2019

PREDICTING ACADEMIC ACHIEVEMENT WITH THE KAUFMAN ASSESSMENT BATTERY FOR CHILDREN—SECOND EDITION

amy cherry

PREDICTING ACADEMIC ACHIEVEMENT WITH THE KAUFMAN ASSESSMENT BATTERY FOR CHILDREN—SECOND EDITION

A Specialty Study

Presented to

the Faculty of the Department of Educational Studies, Leadership, and Counseling

Murray State University

Murray, KY

In partial fulfillment

of the requirements for the Degree of

Specialist in Education

by

Amy Cherry

November 2019

PREDICTING ACADEMIC ACHIEVEMENT WITH THE KAUFMAN ASSESSMENT

BATTERY FOR CHILDREN—SECOND EDITION

DATE APPROVED:_________________________

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Director of Specialty Study

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Member, Specialty Committee

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Member, Specialty Committee

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College Graduate Coordinator

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Dean of the College

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University Graduate Coordinator

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Provost

ABSTRACT

Intelligence progresses in measurable and predictable stages and IQ tests are used to test basic intellectual functioning, such as conceptual thinking, language, and problem solving. The IQ test is used to diagnose developmental disabilities as well as learning disabilities and intellectual disabilities in schools. School aged children may be given an IQ test to determine eligibility and placement for special education services and to pinpoint specific deficits and/or strengths. Part of the strength of using IQ tests is their ability to predict specific attributes, such as academic skills and adaptive skills. However, these correlations change with the child’s age. Understanding these predictions can help eligibility determination, particularly for learning disorders. The purpose of this study was to investigate these changing IQ/achievement predictions in 150 school-aged children, all of whom were referred for special educational testing. Correlations and multiple regression were used to test the hypotheses.

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION

Intelligence testing has been around for over a hundred years. During that time there have been numerous schools of thought as to the best way to assess cognitive abilities. The first test resembling a modern intelligence test (IQ) was developed around the turn of the 20th century by Alfred Binet. He designed a series of questions which he thought children of different ages could answer correctly, and which could distinguish those with special needs from those without. "His test was based on the assumption that intelligence developed with age" (Stough, 2015, p. 62).

Intelligence and intelligence testing has been studied most where it was invented and utilized, mostly in established market economies and mostly in the United States (Grigorenko & Bundy, 2001). Since "IQ is a culturally, socially and ideologically rooted concept" (Grigorenko & Bundy, 2001, p. 6) its predictive qualities are based on the constructs with which the culture defines as success. Tests of intelligence were originally designed to predict educational achievement and indeed they do a good job of predicting. Correlations between IQ scores, achievement test scores, and grades in an educational setting are between .40 -.50 on average (Grigorenko & Bundy, 2001). McGrew and Knopik (1993) noted that correlations between achievement and IQ tend to increase with age.

In schools, a specific use of IQ tests is to help in determining if a child has a specific learning disorder (SLD). According to IDEA, SLD is defined as: 1) The child does not achieve adequately for the child's age or to meet state approved grade-level standards in one or more of the following areas, when provided with learning experiences and instruction appropriate for the child's age or state-approved grade-level standards: oral expression, listening comprehension, written expression, basic reading skills, reading fluency skills, reading comprehension, mathematics calculation, and mathematics problem solving. 2) The child does not make sufficient progress to meet age or state-approved grade-level standards in one or more of the areas above when using a process based on the child's response to scientific, research-based intervention; or the child exhibits a pattern of strengths and weaknesses in performance, achievement, or both, relative to age, state-approved grade-level standards, or intellectual development, that is determined by the group to be relevant to the identification of a specific learning disability, using appropriate assessments, and 3) the findings are not primarily the result of a visual, hearing, or motor disability, intellectual disabilities, emotional disturbance, cultural factors, environmental or economic disadvantage, or limited English proficiency (Individuals with Disabilities Education Act [IDEA], 2004).

Currently, the most researched and validated theory of intelligence is Cattell-Horn-Carroll theory or CHC (McGgrew, 2005). The CHC model postulates the existence of eight factors or constructs. Using this model, most IQ tests and their respective factors reliably predict academic achievement (McGrew, 2005). Since poor academic skills are the hallmark characteristic of specific learning disabilities, it is important to determine which CHC factors best predict specific academic deficits. Ideally, knowing this prediction, schools will have a better understanding of how to identify SLD and how to intervene.

Purpose of the Study

This study was designed to determine which factors from the Kaufman Assessment Battery for Children, Second Edition, (KABC-2) best predicted academic skills and to determine if these predictions changed from elementary to high school. It was hypothesized that the association between the Visual Processing factor from the KABC-2 and the math reasoning and math computation tests from the Woodcock Johnson Test of Achievement, Fourth Edition (WJ-IV Ach) would increase with age. It was also hypothesized that the Crystallized and Long-Term Retrieval factors would predict reading and writing achievement and that these associations would change from elementary to high school.

Significance of the Study

Results from this study should help inform eligibility for learning disabilities in schools. Specifically knowing correlations between cognitive test scores in specific areas and achievement should provide meaningful data to help with determining eligibility for special education services for SLD and help inform treatment and the quality of a student's Individualized Education Plan (IEP). Using results from cognitive and achievement tests, while understanding predictability statistics by age, educators should be in a position to create IEPs for students that are more personalized and effective.

Terms and Definitions

- CHC Model: This is a theory of intelligence developed by Raymond Cattell, John Horn, and John Carroll. This theory is a comprehensive taxonomy of multiple abilities that are overlapping theories of cognition (Flanagan & McDonough 2018). The CHC abilities that relate to the content of intelligence batteries used in this study include Fluid Reasoning

(Gf), Comprehension-Knowledge or Crystallized Intelligence (Gc), Visual-Spatial ability (Gv), and Long-Term Storage and Retrieval (Glr).

- Specific Learning Disability: The Individuals with Disabilities Education Act (IDEA) defines a specific learning disability as “a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations.” (IDEA Sec. 300.8 (c) (10)). The deficits are not the result of visual, hearing, or motor disabilities, due to intellectual disability, or emotional disturbance, or due to environmental, cultural, or economic disadvantage.
- Discrepancy Model: The IQ/achievement discrepancy model is the traditional way of assessing whether or not a student has a Specific Learning Disability by determining if there is a significant difference between a student’s scores on a test of general intelligence and their score on a test of academic achievement.
- RTI Model: Response to Intervention (RtI) refers to a process that places emphasis on how well a student responds to meaningful changes in instruction. A critical element of the RtI approach includes the provision of scientific, research-based instruction and interventions within the student’s general education program. It also includes the monitoring and measurement of student progress in response to the instruction and interventions. The data gleaned from these progress measurements are used to develop instruction and make educational decisions. A student is identified as having a Specific Learning Disability under this model if he or she displays insufficient response to intervention (Reschly & Hosp, 2004).

