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The WISC-IV General Ability and Cognitive Proficiency Indexes in Intellectually Above Average Children

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled " The WISC-IV General Ability and Cognitive Proficiency Indexes in Intellectually Above Average Children" submitted by Breanne Hilles in partial fulfilment of the requirements of the degree of Master's of Science.

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Abstract

There are various approaches to determine who is intellectually and academically gifted; however, IQ scores hold considerable importance for gifted designation and placement in schools. Research suggests that those classified as gifted using the Wechsler Intelligence Scale for Children Fourth Edition, often score higher on the Verbal Comprehension (VCI) and Perceptual Reasoning (PRI) indices compared to Working Memory (WMI) and Processing Speed (PSI) indices. The General Ability Index (GAI) is a score based solely on the VCI and PRI and may more accurately reflect the abilities of many children classified as gifted. In order to examine the use of the GAI in gifted assessment, the scores of children 6 to 12 years of age who obtained a FSIQ above 115 were obtained from assessment clinics at the University of Calgary and the University of Alberta. Children identified as gifted more often had higher GAI and lower PSI scores than FSIQ.

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CHAPTER 1: INTRODUCTION

Educational and psychological assessments provide vital contributions to diagnosis and educational planning in the school system (American Educational Research Association [AERA], American Psychological Association [APA], & National Council on Measurement in Education [NCME], 1999). Intelligence tests are often used to aid in assessment and diagnostic decisions with gifted children. The Wechsler Intelligence Scale for Children (WISC-IV) is the most widely used scale to assess cognitive abilities in children. The WISC-IV is comprised of 10 core subtests and yields a Full Scale Intelligence Quotient (FSIQ; i.e., general intelligence score) and four index scores that represent different cognitive domains. Two new index scores (i.e., General Ability Index [GAI] and Cognitive Proficiency Index [CPI]) have been introduced in recent years that may be relevant to understanding and addressing the educational needs of exceptional children. The GAI is calculated from those subtests which measure abilities that load highest on general intelligence (both crystallized and fluid intelligence) and provides the clinician with a means to examine intellectual abilities separately from the processing component (Harrison, DeLisle, & Parker, 2008). The CPI is intended to represent how efficiently a person processes certain types of cognitive information (Weiss & Gabel, 2008), providing an indication of neurological efficiency.

Being gifted does not solely involve intelligence; however, many school boards require that a child obtain a Full Scale IQ above 130 to enter into their gifted program. There is a trend for children classified as gifted to score higher on the Verbal Comprehension (VCI) and Perceptual Reasoning (PRI) indices than on the Working Memory (WMI) and Processing Speed (PSI) indices of the WISC-IV (Newman, Sparrow

& Pfeiffer, 2008). Therefore, children's' CPI scores can have the effect of pulling down their FSIQ scores and they may miss the entry cut-off for gifted programming; while all the while meeting all other criteria for gifted programming. Among gifted children with Learning Disabilities (LD) and Attention Deficit Hyperactivity Disorder (ADHD) these effects may be even more prevalent as children with LDs and ADHD tend to have lower CPI scores than GAI scores (Schwean & McCrimmon, 2008; Weiss & Gabel, 2008).

The question being addressed in this study is whether the GAI is educationally, clinically, and diagnostically useful in the evaluation, understanding, and intervention planning for above average intelligence and intellectually gifted children. Twenty-six children aged 6 years to 12 years of age were recruited from assessment clinics at the University of Calgary and the University of Alberta. A FSIQ cut-off score of 115 was used in order to increase the sample size and increase the odds that children whose FSIQ had been lowered due to scores on the CPI were included in the sample. Overall, the children in the sample had much higher GAI scores than CPI scores. Furthermore, this effect was even larger among children with clinical disorder (e.g., ADHD, anxiety disorder, or mood disorder). The lowest scores were seen on subtests within the PSI and some possible rationales behind this trend are discussed in the subsequent chapter.

Limitations to this study include the small sample size which further included children with clinical disorders. Additionally, data were obtained anonymously and therefore limited demographic information was collected. Finally, the FSIQ cut-off of 115 makes it more difficult to generalize the results to a gifted population alone. Therefore, the sample will be described as high average intelligence to gifted children.

Overall, this study provides evidence that an examination of the GAI may be sufficient when assessing gifted students, enabling more children to make this cut-off, which would allow more students to access needed gifted programs. Furthermore, the use of the GAI may allow more individuals to be identified as gifted or talented and receive a needed Individualized Program Plan (IPP). However, it is important to note that the CPI should not be discounted as children who have low average to average working memory and processing speed are likely to struggle in most gifted programs. Rather, all the child's cognitive abilities should be taken into consideration to determine if the program will be a good fit for them.

CHAPTER 2: LITERATURE REVIEW

Concepts of Giftedness

The scientific study of giftedness and high intelligence began in the late 1800s with the work of Francis Galton (Robinson & Clinkenbeard, 2008). Research examining gifted individuals gained popularity following Terman's publication of a longitudinal study in which he followed a number of gifted children throughout their lives and concluded that gifted individuals were more successful and better adjusted than the general population (Robinson & Clinkenbeard, 2008). Despite the large amount of research examining giftedness that has been conducted, there is a lack of consensus among researchers and educators on how to define giftedness. Furthermore, what determines whether or not a child is gifted varies from culture to culture, country to country, and school to school (Sparrow, Pfeiffer, & Newman, 2005).

