, their moderate relationship suggests that the visual and perceptual organization abilities measured by the DAS overlap those of the Abstract-Visual Reasoning and Sequential Processing clusters of the SB-IV and the K-ABC (Elliott, 1990a).

The Relationship of the Woodcock Johnson III and the Differential Ability Scales

A previous study conducted by Dumont, Willis, Farr, McCarthy, and Price (2000) compared the DAS with the WJ-R COG with a sample of special education students. Results of this study showed that the broad scores of the DAS and the WJ-R COG correlated significantly with one another, although the size of the correlation between the broad scores was only moderate. Significant differences were also found between the broad mean scores of each battery, as students comprising the sample of the study tended to score higher on the WJ-R COG.

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Moderate correlations were found between measures of crystallized knowledge and short-term memory between the WJ-R COG and the DAS in this study. Weak to moderate correlations were also found between measures of fluid reasoning. Contrary to expectations, a weak relationship was evidenced in the correlation between measures of visual-spatial reasoning of each battery. Discriminant validity of the clusters examined in this study was supported by overall weak correlations between dissimilar measures of cognitive ability. Overall, the results of this study implied that the cognitive abilities measured by each battery diverged from one another to a significant degree, which in turn suggested that the two tests could not be used interchangeably for assessment of students referred for special education services.

Given significant changes to cluster compositions and test items, findings from the Dumont et al. (2000) study cannot be generalized to the WJ III COG. Thus, additional research with the WJ III COG and DAS is needed to evaluate the similarities and differences across the two tests.

A study conducted by McIntosh and Dunham is cited in the technical manual of the WJ III COG (McGrew & Woodcock, 2001). This study compared the DAS GCA and the WJ III COG GIA scores, as well as select clusters of the WJ III COG and the DAS. The correlation between the GIA-Std. and GIA-Ext. scores of the WJ III COG and the GCA score of the DAS supports that the broad scores of each battery are measuring similar abilities ($r=.76$). Mean scores were also comparable, with scores obtained on the DAS an average of four points higher than those obtained on the WJ III COG.

Concurrent validity of the Verbal Ability cluster of the DAS was supported through a strong correlation with the Verbal Ability-Std. cluster of the WJ III COG ($r=.71$). Moderate correlations between the Verbal Ability cluster of the DAS and the Fluid Reasoning (*Gf*) cluster

of the WJ III COG suggests that the Verbal Ability cluster may provide some measure of inductive reasoning similar to that of the WJ III COG. Weak correlations with the *Gv*, *Ga*, *Gs*, and *Gsm* clusters of the WJ III COG supported the discriminant validity of the Verbal Ability cluster of the DAS.

The Nonverbal Reasoning Ability cluster of the DAS was most strongly related to the *Gf* cluster of the WJ III COG in this study ($r=.67$), which supports moderate overlap in the reasoning abilities measured within each battery. A moderate correlation was also found with the *Gc* cluster of the WJ III COG ($r=.55$), supporting that measures of verbal reasoning are contained within the *Gc* cluster. Weak correlations of the Nonverbal Reasoning Ability cluster with the *Gv*, *Ga*, *Gs*, and *Gsm* clusters of the WJ III COG again supports the discriminant validity of the Nonverbal Reasoning Ability cluster of the DAS.

The Spatial Ability cluster of the DAS did not correlate strongly with the *Gv* cluster of the WJ III COG as expected ($r=.19$), although this is similar to previous studies that found a weak relationship between the *Gv* cluster of the WJ III COG with measures of visual-spatial abilities of the WISC-III (Phelps, 2001). Although both clusters contain measures of visual memory, the weak correlation may be influenced by differences in the nature of the specific abilities measured within each cluster. As such, the WJ III COG measures visualization and spatial relations at the subtest level, while visual-motor integration and visual-perceptual and visual reproduction abilities are measured at the subtest level within the DAS. Moderate correlations with the *Gf* cluster of the WJ III COG further supports the notion that the Spatial Ability cluster may contain measures of nonverbal reasoning. Low correlations between the Spatial Ability cluster of the DAS and the *Gc* cluster of the WJ III COG ($r=.32$) supports the

discriminant validity of the cluster, and indicates that comprehension skills are not measured within the Spatial Ability cluster.

A weak relationship overall existed between the clusters of the DAS with the *Ga*, *Gs*, and *Gsm* clusters of the WJ III COG ($r=.24-.42$). Establishing validity of these clusters is hampered by either a lack of similar measures within the DAS and/or the narrow breadth of abilities compared in the McIntosh and Dunham (2001) study. However, the weakness of correlations of these measures of the WJ III COG with the clusters of the DAS supports the discriminant validity of the *Ga*, *Gs*, and *Gsm* clusters in measuring abilities that are unique from verbal abilities, nonverbal reasoning abilities, and spatial reasoning abilities.

Critical Analysis of the Literature

Studies of an instrument's concurrent validity provide practitioners with valuable information regarding the proposed structure of a test. Specifically, concurrent validity studies help to identify if a test measures the constructs it is designed to measure by comparing scores with tests purported to measure similar constructs. Further, by comparing constructs of intelligence batteries, conclusions can be drawn that help support the nature of abilities measured within a given test battery (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999). This information is particularly useful when critiquing new test batteries, which usually lack independent studies of this nature.

Concurrent validity studies also assist in providing evidence to support the theoretical structure of a test battery. This type of information is meaningful as well, given that it is becoming increasingly important to understand the results of cognitive ability assessments according to proposed theoretical models (Kamphaus, Petoskey, & Morgan, 1997). Thus,

information derived from studies of an instrument's concurrent validity helps school psychologists determine if a test battery is useful for evaluating specific abilities, and whether test batteries can be used interchangeably for diagnostic purposes.

Concurrent validity studies typically examine the convergent and discriminant validity between broad and cluster scores of test batteries. Convergent validity establishes whether constructs designed to measure similar abilities actually do so, and to what degree. According to Bracken (1987), correlation coefficients between broad scores of tests should be at .90 or above to demonstrate sound concurrent validity. Correlations at the cluster level should demonstrate correlation coefficients of .80 or above to show sound concurrent validity with another instrument. Further, concurrent validity studies also provide evidence of whether tests discriminate from each other in the abilities that are designed to be dissimilar from one another. Similarities and differences between the abilities measured within test batteries thus provide evidence for the abilities that are actually being measured within a given test battery, which helps to validate whether a test is useful for assessing different cognitive abilities (American Educational Research Association, American Psychological Association & National Council on Measurement in Education, 1999; Anastasi & Urbina, 1997).

Published research supports the construct validity of the WJ III COG and the DAS in providing a sound framework for assessing cognitive abilities. Preliminary literature regarding the concurrent validity of the WJ III COG supports that the cognitive abilities measured within the battery converge with similar abilities measured by other intelligence instruments. Dissimilar abilities with other intelligence batteries tend to be supported by evidence of discriminant validity; with this, research also supports the measurement of unique cognitive abilities within the WJ III COG battery.