- Information Processing Model: This model, used to identify children with SLD, takes advantage of the existing predictive characteristics within the IQ test and between the IQ test and the academic area of concern. Rather than focusing on a large discrepancy between the child's IQ and an academic area like the discrepancy model, SLD is determined when there are unexpected discrepancies among CHC factors within the IQ and between the CHC factor(s) and the academic deficit (Restori & Howard, 2009).
- KABC-2: Kaufman Assessment Battery for Children, 2nd Edition is a comprehensive, individually administered, and norm-referenced cognitive ability test for children ages three to eighteen (Kaufman & Kaufman, 2014). The KABC-2 provides a Fluid/Crystallized cognitive index score (which is comparable to the traditional IQ score) as well as a number of additional scores that represent different cognitive functions or CHC factors, such as memory, reasoning, and verbal comprehension. Index scores on the KABC-2 have a mean of 100 and a standard deviation of 15. Scores 85 to 115 are considered "average" (Kaufman & Kaufman, 2018).
- WJ-IV Achievement: The Woodcock-Johnson IV Tests of Achievement (W-J IV) is an individually administered, norm-referenced test of reading, math, and writing achievement used to determine a student's academic strengths and weaknesses and to assist in educational programming. The standard scores have a mean of 100 and a standard deviation of 15. Scores 90 to 110 are considered "average" (Villarreal, 2015).

CHAPTER TWO: REVIEW OF LITERATURE

In this chapter the Piagetian Model of cognitive development will be discussed. Particular attention will be given to the progression of skills, from basic to applied, and how that affects teaching and learning. The Cattell-Horn-Carrol model (CHC) of intelligence and SLD eligibility models will be compared and contrasted.

Piagetian Model

Piaget developed a theory of cognitive development in 1936 (Ginsburg & Opper, 1988). His theory explains how a child's mental model of the world is created and constructed. He disagreed with the idea that intelligence was a fixed trait, and defined cognitive development as a process involving the child's interaction with their environment and their biological maturation. In the 1920's, Piaget was involved in developing French versions of English intelligence test questions. During this process, he became intrigued by the reasons given by test subjects for their wrong answers. Specifically of interest was their reaction to those test questions requiring logical thinking. Piaget's belief that these incorrect answers revealed important differences between the thinking of adults and children and eventually led to his theoretical model that included specific stages of learning new skills while integrating prior knowledge. Piaget's stages are described below (2004).

Sensorimotor Period: This is an important period from birth to about two years. This stage involves mainly physical action patterns and reflexes. The actions that glean results that a child finds interesting tend to get repeated and eventually become the norm, or a habit, such as thumb-sucking. Children's curiosity drives them at this stage and familiar surroundings are the main focus. Piaget especially noted that children take a special interest in things that are "moderately novel" – not completely new and strange, nor thoroughly familiar. "The object of attention must evidently be slightly discrepant from familiar objects, but not too much so (as it) must bear some relationship to the child's existing schemes." (Ginsburg & Opper, 1988, p. 39). This is also a period where children begin to imitate sounds made by adults or other people/things in their environment – a kind of "vocal contagion" (Ginsburg & Opper, 1988, p. 40). Reality to a child, during this period, is made up of the objects that are in plain sight or physical contact. Objects are there for the moment but then it is as though they cease to exist when they are out of sight or touch. At 4 to 10 months old baby's interest in the environment begins to extend. They become aware of interesting effects their own behaviors can have on their environment and the child learns to anticipate that desired effect. Piaget did not fully characterize such behavior as intelligence due to the activity being more of a discovery through the process of trial and error rather than a deliberate act directed achievement of a goal (Ginsburg & Opper, 1988). However, between 8 and 12 months, a child's behavior becomes more willful and goal driven. Another pivotal development at this stage is the concept of object permanence. In earlier stages, objects that were not within sight seemed not to exist; but now, a child seeks out objects they cannot immediately see. From 12-18 months, children become more intrinsically motivated without adult encouragement. And a bit later, in the final stage of this period, symbolic thought begins. Piaget did not believe that thinking requires communication in the form of language as evidenced in some of a child's earliest thought consisting of the non-linguistic use of symbols. The sensorimotor period is when a child begins imitating behavior and then gradually becomes adept at “deferred imitation (imitating an act that was observed on a prior occasion)” (Ginsburg & Opper, 1988, p.48). In addition, it is during this final state of the sensorimotor period the sense of object permanence is firmly established.

Preoperational Period: At this stage, the 2-7 year old child is able to form “mental representations of ideas and events, although they are not very logical or well organized” (Ginsburg & Opper, 1988, p.50). Mental representations of physical movements increase in the preoperational stage and they become more sophisticated. The preoperational child’s physical movement and reasoning increase and gradually gain sophistication. Deductive reasoning skills are still underdeveloped during this stage and thoughts are not logical and only loosely linked (Ginsburg & Opper, 1988).

Concrete Operational Period: Between ages 7 and 11 the child’s thought becomes more logical, but remains concrete for the most part. Also, during this stage, a child begins to understand the concept of identity. Piaget believed that grasping these concepts are part of innate abilities developed through a child’s experimentation. In reference to social skills, cooperation and compromise are learned during this period. Arguments and disagreements between individuals are a natural part of the process and ultimately allow a person to see another’s point of view, however, the preoperational child is unable to focus on the dual aspects of the situation. This can be problematic because they cannot deal simultaneously with the individual pieces and the whole.

Formal Operational: From the age of 11 to adulthood there is much development and evolution. Early on in this period, a child lacks the ability to handle abstract or hypothetical thinking. Understanding abstract and/or nonexistent objects requires a level of understanding that is quite a leap compared to the understanding at the concrete operational stage which involves relations among tangible objects. Adolescent's reasoning continues to develop and is much like an adult; however, thinking at this early stage is more self-focused than later in adulthood. "Particularly in the early teenage years youngsters tend to exaggerate their own importance, or become excruciatingly self-conscious, thinking that others, an imaginary audience, notice every physical blemish or shortcoming (Elkind & Bowen, 1979, p.40).

Curriculum Progression

Although Piaget's theory was not specifically constructed to develop educational practices, much research explains how features of his theory can be applied to teaching and learning. Piaget's model has been a cornerstone in much educational and curriculum development. The Plowden Report was published in 1967 as a review of primary education. In it were recurring themes focused on learning independently through play and discovery, curriculum flexibility and the importance of varied methods of progress evaluation (Mccleod 2018).

In Piaget's theory, readiness is based upon biological maturation and stages. There are different stages of development and Piaget based his theory on the idea that an individual should only be taught certain concepts at specific stages (McCleod 2018). According to Piaget (1958), assimilation and accommodation require an active learner, not a passive one, because problem-solving skills cannot be taught, they must be discovered. Based on these principles, teaching of students should be primarily focused on the process of learning, rather than the end result. Primary instructional goals, according to Piaget's model include: using collaborative, as well as individual activities (so children can learn from each other), devising situations that present useful problems, creating disequilibrium in the child, and evaluating the level of the child's development so suitable tasks can be set.

When learning progressions are organized by grade level this is sometimes known as grade-level expectations or grade-level standards. While curriculum progressions are typically organized by grade level or grade spans in the United States, some advocate that educational progress should be based more on the individual. Centered on an individual's ability, a faster or slower pace may be necessary in order to learn the required material and demonstrate proficiency. An example of this might be an 11-year-old student, who would usually be enrolled in sixth grade, is capable of doing eighth-grade math, the student should be held to the appropriate learning standards and taught at an eighth-grade level regardless of his or her age.

There is a debate, among mostly educators, researchers and educational experts, as to whether learning progressions are actually learning progressions, or whether they are merely content progressions or teaching progressions (Duncan & Hmelo-Silver, 2009). The main topic of discussion is that standards are created by adults who have only a limited understanding of how students actually learn and develop cognitively by age. With that said, the typical grade level curriculum progression seen is more of an educated guess of ideas about how teaching content should be sequenced. However, the ways in which students actually learn new information/knowledge and acquire new skills are not always reflected. Thus, the debate continues asks regarding the best way to facilitate learning.

Curriculum design, by contrast, revolves around individual student needs. It recognizes that students are not uniform, and therefore should not, in every case, be subject to a standardized curriculum. Each student has a different educational history as well as life history.

So when beginning a specific grade level, although each student is at the same starting point, on paper, the reality is that they are not all equipped with the same level of knowledge, so their race to the finish line may look altogether different, in route and speed. This is why an approach centered around the Piagetian model aiming to empower students to guide their education through choices has more individual engagement, motivation and ultimate success.

As noted in Duncan and Hmelo-Silver (2009) the drawback to the Piagetian form of curriculum design is that it can create pressure on the educator to source materials specific to each student's learning needs. This can be challenging due to teaching time constraints. Essentially, balancing individual student interests with those of the institutions that require a focus on outcomes such as test scores could prove to be a daunting task.

The goal, as a learner is to progress through stages, from basic skills to applying those skills efficiently. In the early years of learning, there are those laws of average/ages where milestones occur. However, within each developmental period of time there are dramatic ranges between individuals and when they meet specific goals. Early on, most all skills are gleaned through modeling. The degree to which a child receives modeling, instruction, and guidance prior to starting school varies among children. For example, if a child begins kindergarten already having been exposed, receptive, and able to take in learning prior to that, that individual is most likely going to move more effortlessly through some basic steps and be able to build skills more swiftly. Conversely, if a child starts out "behind", he or she has more skills to learn along the way in order to get to the next stage of learning. This results in the developmental period taking longer for that individual. If an individual has certain types of disabilities, this progression through these stages could be even more difficult and in some cases unsuccessful, based on severity and type of disability.

CHC Model

At the same time that Piaget was formulating his theory, other researchers were developing and expanding their theories of intelligence. For example, Spearman developed a “two-factor theory” of intelligence. Spearman postulated a general intelligence factor referred to as “g” as well as specific factors referred to as “s.” He believed that the g factor involved three major mental processes—apprehension of experience, deduction of relations, and deduction of correlates. Spearman is generally credited with introducing the notion of factor analysis to the study of human intellectual abilities. According to Carroll (1983), students of Spearman began to study other possible factors beyond g. The Spearman Holzginer Model (1993), which was based on Holzinger's development of the "bi-factor" method, suggested g plus five group factors (verbal, perceptual speed, spatial relations, recognition, and associative memory).

Raymond Cattell was one of Spearman’s students and research associates. The original Gf-Gc theory of intelligence was proposed by him (Cattell, 1941,1943), which led to the formal beginning of the Cattell-Horn Gf-Gc theory. Fluid (Gf) and Crystallized (Gc) intelligence factors were extracted from second-order factor analysis of first-order abilities. Gf intelligence reflected basic reasoning abilities and higher mental processes while Gc reflected what an individual had learned from exposure to their culture through education and experiences. According to Carroll (1993), Horn’s completion of his dissertation represented "the first clear test of the theory."

The basic idea of CHC theory, according to Schneider and McGrew (2012) is that intelligence is both multidimensional and functionally integrated. The dimensions of intelligence can be measured, studied, and understood in terms of their shared and separate antecedents correlates, and causal effects. Raymond Cattell, John Horn, and John Carroll, the fathers of CHC theory, measured individual differences and then made inferences regarding intelligence by studying patterns among the variations in these differences.

Eventually, the models by Cattell, Horn, and Carroll were merged into a model called the CHC model, which represents intelligence as having three layers. The CHC model decompose human intelligence into three layers. At the top layer, there is only one factor of intelligence, called general intelligence. At the second layer, there are the sixteen factors of intelligence. At the third layer, the factors in the second layer are further divided into more detailed factors. Fluid Reasoning is reasoning and induction abilities. Short-Term Memory is an individual's working memory capacity. Comprehension knowledge is culture-specific knowledge. Domain-specific knowledge is knowledge is other specific domains. Reading and Writing factor includes knowledge in reading and writing. Quantitative Knowledge is abilities and knowledge in mathematics. Visual Processing is abilities in processing and recalling what one sees. Auditory Processing is abilities in processing and remembering what one hears. Olfactory abilities involve the sense of smell and the memory of smells. Tactile abilities include tactile processing and memory. Kinesthetic abilities are related to body awareness and condition. Psychomotor abilities are related to body movement. From this model, we can understand the structure and functions of human intelligence. The CHC model is the most researched and valid model of intelligence (McGrew, 2005).