The study examining the relationship between the WJ III COG and the DAS cited in the technical manual of the WJ III COG (McGrew & Woodcock, 2001) supports the convergent validity of the broad scores of each battery, as well as comparable mean scores. This study also provided support for the concurrent validity of the Verbal Ability cluster of the DAS with the Verbal Ability-Std. cluster of the WJ III COG, as well as support for some overlap in the abilities measured within the Nonverbal Reasoning Ability cluster of the DAS and the *Gf* cluster of the WJ III COG. Contrary to expectations, the Spatial Ability cluster of the DAS did not correlate strongly with the *Gv* cluster of the WJ III COG. Correlations between the cluster scores of the DAS and the *Gα*, *Gs*, and *Gsm* clusters of the WJ III COG were moderate to weak, providing support for the discriminant validity of these clusters.

Notwithstanding the results of the McIntosh and Dunham study (2001), more research is needed to substantiate the relationship of the WJ III COG and the DAS in order to clarify the nature of abilities measured within each battery. No published study to date has examined the CHC factor structure of the WJ III COG in its entirety with another test battery, which is useful for determining the theoretical nature of the battery. Published research has also not examined the relationship of the subtests comprising the Diagnostic Battery of the DAS with the clusters of the WJ III COG that would help clarify interpretations of both batteries. Finally, no independent studies to date have examined the relationship of the WJ III COG with the DAS, hence more research is needed to clarify this relationship outside of information available in the Technical Manual of the WJ III COG (McGrew & Woodcock, 2001).

Based on the theoretical background of each test, descriptions in the test manuals, and research reviewed in this chapter, the following patterns of correlations were expected in the current investigation.

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- A high correlation is expected between the GIA-Std. and GIA-Ext. scores of the WJ III COG and the GCA of the DAS. Mean scores are also expected to be comparable within this study.
- A strong relationship is expected between the Comprehension-Knowledge (*Gc*) cluster of the WJ III COG and the Verbal Ability cluster of the DAS. Moderate correlations of the *Gc* cluster of the WJ III COG and the Verbal Ability cluster of the DAS with other clusters of each battery are expected due to evidence in previous research that verbal abilities tend to correlate moderately with other measures of ability (McIntosh & Dunham, 2001; Phelps, 2001).
- Strong correlations are expected between the Fluid Reasoning (*Gf*) cluster of the WJ III COG and the Nonverbal Reasoning Ability cluster of the DAS, with lower correlations between other clusters from both batteries.
- Strong correlations are also expected between the Visual-Spatial Reasoning (*Gv*) cluster of the WJ III COG and the Spatial Ability cluster of the DAS due to similarities in the description of abilities measured within each cluster.
- Due to similarities in the description of abilities measured across DAS diagnostic subtests and WJ III COGCHC clusters, the following relationships are expected: 1) a strong correlation between the *Glr* cluster of the WJ III COG and the Recall of Objects subtest of the DAS, 2) a strong correlation between the *Gs* cluster of the WJ III COG and the Speed of Information Processing subtest of the DAS, 3) a strong correlation between the *Gsm* cluster of the WJ III COG and the Recall of Digits subtest of the DAS (Elliott, 1990a; Mather & Woodcock, 2001).

Chapter III

Methodology

The purpose of this study was to provide information regarding the technical characteristics of two measures of cognitive ability, the Woodcock Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001) and the Differential Ability Scales (DAS: Elliott, 1990). The following specific questions were examined:

- (1) The first question examined in this study was the strength of the relationship between the broad ability scores of the WJ III COG and the DAS. The General Intellectual Ability-Extended (GIA) score of the WJ III COG was compared to the General Conceptual Ability (GCA) score of the DAS. This question also examined how comparable the mean overall composite scores were between the two batteries for the current sample.
- (2) The second question examined the relationship between the WJ III COG CHC clusters: Comprehension-Knowledge (*Gc*), Fluid Reasoning (*Gf*), Visual-Spatial Thinking (*Gv*), Processing Speed (*Gs*), Auditory Processing (*Ga*), Long-Term Retrieval (*Glr*), and Short-Term Memory (*Gsm*) the Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability clusters and diagnostic subtests of the DAS. This allowed for a comparison of the similarities and differences across the theoretical underpinnings of each test.

Participants

Children in grades six through eight who were not receiving special education services were targeted for participation in the study. The recruitment of participants resulted in a sample of 31 middle school aged children. Parents of students who participated were asked to complete a

brief summary of personal demographic data (see Appendix A). Most participants (n = 20) were in eighth grade; however, students in sixth grade (n=3) and seventh grade (n=8) were also included. Also, a larger number of male students (n=20) than female students (n=11) participated in the study. All thirty-one of the students who comprised the sample were Caucasian. The average age of students who participated in this study was 13 years, 1 month. Parental education for both students' mother and father was predominantly a Bachelor's degree (n=15 and 18, respectively) or higher (n=9 and 7, respectively). A summary of the sample demographics in this study is listed in Table 3.1.

Table 3.1

Demographics of the sample (N=31)

Demographic	n	Percentage
Sex:		
Male	20	65
Female	11	35
Grade:		
Sixth	3	9
Seventh	8	26
Eighth	20	65
Race:		
Caucasian	31	100

Table 3.1 (continued)

Demographics of the sample (cont.)

Demographic	n	Percentage
Mother's level of education:		
High school/GED	4	13
Some college	1	3
Technical school	2	7
Bachelor's degree	15	48
Graduate school	9	29
Father's level of education:		
High school/GED	2	7
Some college	3	10
Technical school	1	3
Bachelor's degree	18	58
Graduate school	7	22

Procedures

School districts in western Wisconsin and central Minnesota were contacted for permission to solicit participants. Participants were also solicited via an email message to parents employed by the University of Wisconsin-Stout. A brief description of the study (see Appendix B) and a letter of permission (see Appendix C) were sent to families of children who were eligible to participate in this study. Interested parents were then contacted by phone to

further explain the study. Signed parent consent for participation was obtained prior to all testing.

Once parent permission was obtained, children were administered the WJ III COG and the DAS following standardized procedures for each test. Each child was assigned a code number for all testing materials to ensure confidentiality. Test administrators were graduate students in school psychology who were trained on the procedures and practices specific to each test battery. Tests were administered in a counterbalanced order to avoid practice effects. Children were tested in a private room at their school or at a location of their parents' choosing. Each child's name was entered into a drawing for a \$50 cash prize that was distributed at the conclusion of data collection.

Instrumentation

Woodcock Johnson III Tests of Cognitive Abilities.

The Woodcock Johnson III Tests of Cognitive Abilities (WJ III COG; Woodcock, McGrew, & Mather, 2001) was designed to assess cognitive abilities for people between 2 to 95 years of age. The entire battery is comprised of two components, a standard and an extended battery. Twenty individual tests compose the cognitive batteries.