SLD Models

The Individuals with Disabilities Education Act (IDEA) defines a specific learning disability as "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations." (IDEA Sec. 300.8 (c) (10)). The functional limitations associated with the SLD are not the result of visual, hearing, or motor disabilities, of intellectual disability, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

The IQ/achievement discrepancy model is an approach to determining the existence of a learning disability. This model requires a significant difference between an individual's scores on a test of general intelligence and that same individual's scores on a test of academic achievement. The IQ-achievement discrepancy model is the traditional approach most often used to identify learning disabilities (Flanagan & McDonough, 2018). If a student's score on the IQ test is significantly higher than their scores on an achievement test, and assuming other components of SLD under the IDEA have been satisfied, then that student is identified as having a Specific Learning Disability. Interestingly, it is the child's overall or composite score on the IQ test that is important, not their score on specific CHC factors (Sattler, 2018).

Response to Intervention (RtI) is a term that refers to a process that emphasizes how well a student responds to meaningful changes in instruction. RTI was included in the 2004 reauthorization of IDEA (Mather & Tanner, 2014). The essential elements of the RtI model are: providing scientific, research-based instruction and interventions in a general education setting; the monitoring and measurement of student progress in response to the instruction and interventions; and use of these measures of student progress to inform instruction and make educational decisions. A student is identified as having a Specific Learning Disability if he or she displays insufficient response to scientific, research-based intervention as well as insufficient progress toward grade-level standards (IDEA, 2004)

Discrepancy models and the Response to Intervention model are currently the primary ways a student can be identified as having a specific learning disability (SLD). In Kentucky, if schools use the discrepancy model, school psychologists must use the State-provided reference tables, based on the cognitive assessment and achievement assessment pairings and their correlations (Kentucky Department of Education, 2017, Reference Tables).

In contrast to the discrepancy and RTI models, Jenson (1998; 2006) gives credence to an “information processing model,” which is becoming increasing popular (McGill, Styck, Palomares, & Hass, 2016; Flanagan, Alfonso, Costa, Palma, & Leahy, 2018). The processing model may also be referred to as “processing strengths and weaknesses” (Carmichael, Fraccaro, Miller, & Maricle, 2014, p. 11). Sotelo-Dynega, Flanagan, and Alfonso (2018) state that traditional identification of SLD relies on strengths and weaknesses, in relation to one’s cognitive abilities (Flanagan, Alfonso, Costa, Palma, & Leahy, 2018, p. 608). The “processing disorder causes academic deficits, and that it is not due to another disability or disadvantage” (Hale & Fiorello, 2004, p. 179). When using this approach, the child is considered a mini-computer. The examiner controls what the input to the computer and how it is presented, either visually, verbally, by touch or in combination (Baum & Plata, 1976). The amount of information the subject can reproduce allows for measurement of the central processing functions compared to the normative sample. Dehn (2006) reported that identifying the processing deficits can assist in determining effective interventions (as cited in Floyd & Kranzler, 2012). However, McGill et al. (2016) have reported that the processing model may generate inconsistent diagnoses among practitioners and educational agencies as a result.

Using IQ to Predict Achievement

There are correlations between CHC abilities and specific areas of academic achievement. Although nothing is a predictor 100% of the time, these correlations can be a good indicator of future achievement. Depending on a student's age at the time of testing, these correlations generate varying levels of reliability. Below are some of the relationships between cognitive abilities and specific achievement areas.

In regard to reading achievement, Gf (fluid reasoning) inductive and sequential reasoning abilities have a moderate relationship to reading comprehension. Gc (Crystallized Intelligence) is important for reading acquisition and development, and it becomes more important with age. Gv (Visual Processing) is very important during the elementary years, specifically, for the development of basic reading skills. Glr (Long term memory) is also important during elementary years (Restori et. al., 2009). Math Achievement and cognitive ability relationships exist as well. Gf abilities are consistently very important for math problem solving across all age ranges and Gc abilities in math are important at all age ranges and importance increases with age. Gv is important primarily for higher level math such as geometry and calculus. Glr is necessary for higher level math problem solving.

Fluid Reasoning (Gf) abilities are consistently related, across all age ranges, to written expression. Gc abilities are increasingly important with age, starting around the completion of 2nd grade. Gv is important as it relates to spelling. Glr has some relationship demonstrated with written expression, primarily in writing fluency skills.

Individuals with Gf deficits may have difficulties with word problems and finding relationships between numbers, words and ideas as well as drawing inferences. Students with Gc deficits may have trouble in the area of language, including vocabulary, verbal and listening skills. Glr weakness may create challenges for an individual during the process of storage and retrieval of information. Gv abilities have specific importance as it relates to students as they progress in age. If there are deficits in this area, individuals may have trouble with puzzles, interpreting graphs and charts as well as with advanced math.

Because children with learning and other disabilities do not develop in a predictable of a fashion as other children, these correlations need to be studied in a clinical sample. If IQ tests are to be used to find unexpected academic weaknesses as in the discrepancy model or the processing model, then these changing correlations need to be discovered.

CHAPTER THREE: METHODS

Participants

All data for this study were taken from the archives of one school district in Southern Illinois (student population = 2,218). This archival search resulted in 150 students (50 per group)—there were 61 males (40.7%) and 89 females (59.3%). In the elementary group, there were 19 (38%) males and 31 (62%) females. In the middle school group there were 23 (46%) males and 27 (54%) females and in the high school there were 19 (38%) males and 31 (62%) females. Regarding eligibility category, the 150 students were largely determined eligible for specific learning disability (76%) and Other Health Impaired (17.3%), followed by intellectual disabilities (3.3%), emotional disorder (2%), and autism (1.3%). Three students (<1%) were eligible for speech services. A summary of the demographic information for the 150 participants is provided in Table 1.

Procedures

Following approval by MSU's Institutional Review Board, the first 50 elementary age students (ages 7 to 9) who had been evaluated for special education eligibility determination who had a complete Kaufman Assessment Battery for Children—Second Edition (KABC-2) and a complete Woodcock-Johnson IV Tests of Achievement were included. This was repeated for middle school students (ages 10 to 13) and for high school students (ages 14 to 17). In addition to age, sex, and eligibility category, all index scores from the KABC-2 and the WJ-IV Achievement were entered into Excel, then into SPSS. No identifying information was collected.

Instrumentation

KABC-2. The Kaufman Assessment Battery for Children—Second Edition (KABC-2) is a comprehensive, norm-referenced measure of cognitive abilities (Kaufman & Kaufman, 2014). This test is comprised of 18 subtests that have a mean of 10 and a standard deviation of 3, although only 10 subtests are typically administered to any particular child. The subtests are combined to generate a series of index scores that have a mean of 100 and a standard deviation of 15. Average index scores are 85 to 115.

The four indices included for this study were Crystallized-Knowledge (Gc), Fluid Reasoning (Gf), Visual Processing (Gv), and Long-Term Retrieval (Glr). The Short-Term Memory (Gsm) index was not included in this study. Gc measures the extent of school-based knowledge that a child has acquired. It includes word knowledge and factual information, as well as the ability to apply this knowledge. Gf measures the ability to solve novel problems with adaptability and flexibility and to use inductive and deductive reasoning. Gv measures the ability to perceive, manipulate, and think in terms of visual images, patterns, and stimuli. Glr measures the ability to both store and retrieve information fluently and efficiently. Finally, the index scores are aggregated to generate a composite score, known as the Fluid-Crystallized Index. This index is considered the best overall measure of intellectual functioning and academic potential (Kaufman & Kaufman, 2014).

Regarding the normative sample, 700 children and adolescents ages 3 years, 0 months to 18 years, 11 months was collected. The sample matched the U.S. population on the stratification variables of gender, race/ethnicity, parent education level, and region. Each year of age for children three to 18 was represented by 50 children, equally divided between males and females (Kaufman & Kaufman, 2014).

In terms of reliability and validity, the KABC-2 manual (Kaufman & Kaufman, 2014) noted that average internal consistency for the MPI and FCI ranges from .95 to .97. Average test/retest indices for the Mental Processing Index and Fluid Crystallized Index ranged from .86 to .94, and the correlations improved with age, a finding supported by others (Lichtenberger, Sotelo-Dynega & Kaufman, 2009).

Construct validity is supported by factor-analysis studies available in the KABC-2 Manual. Confirmatory factor analysis reports high loadings on the intended scale and on the general factor. KABC-2 is also supported by correlations with the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV), Wechsler Preschool & Primary Scale of Intelligence (WPPSI-III), The Kaufman Adult Intelligence Test (KAIT), and Woodcock Johnson, Third Edition (Kaufman & Kaufman, 2004).

WJ-IV ACH. The Woodcock-Johnson IV Tests of Achievement (WJ-IV ACH) is a comprehensive, norm-referenced measure of academic skills. It is an individually administered, norm referenced test of reading, math, and writing achievement used to determine a student's academic strengths and weaknesses and to assist in educational programming. The standard scores have a mean of 100 and a standard deviation of 15. Scores 90 to 110 are “average” (McGrew et al. 2014).

The Woodcock-Johnson Achievement indices included for this study were Broad Reading Skills, Broad Math Skills and Broad Writing Skills. Each of those three areas are comprised of subtests. As explained in Woodcock Johnson IV Technical Manual (McGrew et al. 2014), Broad Reading includes the Letter-Word Identification subtest, which is a measure of a student’s word identification skills. The Reading Fluency measures a student’s ability to read simple sentences quickly, and the Passage Comprehension subtest measures a student’s ability to understand written text.

Next, the Broad Mathematics cluster include three tests—Calculation, Math Facts Fluency, and Applied Problems. Calculation is a measure of a student’s ability to perform paper and pencil math computations and the Math Facts Fluency subtest measures a student’s efficiency when asked to solve addition, subtraction and multiplication facts. Lastly, the Applied Problems subtest measures a student’s ability to analyze and solve applied math problems.

Lastly, the Broad Writing Skills cluster combines three writing tests. The Writing Fluency measures a student’s ability to construct and write sentences quickly. The Spelling subtest is a measure of a student’s ability to correctly write words that the test administrator orally presents. Finally, the Writing Samples subtest is a measure of a student’s ability to write meaningful sentences when given verbal and/or visual cues.

Regarding the normative sample (McGrew et al. 2014), the WJ IV norming study was conducted between December 2009 and January 2012. Data were collected from 7,416 individuals representing 46 U.S. states and geographically diverse communities. Six hundred sixty four children between the ages of 2-5 and who were not yet enrolled in kindergarten made up the pre-school sample. The sample of kindergarten through 12th-grade consisted of 3,891 examinees. The college/university sample was composed of 775 undergraduate and graduate students. There were 2,086 examinees in the adult sample.

The norming sample was selected and constructed to be an authentic reliable representation of the U.S. population. The examinees were randomly selected within a stratified sampling design to represent the U.S. population from ages 24 months to 90 years and older. The sample was based on 2010 projections from a U.S. Census Bureau report. Age, sex, race, ethnicity, origin of birth, parent education, type of school/college/educational attainment, status of employment, level of occupation as well as community type were the basis for the stratified samples. Data were collected from 7,416 individuals from geographically diverse areas. Further explanation was given by Villarreal (2015). Distribution comparisons between the WJ IV norming sample and the U.S. Census matched closely. The application of examinee weighting assisted in determining constructs for the test norm and to account for discrepancies. For example, if an examinee belonged to a category that was overrepresented in the norming study sample, partial weight for that individual variable was less than 1.0, and vice versa.

In terms of reliability and validity, the Woodcock Johnson manual (McGrew et al. 2014) noted that "internal consistency reliabilities for all untimed tests with dichotomously scored items were calculated using the split-half procedure based on odd and even items". The majority of these were considered reliable tests rated in the acceptable to excellent range (.84-.94). Reliability of the multiple-point item tests were generated using mean square error values. Re-tests were in the excellent range (.90-.96) of reliability. Compared to reliability estimates for the WJ II ACH the more current WJ IV ACH are improved. Additionally, cluster scores appear to be most reliable so they are recommended for interpretation. According to Ysseldyke and Nelson (2012) the reliabilities of WJ IV ACH cluster scores are higher than those for the individual tests and meet the statistical requirements needed to make important decisions. Villarreal (2015) further noted that the reliabilities for the speeded tests were based on a test–retest model with a one-day timeframe. In most cases, test–retest correlations were in the acceptable to excellent range (.83-.95), indicating adequate test/retest stability. These also appear to be reliability improvements as compared to WJ III ACH, and the reliabilities of cluster scores that include speeded tests are in the acceptable range for making important decisions.

Regarding validity, multidimensional scaling (MDS) was used as a supplemental empirical tool. MDS provides information about content and processes underlying performance on diverse tasks. The Technical Manual (McGrew, LaForte, & Schrank, 2014) provides detailed information on the results of MDS analyses of the WJ IV tests, and results suggest adequate content validity.

When multidimensional scaling (MDS) methods have been applied to data sets previously analyzed by exploratory or confirmatory factor analysis methods, “new insights into the characteristics of tests and constructs previously obscured by the strong statistical machinery of factor analysis emerge” (Schneider & McGrew, 2012, p. 110) as cited by McGrew (2014).