The WJ III COG was designed to provide an operational definition of the Cattell-Horn-Carroll (CHC) theory of intelligence (Woodcock, McGrew, & Mather, 2001). As such, 14 of the 20 subtests combine to form seven CHC clusters scores. Additional cluster scores can be derived from the WJ III COG; however, given that the purpose of this study was to compare CHC cluster scores with the DAS, only Test 1 to Test 7 and Test 11 to Test 17 were administered from the WJ III COG. Tests underlying each CHC cluster were designed to represent a distinct narrow ability within the CHC model.

The overall composite score for the WJ III COG, referred to as the General Intellectual Ability (GIA) score, is a weighted score based on those tests that loaded most highly on the first principal components analysis of all WJ III COG subtests. Thus the GIA is thought to be reflective of general intellectual ability, or “g”. The General Intellectual Ability-Standard Scale (GIA-Std) is based on Tests 1-7 of the Standard Battery. The General Intellectual Ability-Extended Scale (GIA-Ext) provides a broader measure, as it is based on Tests 1-7 and Tests 11-17 from the Extended Battery.

Normative data for the WJ III COG was gathered from 100 communities in the United States. The norming sample was selected to be representative of the United States population according to 2000 U.S. census data. Stratification variables included region, community size, sex, race, and the type of school each child attended. Approximately 8,000 subjects comprised the entire norming sample. Test norms are represented by age groups in which standard scores are calculated in one-month intervals for the ages of two through nineteen years. Raw scores, percentiles, age and grade equivalents, W-scores, and a Relative Proficiency Index (RPI) can also be calculated for further test interpretation. See Table 3.2 for a description of the subtests comprising the WJ III COG battery used in this study.

Table 3.2

Description of tests comprising the WJ III COG battery

Test (CHC cluster)	Description
Standard Battery:	
Test 1: Verbal Comprehension (<i>Gc</i>)	Examinees are required to orally identify synonyms, antonyms, and verbal analogies that are orally presented by the examiner.
Test 2: Visual-Auditory Learning (<i>Glr</i>)	Measures an examinee's ability to learn and recall rebuses. Examinees are required to orally name each symbol, and read each symbol point by point in a story format.
Test 3: Spatial Relations (<i>Gv</i>)	Assesses the ability to identify two or three pieces that form a complete shape.
Test 4: Sound Blending (<i>Ga</i>)	Assesses the ability to synthesize phonemes. The examinee listens to an audio recording and blends the sounds heard into a coherent word.
Test 5: Concept Formation (<i>Gf</i>)	The examinees are presented with a set of pictures and are asked to state the rule that determines how the pictures are alike or different from the others.
Test 6: Visual Matching (<i>Gs</i>)	Measures the ability to match two identical numbers in a row of six numbers. The task increases in difficulty from two to three digits. A three-minute time limit is given.
Test 7: Numbers Reversed (<i>Gsm</i>)	Measures an examinees ability to hold numbers in immediate memory while reversing the sequence. Examinees are required to repeat the reversed sequence orally.

Table 3.2

Description of tests comprising the WJ III COG battery (cont.)

Test (CHC cluster)	Description
Extended Battery:	
Test 11: General Information (<i>Gc</i>)	Measures an examinee's depth of general knowledge. Two tests measure an examinee's conceptualizations of where common objects are found and what they are used for.
Test 12: Retrieval Fluency (<i>Glr</i>)	Assesses fluency of an examinee's retrieval of stored knowledge. This test requires an examinee to list as many items as possible from a given category within a one-minute time limit.
Test 13: Picture Recognition (<i>Gv</i>)	Assesses an examinee's ability to recognize a set of pictures within a field of other distracting pictures.
Test 14: Auditory Attention (<i>Ga</i>)	Assesses auditory discrimination. The examinee listens to a word and is asked to point to the correct picture out of a set of four pictures amid increasing background noise.
Test 15: Analysis-Synthesis (<i>Gf</i>)	Measures an examinee's ability to draw conclusions based on a given set of conditions. The examinee is given instructions on how to perform a procedure, which becomes increasingly complex with the progression of items.
Test 16: Decision Speed (<i>Gs</i>)	Measures an examinee's speed at processing simple concepts, which requires locating similar pictures in a set of stimuli.
Test 17: Memory for Words (<i>Gsm</i>)	Assesses the ability of an examinee to repeat lists of unfamiliar words in correct sequences.

Differential Ability Scales: School Age Battery.

The school-age battery of the Differential Ability Scales (DAS; Elliott, 1990) is designed to assess cognitive abilities in children between the ages of 6 and 18 years. The school-age battery is divided into two components, a core battery which consists of six subtests, and three additional diagnostic subtests. Subtests of the core battery include Pattern Construction, Recall of Designs, Word Definitions, Matrices, Similarities, and Sequential and Quantitative Reasoning. Diagnostic subtests of the school-age battery include Recall of Digits, Recall of Objects, and Speed of Information Processing.

The DAS is based on an eclectic theory of intellectual functioning. The hierarchical structure of the battery reflects components of Spearman's notion of general intelligence, as well as Thurstone's Theory of Primary Mental Abilities and modern *Gf-Gc* theory (Flanagan & McGrew, 1998). Each of the individual subtests of the DAS is structured to represent a distinct, specific cognitive ability. Six of the nine subtests that loaded most highly on the first unrotated factor combine to form the Core Battery of the DAS. Three cluster scores, namely the Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability clusters, and an overall General Conceptual Ability (GCA) score are also derived from the six subtests of the Core Battery. It is this composition that is reflective of Elliott's theoretical emphasis on general intelligence, or "g". The three additional subtests that do not have significant loadings on the general factor, and therefore do not contribute to the GCA or cluster scores provide supplementary diagnostic information regarding cognitive abilities and information processing in children. Abilities measured by the diagnostic subtests include short-term memory and processing speed (Elliott, 1990, 1997).

Normative data for the DAS was gathered from a sample of 3,475 children between the ages of 2 years, 6 months and 17 years, 11 months living in the United States at the time of data collection. The norming sample was chosen to be representative of the United States population according to the 1986 U.S. Census Bureau data. Stratification variables included age, sex, race/ethnicity, parent education, and geographic region. Norms are represented in two months intervals for the ages of 6 years to 7 years, 11 months, and five-month intervals for the ages of 8 years to 17 years, 11 months. Subtest scores are reported as T-scores ($M = 50$, $SD = 10$), while cluster scores and the GCA are reported as standard scores ($M = 100$ and $SD = 15$). Refer to Table 3.3 for a description of the tests comprising the DAS battery and their CHC factor categorization (McGrew & Flanagan, 1998).