Hypotheses

Based upon previous research (Flanagan & McDonough, 2018) with typically developing children, it was hypothesized that the association between the different cognitive factors from the

KABC-2 and the different academic tests from the WJ-IV Achievement would change according to age.

Analyses

To test the hypotheses, several statistical analyses were conducted. First, Pearson correlations between the KABC-2 indices and the WJ-IV Achievement tests were conducted. This was followed by a multiple regression across the combined sample, then by multiple regression at the group level (i.e., elementary, middle, and high school group).

CHAPTER FOUR: RESULTS AND DISCUSSION

Results

Tables 2 and 3 provide the mean KABC-2 and mean WJ-IV achievement scores for the entire sample and for the three groups. Regarding cognitive testing, the overall mean FCI score was 82.2 (*SD* = 11.6). This score was in the below average range. The aggregated index scores were very similar—the Gc mean was 88.7 (*SD* = 12.8), followed by Glr mean of 87.0 (*SD* = 12.6), the Gf mean of 84.6 (*SD* = 12.9), and the Gv mean of 79.4 (*SD* = 14.2). Only the Glr score was in the average range (average scores for the KABC-2 are 85 to 115). The mean FCI score for the elementary group was 78.8 (*SD* = 9.8) which was in the below average range. At the index level, the mean Gc score was 86.6 (*SD* = 12.4) and the mean Gv score was 76.9 (*SD* = 12.4). The respective mean Gf and Glr scores were 81.6 (*SD* = 12.9) and 84.9 (*SD* = 13.4). The mean FCI score for the middle school group was 85.2 (*SD*=12.4) and was at the lowest limit of the average range. The mean Gc, Gv, Gf, and Glr scores were 91.3 (*SD* = 13.2), 80.9 (*SD* =13.8), 87.4 (*SD* =

12.2), and 89.4 (*SD* = 11.5). Lastly, at the high school level the mean FCI score of 82.5 (SD = 11.7) was in the below average range. This groups respective Gc, Gv, Gf, and Glr scores were 88.1 (*SD* = 12.6), 80.2 (*SD* = 16.2), 84.7 (*SD* = 13.1), and 86.6 (*SD* = 12.8). For all three groups, the standard deviations were similar to those in the KABC-2 normative sample (i.e., 15 pts).

For the WJ-IV ACH, the average word reading score for the aggregated sample of 86.2 (*SD* = 11.5) was in the low average range and was quite similar to the aggregated reading comprehension score of 82.1 (*SD* = 11.2). The average math computation score for the sample was 80.5 (*SD* = 15.8) and the average math reasoning score for the sample was 81.1 (*SD* = 14.1). Both scores were in the low average range. The average spelling score of 85.0 (*SD* = 14.1) and the average written expression score of 82.2 (*SD* = 12.9) for the aggregated sample were in the low average range. For the elementary sample, the academic scores ranged from a low range score of 79.1 in spelling to a low average range score of 84 in word reading. For the middle school group, the scores ranged from a low range score of 80 in math reasoning to an average range score of 93 in written expression. Lastly, the scores for the high school group ranged from a low range score of 77 in math computation to an average range score of 93 in written expression.

Tables 4 through 7 summarize the cognitive test/academic achievement test Pearson correlations for the aggregated/total sample of 150 children and each of the groups (elementary, middle, and high school). Consistent with expectations, nearly all comparisons for the combined sample were statistically significant at the .05 level or less. At the group level, the lowest number of correlations were found for the elementary group while the highest number of significant correlations were found for the high school group. Regarding the total sample, 24 out of 25 comparisons were statistically significant. The only non-significant comparison was between the Glr and Math Calculation, and even this was close to significance at .059. For the elementary group, 10 of 25 correlations were statistically significant. The highest statistically significant correlation was between the FCI and Math reasoning at r = .524 and the lowest statistically significant correlation was between the Glr and Reading Comprehension at r = .284. Next, for the middle school group, 20 of 25 pairings were significant. The highest, at r = .615, was between the FCI and Math Reasoning and the lowest, at r = .279, was between Glr and Math Computation. Finally, for the high school group, 28 out of 30 pairings were statistically significant. Here, the highest significant correlation was between Gv and Math Reasoning at r = .721 and the lowest significant correlation was between Gv and Spelling at r = .333. Overall, these findings were consistent with those described in the KABC-2 manual (Kaufman & Kaufman, 2018).

Next, in order to determine which factors or combination of factors best predicted the academic scores, a series of stepwise multiple regressions were calculated. These results are provided in Tables 8 -14. Stepwise regression is a process of building a model by adding or removing variables in succession based solely on the *t*-statistics of their estimated coefficients. It is important to note that the FCI score was not included in these regressions because the FCI score represents a combined composite of the five factors (i.e., Gc, Gv, Gf, Gsm, and Glr). First, regarding the combined sample, Glr/Long-Term Retrieval accounted for about 16% of the variance in word reading. Glr accounted for 21% at the middle school level and Gc/Crystallized Knowledge or Comprehension-Knowledge, accounted for 32% of the variance. Regarding reading comprehension, Glr again accounted for 8% and 21% of the variance at the elementary and middle school levels, respectively, while Gc again accounted for 51% of the variance at the high school level.

For math computation, Gf/Fluid Reasoning accounted for 13% of the variance at the elementary level and Gv/Visual Processing accounted for 18% of the variance at the middle school level. At the high school level, two models predicted math computation. In the first model, Gc accounted for 47% of the variance and Gc and Gf combined accounted for 54% of the variance. For math reasoning, Gf accounted for 24% at the elementary level. For the middle school students, Gv accounted for 35% while Gv and Gc together accounted for 48%. At the high school level, the first model, using Gv, predicted 52% while Gv and Gf together accounted for 60% of the variance in math reasoning.

Lastly, for writing, none of the KABC-2 factors predicted spelling or written expression. However, at the middle school level for spelling, Glr explained 18% of the variance and at the high school level Gc accounted for 17%. Finally, Gv accounted for 13% of the variance for middle school students and Gf explained 24% of the variance at the high school level.

Discussion

Consistent with the proposed hypotheses, the cognitive predictors for all academic areas changed as the children aged. Additionally, for math, the models became more complicated in that there were more than one model to explain the variance. Long-term retrieval accounted for the bulk of the variance for both word reading and reading comprehension at the elementary and middle school levels. This is reasonable in that Glr is a measure of the ability to learn and store then later use verbal information. However, at the high school level, the fund of general knowledge and word knowledge, or Gc, became a much stronger predictor. Thus, consistent with

Piaget's thinking, these data indicate that students transition from learning the basic skills to using the information in order the read words and comprehend what they read. In math, Gf or Fluid Reasoning explained much of the student's achievement at the elementary level. Gf is the ability to grasp and solve unfamiliar problems and the ability to generalize knowledge. In middle school, Gv, or visual processing became more prominent, perhaps because of the introduction of geometry, interpretation of charts and diagrams, and other visually demanding material. In high school, for math computational skills, Fluid Reasoning in combination with Crystallized Knowledge accounted for an impressive degree of variance, at 54%. This too makes logical sense in that at high school students are required to generalize knowledge in applied settings, which presumably require a degree of reading, prior knowledge, and generalized information. For math reasoning, however, Visual Processing in combination with Fluid Reasoning were important. In high school, when math reasoning is involved, the curriculum requires a combination of visual problem solving, such as planes and geometry, as well as reasoning, such as algebra.

It is unclear why, at the elementary level, that none of the factors predicted spelling or written expression. It is likely that in the early grades students utilize all of the factors relatively equally. This makes partial sense given that FCI and Spelling do not correlate at the elementary level ($r = -.044$). However, for Written Expression, FCI and writing are statistically associated ($r = .339$). This would explain why none of the factors predicted Spelling or Writing achievement at the elementary level. At the middle school level, Glr predicted Spelling and at the high school level Gc predicted Spelling, although in both cases the resulting correlations were quite small. This is logical given that Glr measures learning and association and that Gc measures word knowledge and fund of general information. At the middle school level regarding Written Expression, Gv predicted Written Expression and at the high school level Gf predicted written expression. Although associations too were rather small, it is clear that learning and storage processes and fund of knowledge are both needed to spell accurately at the middle and high school levels. When written expression is required, however, which is a much more complex process than spelling, Visual Processing and Fluid Reasoning are important cognitive processes. This is plausible since Gv is involved in word spacing and recognizing grammar, punctuation and word usage, and Gf is needed to apply/generalize previously learned knowledge and to plan ahead in writing.

Overall, these results are similar to those described by a host of cognitive researchers who have documented the changes in predicting academic skills from cognitive factors that occur with age (Mcleod, 2018). Essentially, it can be reasoned that as the curriculum becomes more advanced, a more complex series of cognitive factors must be brought to bear to learn, retain, generalize, and expand that knowledge. Similarly, these results are consistent with suggestions by Piaget who believed that a child constructs a mental model of the world. He disagreed with the idea that intelligence was a fixed trait, and regarded cognitive development as a process that occurs due to biological maturation and interaction with the environment.

CHAPTER FIVE: IMPLICATIONS, LIMITATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

Implications

There are two primary implications for these findings. First, from an instructional perspective, these findings suggest that all cognitive factors are needed to progress successfully from elementary through high school for children with learning problems. These findings are consistent with those noted by others (McGrew & Wendling, 2010). While word knowledge and learning/associational efficiency (reflected in Gc and Glr) are obviously meaningful in the early grades, visual and fluid reasoning abilities are needed in the higher grades. Thus, using visual imagery and generalizing knowledge are called upon to foment learning and mastery. These findings suggest that a curriculum heavily devoted to building vocabulary, general knowledge, and associational learning and memory in the early grades should help students. By middle school, the curriculum should incorporate visual processing (that is, using visual imagery, understanding spatial relations) and fluid processing (that is, generalizing knowledge, solving unfamiliar problems). While instruction devoted to visual reasoning, visual imagery, planning, and generalizing information (perhaps through instruction logic, analysis and synthesis of ideas) may seem counterintuitive when students are learning social studies, science, higher-level English, these findings suggest that visual and fluid processing are more important than language and fund of general knowledge (at least for children referred for learning problems).

Second, these findings should help school psychologists better predict the presence of learning disorders in school-aged children when using the processing model. Unlike the IQ/Achievement discrepancy model, which requires a very large discrepancy between overall IQ and an academic area, and the RTI model, which simply requires failure to respond to instruction as the criteria for eligibility for SLD, the processing model utilizes unexpected differences between cognitive factors and achievement, irrespective of the child's overall IQ. For example, the processing model suggests that to determine eligibility for a reading disorder, the cognitive factor most highly associated with reading needs to be significantly lower than expected given the other cognitive factors, and the child's reading skills should be lower than expected given their age and grade placement. While this processing model is not new, it is the changing nature of the cognitive factor predictors over the child's age that should be carefully considered. Rather than using aggregated data for all ages to determine which cognitive factors predict achievement, school psychologists should consider the child's age when using the KABC-2 and the WJ-IV achievement test in combination.

Limitations

Like all studies, this study has limitations that should be considered. First, the sample was rather small and obtained from one school district. This would hinder generalization. Second, the sample included children referred for learning disabilities as well as other academic and behavior problems, including intellectual disabilities and other health impairments (e.g., ADHD). Although learning disabilities is considered a rather heterogeneous condition, the findings are limited by the fact that the sample included children referred for a range of conditions—this could hinder generalization as well. Lastly, this study included only one intelligence test (the KABC-2) and one academic test (the WJ-IV Achievement). The results might not generalize to other measures of cognition and other measures of achievement.

Future Research

Future research should consider the limitations described above and include a larger, more diverse sample, include only children referred for learning disabilities, and employ different intelligence tests. Future research too could pursue the question of whether there is any credence to the idea of modifying the curriculum by incorporating visual and fluid processing strategies and improved reading, writing, and math skills.

Tables

Table 1

Demographic Information for the Participants

Group	N	Males	Females	SLD	OHI	ID	Aut	Ed
Elem	50	19	31	36	9	2	1	1
Middle	50	23	27	39	10	1	0	0
High	59	19	31	39	7	2	1	2

N = 150.
Note: SLD = Specific Learning Disability, OHI = Other Health Impairment, ID = Intellectual Disability, Aut = Autism, Ed = Emotional Disability

Table 2

Mean Cognitive Ability Scores

FCI	Gc	Gv	Gf	Glr

Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Aggregate	82.2	11.6	88.7	12.8	79.4	14.2	84.6	12.9	87.0	12.6
Elementary	78.8	9.8	86.6	12.4	76.9	12.4	81.6	12.9	84.9	13.4
Middle	85.2	12.4	91.3	13.2	80.9	13.8	87.4	12.2	89.4	11.5
High	82.5	11.7	88.1	12.6	80.2	16.2	84.7	13.1	86.6	12.8