Table 3.3

Description of tests comprising the DAS battery

Test	Description
Core Battery:	
<i>Verbal Ability</i>	
Word Definitions (<i>Gc</i>)	Measures a child's ability to define vocabulary words. Each word is presented orally to the child, and the child is asked to state what each word means.
Similarities (<i>Gc</i>)	Two items are orally presented to the child, and the child is asked to give a response stating how the two items are alike.
<i>Nonverbal Reasoning Ability</i>	
Matrices (<i>Gf</i>)	The child is presented with a sequence of visually geometric patterns, and is asked to choose a picture that best completes the pattern of each task from several options.
Sequential and Quantitative Reasoning (<i>Gf</i>)	Each child is asked to deduce the next number in a numerical sequence that is presented visually. Each item contains a missing object, where the child must deduce the missing pattern based on the sequence of other objects.
<i>Spatial Ability</i>	
Recall of Designs (<i>Gv</i>)	A picture is visually presented to each child for five seconds. After the picture has been removed from view, the child is asked to draw the picture from memory.
Pattern Construction (<i>Gv</i>)	The child is asked to reproduce visually presented geometric patterns using colored blocks.

Table 3.3 (continued)

Description of tests comprising the DAS battery (cont.)

Test	Description
<i>Diagnostic tests:</i>	
Recall of Digits (<i>Gsm</i>)	The child is asked to repeat sequences of digits that are presented orally. Digits are presented at a rate of one per second, with the number of digits in each sequence increasing progressively.
Recall of Objects-Immediate (<i>Gsm</i>)	The child is asked to look at a card containing several different objects, then asked to orally recall the objects on the card after the pictures have been removed from sight.
Recall of Objects-Delayed (<i>Glr</i>)	The child is to orally recall the objects presented in the Recall of Objects-Immediate subtest after a period of delay and interference from other tests.
Speed of Information Processing (<i>Gs</i>)	The child is required to scan a set of simple numerical items for the largest number and mark the correct response.

Data Analyses

Pearson product moment correlation coefficients were calculated to examine the nature of the relationship between broad ability and cluster scores from each battery. Pair-wise t-tests comparing the broad ability cluster scores of each test were calculated in order to determine whether significantly different performance levels existed across the batteries. Further analysis of variance was conducted of the correlations between broad and cluster scores in order to determine the amount of shared variance of scores between each test battery.

Chapter IV

Results

The purpose of this study was to examine the concurrent validity between the cluster and broad scores of two contemporary intelligence assessment batteries, the Woodcock Johnson III Tests of Cognitive Ability (WJ III COG; Woodcock, McGrew, & Mather, 2001), and the Differential Ability Scales (DAS; Elliott, 1990). Thirty-one students in grades six, seven, and eight from Western Wisconsin and the Twin Cities metro area of Minnesota were recruited through announcements made at schools. Each student was administered the WJ III COG and the DAS in order to provide the data from which to base a comparison of the scores obtained on the two test batteries. The scope of this research was limited to examining the relationship of the broad General Conceptual Ability (GCA), cluster, and diagnostic subtests of the DAS with the broad General Intellectual Ability (GIA) score and Cattell-Horn-Carroll (CHC) factor scores of the WJ III COG.

Mean scores, standard deviations, Pearson product-moment correlation coefficients, and t-test techniques were utilized to examine the overall performance of participants in the sample and to examine the relationships between the two tests. Descriptive analyses are discussed first in this chapter, which includes the distribution of scores in terms of means, standard deviations, and skewness values. Results from correlation analyses are then summarized according to each respective research question. Discussion and implications for future research are outlined in Chapter V.

Descriptive Analyses

A summary of the means, standard deviations, and skewness values for the WJ III COG and the DAS subtest and cluster scores are outlined in Table 4.1 and Table 4.2, respectively. The

broad and cluster scores in this study generally followed a normal distribution pattern, with the exception of the *Gsm* and *Glr* clusters of the WJ III COG. The *Gsm* cluster had a negative skew, which indicates that there was a greater frequency of higher scores. Conversely, the *Glr* cluster had a positive skew, indicating a greater frequency of lower scores on this cluster for the obtained sample of students.

The mean WJ III COG scores were generally in the average range, with the exception of the *Gc* cluster. This was in the above average range for this sample of students. The standard deviation for the GIA-Ext. score (SD = 14.76) was similar to that which is reported in the Examiner's Manual (SD = 15) (Mather & Woodcock, 2001). Standard deviations of the cluster scores of the WJ III COG were also comparable to that reported in the Technical Manual (2001) (SD=15). An exception was the exception of the *Gv* cluster (SD=11.00), which was somewhat restricted.

The mean DAS GCA score was in the above average range. Similarly, the mean values for the Verbal Ability cluster and the Spatial Ability cluster were also in the above average range. The standard deviations for the DAS GCA score (SD=19.19) and Verbal Ability cluster (SD=18.94) were somewhat higher than that reported in the Technical Manual (SD=15) (Elliott, 1990a). The standard deviation for the Recall of Objects-Delayed subtest (SD=7.01) was also be restricted, as compared to the standard deviation for subtests in the Technical Manual (SD=10) (Elliott, 1990a).

Table 4.1

Means, standard deviations, and skewness values for the WJ III COG broad and cluster scores (N=31).

Test/Cluster	M	SD	Skewness
WJ III COG General Intellectual Ability-Extended (GIA-Ext.)	113.55	14.76	-.071
Comprehension-Knowledge (<i>Gc</i>)	119.61	18.29	-.164
Long-Term Retrieval (<i>Glr</i>)	103.19	14.95	1.022
Visual-Spatial Reasoning (<i>Gv</i>)	105.90	11.00	.111
Auditory Processing (<i>Ga</i>)	114.61	14.07	.054
Fluid Reasoning (<i>Gf</i>)	108.13	13.52	-.041
Processing Speed (<i>Gs</i>)	98.19	13.40	-.223
Short-Term Memory (<i>Gsm</i>)	109.00	12.09	-.583

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Table 4.2

Means, standard deviations, and skewness values for the DAS broad and cluster scores (N=31).

Test/Cluster	M	SD	Skewness
General Conceptual Ability (GCA)	118.0	19.19	-.427
Verbal Ability	118.58	18.94	-.229
Nonverbal Reasoning Ability	112.26	16.81	-.337
Spatial Ability	114.77	17.78	-.222
<i>Diagnostic Subtests:</i>			
Recall of Objects-Immediate	50.68	7.47	-.509
Recall of Objects-Delayed	48.48	7.01	-.067
Recall of Digits	52.00	11.75	.414
Speed of Information Processing	47.45	11.84	.509

Research Question One

What is the strength of the relationship between the broad scores of the WJ III COG and the DAS? How comparable are the mean scores between the broad factors of the WJ III COG and the DAS?