Note. Agg.= combined sample. Total sample *N* = 150.
FCI = Fluid/Crystallized index; Gc = Comprehension-Knowledge aka Crystallized factor; Gv = Visualization factor; Gf = Fluid Reasoning factor; Glr = Long-Term Retrieval factor

Table 3

Mean Academic Achievement Scores

	Word Read		Read. Comp.		M. Calc.		Math Reas.		Spelling		Writing	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Agg.	86.2	11.5	82.1	11.2	80.5	15.8	81.1	16.7	85.0	14.1	82.2	12.9
Elem	84.4	10.6	80.2	11.9	82.9	17.8	84.1	14.6	79.1	13.0	82.2	12.9
Mid.	87.0	12.2	83.6	8.5	81.1	15.4	80.8	18.6	86.1	13.8	93.0	11.8
High	87.2	11.7	82.6	12.7	77.5	13.8	78.2	16.4	89.7	13.6	93.2	13.8

N for Aggregated Sample = 150. *n* for Elementary, Middle, and High School samples is 50 each.

Table 4

Cognitive Ability and Academic Achievement Correlation Matrix for Combined Sample

		Cognitive Factors			
ACH Tests	FCI	Gc	Gv	Gf	Glr
Word Reading	.389	.411	.265	.298	.400
Read Comp.	.432	.429	.275	.346	.426
Math Calc.	.419	.421	.379	.401	.154*
Math Reason.	.592	.502	.579	.500	.205
Spelling	.283	.240	.209	.215	.221
Writing	.406	.338	.339	.367	.245

N = 150. All Pearson correlations significant at .01 except Glr and Math Calculation denoted with *

Table 5

Cognitive Ability and Academic Achievement Correlation Matrix for Elementary Sample

			Cognitive Factors		
ACH Tests	FCI	Gc	Gv	Gf	Glr
Word Reading	.176	.273	-.083	.058	.395**
Read Comp.	.231	.268	.102	.239	.284*
Math Calc.	.362**	.345*	.214	.366**	-.099
Math Reason.	.524**	.352*	.464**	.489**	.026
Spelling	-.044	.014	.175	-.028	-.004
Writing	.339*	.218	.268	.230	.186

N = 50. ** = significant at .01; * = significant at .05 or less.

Table 6

Cognitive Ability and Academic Achievement Correlation Matrix for Middle School Sample

	Cognitive Factors				
ACH Tests	FCI	Gc	Gv	Gf	Glr
Word Reading	.382**	.372**	.312*	.376**	.462**
Read Comp.	.381**	.234	.245	.229	.460**
Math Calc.	.348*	.321*	.421**	.287*	.279*
Math Reason.	.615**	.568**	.595**	.464**	.242
Spelling	.283*	.250	.324*	.232	.420**
Writing	.271	.269	.353*	.268	.274

N = 50. ** = significant at .01; * = significant at .05 or less.

Table 7

Cognitive Ability and Academic Achievement Correlation Matrix for High School Sample

	Cognitive Factors				
ACH Tests	FCI	Gc	Gv	Gf	Glr
Word Reading	.533**	.564**	.443**	.409**	.336*
Read Comp.	.618**	.711**	.398**	.486**	.526**
Math Calc.	.687**	.685**	.584**	.645**	.400**
Math Reason.	.743**	.637**	.721**	.649**	.386**

Spelling	.455**	.415**	.333*	.349*	.228
Writing	.480**	.472**	.333*	.486**	.213

N = 50. ** = significant at .01; * = significant at .05 or less.

Table 8

Stepwise Multiple Regression using Cognitive Factors to Predict Word Reading

Elementary	B	T	p	R	R^2
Constant	57.782	6.385	.000		
Glr	.314	2.982	.004	.395	.156
Middle					
Constant	43.043	3.508	.001		
Glr	.492	3.611	.001	.462	.214
High School					
Constant	41.083	4.182	.000		
Gc	.523	4.737	.000	.564	.319

n = 50 for each level

Table 9

Stepwise Multiple Regression using Cognitive Factors to Predict Reading Comprehension

Elementary	B	T	p	R	R^2
Constant	58.711	5.545	.000		
Glr	.253	2.052	.048	.224	.081
Middle					
Constant	53.319	6.263	.00		
Glr	.339	3.590	.001	.460	.212
High School					
Constant	19.667	2.166	.035		
Gc	.714	6.999	.000	.711	.505

n = 50 per group

Table 10

Stepwise Multiple Regression using Cognitive Factors to Predict Math Computation

Elementary	B	T	p	R	R^2
Constant	41.752	2.728	.009		
Gf	.505	2.723	.009	.366	.134
Middle					
Constant	43.054	3.585	.001		
Gv	.470	3.212	.002	.421	.177
High School (Model 1)					
Constant	11.595	1.135	.262		
Gc	.749	6.521	.000	.685	.470
High School (Model 2)					
Constant	2.416	.236	.814		
Gc	.504	3.539	.001		
Gf	.363	2.651	.011	734	.538

n = 50 per group

Table 11

Stepwise Multiple Regression using Cognitive Factors to Predict Math Reasoning

Elementary	B	T	p	R	R^2
Constant	38.982	3.317	.002		
Gf	.553	.553	.000	.489	.239
Middle (Model 1)					
Constant	15.869	1.236	.223		
Gv	.803	5.131	.000	.595	.354
Middle (Model 2)					
Constant	-15.844	-1.049	.300		
Gv	.584	3.717	.001		
Gc	.542	3.311	.002	.690	.476
High School (Model 1)					
Constant	19.686	2.390	.021		
Gv	.729	7.215	.000	.721	.520
High School (Model 2)					
Constant	-1.287	-.128	.899		
Gv	.526	4.662	.000		
Gf	.440	3.160	.003	.777	.604

n = 50 per group

Table 12

Stepwise Multiple Regression using Cognitive Factors to Predict Spelling

Middle	*B*	*T*	*p*	*R*	R^2
Constant	40.973	2.891	.006		
Glr	.505	3.21	.002	.420	.177
High School					
Constant	50.297	3.994	.000		
Gc	.497	3.162	.003	.415	.172

Note. No variables entered the equation for the elementary group
n = 50 per group

Table 13

Stepwise Multiple Regression using Cognitive Factors to Predict Written Expression

Middle School	*B*	*T*	*p*	*R*	R^2
Constant	69.437	7.197	.000		
Gv	.303	2.615	.012	.353	.125
High School					
Constant	49.754	4.367	.000		
Gf	.512	3.854	.000	.486	.238

Note. No variables entered the equation for the elementary group
n = 50 per group

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