Pearson product-moment correlation coefficients were calculated between the broad ability scores of the WJ III COG and DAS. The correlation between the WJ III COG GIA Extended and DAS GCA scores ($r=.87$) was significant and suggests strong concurrent validity between the overall scores from each test. This correlation size suggests that 76% of the variance for both measures is shared. Comparisons of the overall mean scores of the WJ III COG GIA Extended ($M = 113.55$, $SD = 14.76$) and the DAS GCA ($M = 118$, $SD = 19.19$) indicated that on average, participants in this sample score 4.45 points higher on the DAS. A pair-wise t-test between the broad scores of the WJ III COG and the DAS indicated that the difference in the mean scores is significant ($t = -2.573$, $p < .05$).

Research Question Two

What is the level of concurrent validity between the cluster scores of the WJ III COG and the cluster scores and diagnostic subtests of the DAS?

Pearson product-moment correlation coefficients were also calculated between the cluster scores of the WJ III COG and the cluster scores and diagnostic subtests of the DAS. A number of correlations between the clusters of the two batteries were statistically significant; however, for a better understanding of the relationships between the tests, correlation findings for this study are discussed in terms of the size of correlation coefficients and amount of variance shared rather than significant levels alone. Correlation coefficients between the cluster scores of the WJ III COG and the cluster scores and diagnostic subtests of the DAS are reported in Table 4.3.

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Findings are discussed below in terms of relationships between cluster scores and relationships between WJ III COG CHC factors and DAS diagnostic subtests. Subtest correlation matrices are found in Appendix D.

Table 4.3

Correlations between cluster scores of the WJ III COG and cluster scores and diagnostic subtests of the DAS (N=31).

DAS	WJ III COG						
	<i>Gc</i>	<i>Glr</i>	<i>Gv</i>	<i>Ga</i>	<i>Gf</i>	<i>Gs</i>	<i>Gsm</i>
Verbal Ability	.83**	.53**	-.04	.54**	.58**	.28	.46**
Nonverbal Reasoning Ability	.58**	.61**	.19	.66**	.81**	.38*	.66**
Spatial Ability	.57**	.65*	.22	.65**	.64**	.37*	.62**
Recall of Obj.-Imm.	.23	.20	-.05	.35	.29	.39*	.13
Recall of Obj.-Delayed	.34	.27	.18	.31	.27	.38*	.17
Speed of Info. Processing	.10	.15	.35*	-.04	.35	.48**	.43*
Recall of Digits	.28	.45**	.14	.42*	.49**	.37*	.44**

** Correlation is significant at the .01 level (2-tailed test)

* Correlation is significant at the .05 level (2-tailed test)

Relationships Across Clusters

The Verbal Ability cluster of the DAS and the *Gc* cluster of the WJ III COG were most strongly related ($r=.83$, 69% shared variance). Moderate correlations also existed between the Verbal Ability cluster and the *Gf*, *Ga*, *Glr*, and *Gsm* clusters of the WJ III COG. As expected,

the *Gv* and *Gs* clusters of the WJ III COG were not strongly related to the Verbal Ability cluster of the DAS.

The Nonverbal Reasoning Ability cluster of the DAS demonstrated a similarly strong correlation with the *Gf* cluster of the WJ III COG ($r = .81$, 66% shared variance). Moderate relationships also existed between the Nonverbal Reasoning Ability cluster and several WJ III COG clusters including, *Ga*, *Gsm*, *Glr*, and *Gc*.

Similar to previous research, the WJ III COG *Gv* cluster was not strongly related to any of the DAS ability clusters, including the Spatial Ability cluster. Instead, the Spatial Ability cluster of the DAS was moderately related to the *Ga*, *Glr*, *Gf*, *Gsm* and *Gc* clusters of the WJ III COG.

In general, a pattern of discriminant and convergent validity emerged across the cluster score correlations. The pattern was reflective of expected relationships between WJ III COG CHC clusters and DAS ability clusters. However, the size of relationships across several clusters was somewhat higher than expected given previous research.

Relationship Between WJ III COG CHC Clusters and DAS Diagnostic Subtests

Unlike correlations at the cluster score level, correlations between the DAS diagnostic subtests and the WJ III COG clusters did not evidence convergent and discriminant validity as distinctly. Further, the size of relationships between the DAS diagnostic subtests and WJ III COG clusters were not as strong.

The Speed of Information Processing subtests did demonstrate its strongest relationship with the WJ III COG *Gs* cluster ($r = .48$, 23% shared variance). However, it was also moderately correlated with the *Gsm* cluster ($r = .43$). The Recall of Digits subtest was moderately related to several WJ III COG clusters including *Gf*, *Gsm*, *Glr*, and *Ga*. The

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strongest relationships between the Recall of Objects-Immediate and Recall of Objects-Delayed subtests were with the *Gs* cluster of the WJ III COG ($r = .39, .38$ respectively); however, these relationships accounted for 15% and 14% of shared variance respectively.

Chapter V

Discussion

Prior to the current study, only one published study (McIntosh & Dunham, 2001) examined the relationship between the Woodcock Johnson III Tests of Cognitive Abilities (WJ III COG; Woodcock, McGrew & Mather, 2001) and the Differential Ability Scales (DAS; Elliot, 1990). Further, no information is presently available to compare the DAS diagnostic subtests with Cattell-Horn-Carroll (CHC; McGrew, 1997) factors from the WJ III COG (McGrew & Woodcock, 2001). Thus, further research with regard to the nature of abilities measured by the WJ III COG and the DAS is needed. The present study adds to the literature on the relationship between the WJ III COG and other intelligence batteries. It also extends practitioners knowledge of the utility of the DAS diagnostic subtests by comparing them to constructs representative of current intellectual theory, i.e., the WJ III COG CHC cluster scores (Woodcock, McGrew, & Mather, 2001).

The purpose of this study was to examine the concurrent validity between the WJ III COG and another commonly used assessment tool, the DAS. Specifically examined was the concurrent validity between the broad ability scores of both tests as well as the CHC clusters of the WJ III COG with the clusters and diagnostic subtests of the DAS. The following chapter discusses the findings with regard to each research question. In addition, limitations of the present study and implications for future research are presented. Thirty-one students from the Twin Cities metropolitan area and Western Wisconsin participated in this study. Students who participated were in grades six, seven, and eight at the time they were administered the WJ III COG and the DAS. Each student involved in the study was of Caucasian descent. Parent education levels for the participants was predominantly college or higher. Overall, a greater

number of males than females participated in the study. Given that the obtained sample of participants was not as diverse as desired on characteristics of geographical region, ethnicity, parent education levels, grade, and gender, and that the mean performance of participants was in the above average range, generalization of findings from the study is limited. The findings are best interpreted as representative of average to above average ability, Caucasian, middle school-age children with college educated parents.

Participants were administered the WJ III COG tests contributing to the CHC clusters, along with the core and diagnostic subtests of the DAS. Students were administered both test batteries within a two-week time frame in counter-balanced order to avoid practice effects. Correlation coefficients of the broad scores were examined to determine whether the WJ III COG and the DAS are measuring similar broad factors of intelligence. Mean overall scores were also compared to determine whether students obtained similar overall scores on each battery. Correlation coefficients of the CHC clusters of the WJ III COG and the cluster and diagnostic subtests of the DAS were also compared to determine whether similar abilities are being measured within the respective cluster areas according to the theoretical underpinnings of each test.

Research Question One

Previous research (Flanagan et al., 2001; Phelps, 2001) provides support for the General Intellectual Ability (GIA) score of the WJ III COG as a measure general intelligence as it is positively correlated with broad ability scores from several commonly used intelligence tests. Concurrent validity of the WJ III COG and the DAS was also examined in a study conducted by McIntosh and Dunham (2001). Findings suggest that the WJ III COG is least like the Cognitive

Assessment System (CAS; Naglieri & Das, 1997), while being more similar to the DAS and WISC-III in terms of abilities measured.

Results of the present study are consistent with previous research stating that the WJ III COG GIA-Ext. score is strongly correlated with the DAS General Conceptual Ability (GCA) score. The overall correlation suggests 76% shared variance across the two tests. With this, these results indicate that the broad factors of the WJ III COG and the DAS are strongly related to one another in a theoretical sense. The degree of relationship was higher than that reported in previous studies, however. This may be reflective of an overall pattern of average to above average scores by participants.

Similarly, the mean score of the DAS was 4.45 points higher in this study than that of the WJ III COG, which also parallels differences in the mean scores between the WJ III COG and the DAS in the McIntosh and Dunham study (2001). Differences in mean scores may be attributed to the Flynn Effect, which implies that mean IQ scores tend to rise by an average of three points per decade (Flynn, 1984). Due to the fact that the DAS was standardized approximately ten years earlier than the WJ III COG, the Flynn Effect may account for this difference in the mean scores. When this adjustment is taken into account, no significant difference exists between the mean scores of each test battery.

Research Question Two

Results of this study showed a strong relationship between the *Gc* cluster of the WJ III COG and the Verbal Ability cluster of the DAS, which was expected given the nature of abilities measured within each cluster. Similar results were found in the relationship between the *Gf* cluster of the WJ III COG and the Nonverbal Reasoning Ability cluster of the DAS, which again was consistent with expectations. A weak relationship between the *Gv* cluster of the WJ III COG

and the Spatial Ability cluster of the DAS contradicted expected findings, although it was similar to findings reported in the McIntosh and Dunham study (2001) where a weak relationship between these two measures was also evidenced.

Among the subtests of the DAS, weak relationships were found between the Recall of Objects-Immediate subtest with the *Gsm* cluster of the WJ III COG, as well as the Recall of Objects-Delayed subtest with the *Glr* cluster of the WJ III COG. These results contradicted expected findings. Moderate relationships were found, however, between the Speed of Information Processing subtest of the DAS with the *Gs* cluster of the WJ III COG and the Recall of Digits subtest with the *Gsm* cluster of the WJ III COG, which converged somewhat with expected findings. Further discussion of these findings will be discussed in the following section.

Relationships among cluster scores.

Concurrent validity for the *Gc* cluster of the WJ III COG was established by a substantial amount of overlap with the Verbal Ability cluster of the DAS. At the test level, the *Gc* cluster of the WJ III COG is defined as measuring lexical knowledge, language development, verbal reasoning, and general information, which appears to be comparable to verbal abilities measured by the DAS. The relationship between verbal factors on the WJ III COG and the DAS is similar to the strong relationship of the WJ III COG *Gc* cluster with the Verbal IQ and Verbal Comprehension Index of the WISC-III (Wechsler, 1991). This provides further support for the *Gc* cluster as a sound measure of verbal reasoning and comprehension. The moderate correlations of the *Gc* cluster with the Nonverbal Reasoning Ability and Spatial Ability clusters of the DAS are also similar to previous research (McIntosh & Dunham, 2001), and suggest that in general, higher level cognitive abilities tend to be somewhat more strongly related (Horn & Noll, 1997).

Results from this study also support a strong relationship between the WJ III COG *Gf* cluster with the Nonverbal Reasoning Ability cluster of the DAS, which suggests that similar inductive and deductive reasoning abilities are being measured by each test. Moderate correlations between the *Gf* cluster and the Verbal Ability and Spatial Ability clusters of the DAS were also found, which is similar to the pattern of relationships reported in the McIntosh and Dunham study (2001). Similarities may be due to indices of verbal reasoning within the Verbal Ability cluster of the DAS, along with measures of visual reasoning within the *Gf* cluster of the WJ III COG that are similar to those of the DAS at the subtest level. However, the overall strength of correlations between the *Gf* cluster and DAS ability clusters were stronger than previously reported.

Consistent with previous research (McIntosh & Dunham, 2001), the *Gv* cluster of the WJ III COG and the Spatial Ability cluster of the DAS were not significantly related to one another. Similarly, the *Gv* cluster of the WJ III COG does not appear to be related to visual-spatial abilities measured within the WISC-III (Phelps, 2001). One interpretation of this may be that the *Gv* cluster is measuring visual-spatial abilities that are unique to the WJ III COG test battery. As such, the *Gv* cluster measures specific visual-abstract reasoning abilities that are not contained within the DAS battery, which may help explain the weak relationship between the two clusters. Examination of the specific abilities comprising these clusters shows that visual memory is measured within each cluster. However, the tasks of the DAS appear to contain more indicators of visual-motor integration and working memory, which is evidenced by stronger correlations with tests measuring these abilities within the WJ III COG. Similarly, the tests comprising the *Gv* cluster of the WJ III COG correlated more strongly with subtests measuring visual reasoning and short-term memory within the DAS, providing support of the overlap for these abilities

within the WJ III COG and the DAS. This may also support moderate correlations between the DAS Spatial Ability cluster with the *Gf* and *Gsm* clusters of the WJ III COG.

The WJ III COG *Glr* cluster was moderately related to both the DAS Spatial Ability and Nonverbal Reasoning Ability clusters. This finding was unanticipated given a lack of similar findings in previous research with the WJ III COG and WISC-III and the fact that the DAS ability clusters are not defined as measures of memory skills. This may be due in part to similarities in the measurement of abstract perceptual tasks that are presented in subtests within both the *Glr* cluster and Spatial and Nonverbal Reasoning Ability clusters. The *Glr* cluster also measures coding, cognitive speed, retrieval, and fluency measures that are also measured within the Spatial Ability cluster of the DAS.

Patterns of discriminant validity were expected between the *Ga* cluster of the WJ III COG with the DAS clusters, given that the DAS lacks a specific measure of auditory processing. However, moderate correlations were found between the Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability clusters of the DAS. While this could be interpreted as an indication that the *Ga* tests were also influenced by language, visual-spatial, and reasoning abilities, such a conclusion is unlikely. In previous research, the WJ III COG *Ga* factor was not found to be strongly related to similar cluster scores from other tests. Instead, unique features of the performance of individuals in the present sample have likely influenced the findings.

Moderate relationships between the WJ III COG *Gsm* cluster and the Nonverbal Reasoning Ability and Spatial Ability clusters of the DAS were found in this study. This was stronger than those reported by McIntosh and Dunham (2001), and contrary to expectations for the study. Given that the Nonverbal Reasoning Ability cluster of the DAS measures sequential patterns that are similar to those measured within the *Gsm* cluster of the WJ III COG, moderate

correlations may be expected between the two clusters. Similarly, the Spatial Ability cluster of the DAS also contains a measure of short-term memory within the Recall of Designs subtest that may also explain the relationship with the *Gsm* cluster.

Finally, weak relationships between the DAS Verbal Ability, Nonverbal Reasoning Ability, and Spatial Ability clusters and the WJ III COG *Gs* cluster supports the discriminant validity of the *Gs* cluster from measures of verbal, spatial, and reasoning abilities.

Relationships between DAS diagnostic subtests and WJ III COG CHC clusters.

Strong correlations were expected between the Recall of Objects-Immediate subtest of the DAS with the *Gsm* cluster of the WJ III COG, as they are both purported to measure short-term memory abilities. However, the results of this study imply that are weakly related to one another. Differences at the subtest level of each cluster suggest that the abilities measured diverge from one another in that the *Gsm* cluster provides a measure of working memory and memory span where tasks are worked though orally. The Recall of Objects-Immediate subtest, which does tap memory ability, includes a visual prompt with an oral response. This suggests that different short-term memory abilities are being sampled within each test battery. A stronger, albeit moderate, relationship with the *Gs* cluster of the WJ III COG suggests that the Recall of Objects-Immediate subtest of the DAS may also be an index of cognitive fluency and attention. However, further research is needed to clarify the nature of this relationship between the WJ III COG and the DAS.

A similar moderate correlation was found between the Recall of Objects-Delayed subtest of the DAS with the *Gs* cluster of the WJ III COG, providing support for measures of cognitive speed within this subtest. This corresponds with the nature of the task, which requires students to complete the task within a specified time limit. With this, a student's ability to sustain attention

completing the Recall of Objects-Delayed subtest may also be similar to the tasks of the *Gs* cluster, which may account for the correlation between factors. Correlations were weak with the *Glr* cluster of the WJ III COG, which contradicted expected results. However, examination of the specific subtests contributing to these measures shows that the tasks of the *Glr* cluster contain visual-associative tasks, which departs from those of the Recall of Objects-Delayed subtest of the DAS. Weak correlations were also evidenced in the relationship between the Recall of Objects-Delayed subtest and the other CHC clusters of the WJ III COG, supporting the discriminant validity of the subtest.

The moderate relationship between the Speed of Information Processing subtest of the DAS with the *Gs* cluster of the WJ III COG suggests that measures of perceptual speed and attention abilities are contained within each cluster. The Speed of Information Processing subtest of the DAS also correlated moderately with the *Gsm* cluster of the WJ III COG. The significance of the correlation between these clusters also suggests overlap in the measurement of cognitive fluency. The moderate correlation of the Speed of Information Processing subtest of the DAS with the Retrieval Fluency test of the WJ III COG, another measure of cognitive fluency, further provides support of this relationship. This in turn is similar to the relationship between the *Gsm* cluster with the Freedom from Distractibility index of the WISC-III in previous research (McGrew & Woodcock, 2001), which is derived from measures of mental operations and short-term memory abilities.

The Recall of Digits subtest of the DAS correlated moderately with the *Glr*, *Ga*, *Gf*, and *Gsm* clusters of the WJ III COG. Examination of the tasks between the Recall of Digits subtest with these clusters shows similarities between measures of attention, concentration, and memory span within the Auditory Attention, Analysis-Synthesis, Retrieval Fluency, Numbers Reversed

tests of the WJ III COG. Further analysis of the relationship between the Recall of Digits subtest with tests of the WJ III COG showed a weak relationship with the Memory for Words test, which was unexpected due to the fact that they are both designed to measure short-term memory abilities. This could be due to differences in the tasks, as this information is presented numerically within the Recall of Digits subtest and lexically within the Memory for Words test. However, further research is needed to clarify the nature of this weak relationship. Weak correlations between the Recall of Digits subtest with the *Gc* and *Gv* clusters support that comprehension and abstract-visual abilities are not measured within this subtest of the DAS.

Conclusions and Implications for Further Research

The results of this study indicate that the WJ III COG and the DAS are measuring similar broad constructs from a theoretical standpoint. However, they may yield different global scores, as scores obtained on the DAS tend to be significantly higher than those of the WJ III COG. The Flynn Effect may cause this difference, as the DAS was standardized ten years earlier than the WJ III COG. With this, scores in general may be slightly higher than on newer test batteries (Flynn, 1984). In general, the DAS clusters correlated most strongly with the anticipated factors of the WJ III COG, supporting interpretation of the DAS clusters from a CHC framework. However, clusters measuring visual-spatial skills on both test batteries appear to diverge significantly from one another. Further research examining the relationship between the WJ III COG *Gv* factor and additional measures of visual-spatial ability are needed to determine the nature of abilities measured within this factor.

Although the *Ga* and *Glr* clusters evidenced moderate concurrent validity with the clusters of the DAS, these factors appear to measure abilities that are unique to the WJ III COG battery. Additional research is needed to substantiate the relationship of these factors with other

measures of cognitive abilities, as well as what abilities contribute to performance on these clusters. This also helps to define whether the WJ III COG adequately measures the factors that contribute to current CHC theory.

The results of this study imply that the diagnostic subtests of the DAS are not strongly related to the CHC clusters of the WJ III COG. This suggests that the diagnostic subtests may be mixed measures of CHC abilities. However, issues such as attention, cognitive fluency, and working memory may contribute to the differences in scores between these subtests; therefore, further research examining the extent to which these issues may impact performance may yield more information regarding the nature of the relationship between these factors of ability. Further, it appears from the size of correlations found in this study that the diagnostic subtests of the DAS are mixed measures of short-term memory, long-term memory, and processing speed. Additional research is needed to clarify the specific abilities measured within these subtests. With this, little published research has examined the diagnostic subtests with abilities measured within other intelligence batteries. More research investigating the nature of abilities measured within these subtests would help to clarify this question. This in turn aids practitioners in determining whether the diagnostic subtests are useful for measuring various academic needs in children.

Limitations of the Study

Limitations of the study with regard to sample characteristics were described earlier in this chapter. A larger sample size with a greater diversity of participants would provide results that may potentially generalize to a greater population of students. In addition, the results of this study are limited by the fact that no special education students were asked to participate in testing. With this, the distribution of scores tended to be in the average to above-average range of

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ability. Greater representation of ability in the sample would aid in providing greater interpretation of results that are not limited by restricted range. Lastly, this study focused only on the CHC factors of the WJ III COG, whereas research involving the entire battery may aid in understanding the relationship of the broad factor, clusters, and subtests with other intelligence batteries.

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Appendix A

WJ III COG/DAS Study
Demographic Data

Identification Number: _____

Birthdate: _____

Age: _____

School: _____

Grade: _____

Gender: _____ Male
 _____ Female

Ethnicity: _____ Caucasian
 _____ African-American
 _____ Hispanic
 _____ Asian
 _____ Native American
 _____ Other (please specify _____)

What is the highest educational level of the child's **mother/female guardian**?

- _____ less than high school (please specify highest grade completed __)
- _____ high school graduate or GED
- _____ technical school
- _____ some college
- _____ bachelor's degree
- _____ some graduate school
- _____ graduate school (please specify degree completed _____)

What is the highest educational level of the child's **father/male guardian**?

- _____ less than high school (please specify highest grade completed __)
- _____ high school graduate or GED
- _____ technical school
- _____ some college
- _____ bachelor's degree
- _____ some graduate school
- _____ graduate school (please specify degree completed _____)

Appendix B

Description of the Study

INFORMED CONSENT FORM

This research examines how comparable intelligence instruments are in the cognitive abilities they are designed to assess. The goal of this study is to administer two popular intelligence instruments widely used in schools, the Woodcock Johnson-Third Edition Tests of Cognitive Ability and the Differential Ability Scales, in order to evaluate the comparability of the cognitive abilities measured by each instrument. Before participating in this study, we are requesting that you read and sign the consent form, indicating that you understand the potential benefits and risks of participating in this study, as well as your rights as a participant. If you have any questions, please contact Karen Pauly, the primary researcher, at 952-466-9993.

PROCEDURES

Each student will be administered two intelligence tests, the Woodcock Johnson-Third Edition Test of Cognitive Ability and the Differential Ability Scales. Each administration will take approximately two and one-half hours. Each test will be administered at your child's school after school hours.

RISKS

There is no risk for participating in this study. All results are kept completely confidential and all participants will remain anonymous in the final analysis of the study.

BENEFITS

The results of this study will benefit those working in schools in supporting whether or not these tests are useful in educational decision-making. Parents can have their child's results made available to them upon request. Any child who demonstrates academic need based on the results of these assessments can have the option of have appropriate referrals made for support services.

CONFIDENTIALITY OF RESPONSES

All results from this study will be kept completely confidential. Each student will be assigned a code number to protect their identity. Only the primary researcher and her designee will have access to the original data.

RIGHT TO WITHDRAW OR DECLINE TO PARTICIPATE

Your child's participation in this study is completely voluntary. Your choice to participate will not have any adverse consequences to you or your child. In the event that you choose to participate and later withdraw from the study, there will be no adverse consequences from doing so.

NOTE: Questions or concerns about participation in the research or subsequent complaints should be addressed first to the researcher or research advisor and second to the Chair of the Institutional Review Board for the Protection of Human Subjects in Research, 11 HH, UW-Stout, Menomonie, WI, 54751, (715) 232-1126.

I attest that I have read and understand the above, including potential risks, benefits, and my rights as a participant in this study, and that my questions regarding this study have been answered to my satisfaction. I hereby give my informed consent to participate in this study.

Signature _____

Date _____

Appendix C

Letter of Permission

Dear Parent:

I am a graduate student in the School Psychology training program at the University of Wisconsin-Stout. Currently, I am obtaining data for my specialist's thesis. The purpose of the study is to examine the differences in cognitive abilities in children. This is important for professionals who work with children in providing appropriate educational services according to a child's academic abilities.

I would like to ask for your permission for your child to participate in this study. This involves administering two intelligence assessments to your child. These are the Woodcock Johnson III Tests of Cognitive Abilities and the Differential Ability Scales. Administration of these assessments will take approximately two and one-half hours.

Children who participate in this study will be kept completely anonymous. Only the scores received by each child will be recorded along with any pertinent demographic data to ensure confidentiality.

If you would like more information about this study, please complete this form and return it to your child's teacher. You will be contacted shortly thereafter with any further information about the nature of the study and your child's participation. If you have any questions, feel free to contact me at 952-466-9993, or contact the University of Wisconsin-Stout at 715-232-2211.

Thank you,

Karen Pauly
University of Wisconsin-Stout

Please contact me regarding this study

Child's name _____

The best time to reach me is:

- Morning
 Afternoon
 Evening
 Other (please specify)

Phone Number: _____

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Appendix D

Subtest Correlation Matrices

DAS	WJ III COG						
	Verbal Comp.	Visual- Aud. Learning	Spatial Relations	Sound Blending	Concept Formation	Visual Matching	Numbers Reversed
Recall of Designs	.41*	.48**	.40*	.51**	.43*	.45*	.68**
Word Defintions	.75**	.44*	.36*	.38*	.44*	.24	.33
Pattern Construction	.53**	.55**	.45*	.56**	.51**	.46**	.46**
Matrices	.34	.38*	.47**	.48**	.67**	.47**	.66**
Similarities	.74**	.45*	.39*	.53**	.46**	.27	.45*
Sequential and Quantitative Reasoning	.57**	.57**	.50**	.60**	.62**	.42*	.62**
Recall of Digits	.25	.36*	.35	.33	.40*	.38*	.53**
Recall of Obj.-Imm.	.12	.14	.03	.19	.23	.41*	.24
Recall of Obj.- Delayed	.31	.19	.22	.23	.16	.41*	.21
Speed of Information Processing	.10	-.01	.11	-.04	.34	.41*	.34

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)

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Appendix D

Subtest Correlation Matrices (cont.)

DAS	WJ III		COG				
	General Information	Retrieval Fluency	Picture Recognition	Auditory Attention	Analysis-Synthesis	Decision Speed	Memory for Words
Recall of Designs	.51**	.35	.01	.35	.67**	.06	.32
Word Definitions	.75**	.39*	-.27	.38*	.54**	.19	.31
Pattern Construction	.58**	.65**	-.06	.44*	.50**	.13	.38*
Matrices	.51**	.54**	-.05	.37*	.77**	.19	.39*
Similarities	.82**	.43*	-.30	.32	.48**	.16	.33
Sequential and Quantitative Reasoning	.68**	.49**	-.16	.44*	.60**	.07	.33
Recall of Digits	.28	.51**	-.06	.40*	.49**	.23	.20
Recall of Obj.-Imm.	.32	.28	-.08	.55**	.29	.24	-.02
Recall of Obj.-Delayed	.34	.37*	.07	.35	.36*	.22	.06
Speed of Information Processing	.09	.51**	.34	-.01	.28	.40*	.336

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)