Certain theorists believe that there are a number of different types of intelligences. For example, Howard Gardner has suggested kinaesthetic, musical, mathematical, visual-spatial, interpersonal, intrapersonal, linguistic, and naturalist intelligence (Gardner, 1982; Sternberg, 2004). An individual could be considered gifted if they have superior abilities in any of these areas. Conversely, Sternberg (2000; 2004) believes that giftedness is better understood as patterns of intelligence rather than types of intelligence. According to Sternberg, different patterns of intelligence can be defined using three abilities: analytical, creative, and practical. Analytical abilities represent the capacity to analyze and evaluate ideas. Whereas, creative abilities are the capacity to generate high quality ideas and practical abilities represents the capacity to convince others of the value of one's ideas (Sternberg, 2000; 2004). Based on these three abilities, Sternberg argues for

seven different patterns of giftedness. For example, the analyst has high analytical abilities and does well in the academic world but struggles to develop creative ideas and use them in the real world. Conversely, the Consummate Balancer is gifted in all three areas and is in the best position to make gifted contributions to the world (Sternberg, 2000). While theories of what it means to be gifted tend to vary, the most commonly shared characteristic between theorists and educators is that gifted individuals have superior intelligence (Pfeiffer, 2002; Sparrow et al., 2005; Stephens & Karnes, 2000; Winner; 1997).

Yet, intelligence itself is a debated construct among researchers. Nevertheless, researchers generally agree that intelligence represents mental abilities necessary for one to adapt to their current environment (Sternberg, 1997). More specifically, intelligence has been described as "goal-directed mental activity marked by efficient problem solving, critical thinking, and effective abstract reasoning" (Pfeiffer, 2001, p. 138). Concepts of intelligence are culturally loaded as what is considered to be intelligent behaviour varies by culture. However, it can be argued that while what is considered intelligent behaviour varies by culture, the mental processes behind these behaviours are essentially the same across cultures (Sternberg, 1997). When intelligence is viewed this way it can be explained as mental processes, such as the capacity to learn or problem solve, which manifest themselves in different ways depending on the culture or environment someone finds themselves in (Sternberg, 1997).

The Role of Intelligence Tests

The most commonly used method to quantify intelligence is an intelligence test. Most intelligence tests provide an overall composite which represents general intellectual

ability or "g" which is conceptualized as the general cognitive abilities which allow one to learn, reason, problem solve, and use and understand abstract ideas (Gottfredson, 2008). Intelligence tests have a long history of misuse and in the past were used in order to justify a number of unethical practices carried out on individuals deemed to be mentally inferior, such as forced sterilization, hospitalization, and deportation of individuals (Benjamin & Baker, 2004; Law Reform Commission of Canada, 1979; Richardson, 2003). However, current intelligence tests have excellent psychometric properties (Wechsler, 2003a; Saklofske, Weiss, Raiford, & Prifitera, 2006) and there are a number of ethical policies in place to ensure that the results of intelligence tests are not misused (AERA, APA, & NCME, 1999; College of Alberta Psychologists [CAP], 2005; Canadian Psychological Association [CPA], 2004; National Association of School Psychologists [NASP], 2000).

Intelligence tests and gifted programs.

Many school districts in the United States base their gifted program entrance criteria on definitions of giftedness published in the Marland Report (Stephens & Karnes, 2000). The Marland report defined gifted children as those that were capable of high performance in one or more of the following areas: general intellectual ability, specific academics, creativity, leadership, visual or performing arts, and psychomotor ability (Marland, 1972). Psychomotor ability is largely ignored by most states, with intellectual ability, superior academic ability, and creativity being the three most commonly mentioned areas of strength in definitions of giftedness (Stephens & Karnes, 2000). Generally, children are considered to be intellectually gifted when they have a Full Scale Intelligence Quotient (FSIQ) of two standard deviations above the mean. Therefore,

many gifted programs across Canada and the United States also identify IQ scores (e.g., FSIQ of 130 or above) or ranges which are necessary in order to obtain entrance into their programs (McCoach, Kehle, Bray, & Siegle, 2001; Stephens & Karnes, 2001; Winner, 2000; Calgary Board of Education, 2009; Halton District School Board, 2009). For example, the Gifted and Talented Education program (GATE) through the Calgary Board of Education examines an individual's IQ and achievement test results when accepting students, with a FSIQ of 130 needed in order to gain acceptance into the program (Calgary Board of Education, 2009). In other words, in this school district a student must meet the intellectual ability criteria in order to gain entrance into a gifted program regardless of their abilities in other areas.

Conversely, a large body of research suggests that giftedness should not be based on IQ alone as it encompasses many other areas of ability such as creativity, artistic talent, and leadership (Margulies & Floyd, 2004; Pfeiffer & Jarosewich, 2003). Furthermore, it is not best practice or considered ethical to use only intelligence tests when making diagnostic or educational decisions. (AERA, APA, & NCME, 1999; CAP, 2005; CPA, 2004; Gregoire et al, 2008; NASP, 2000). A comprehensive assessment, including standardized tests (e.g., intelligence tests), informal measures (e.g., gifted rating scales or portfolio of work), observations, and interviews should be conducted when making diagnostic or academic placement decisions (Sattler, 2008). Therefore, clinicians need to ensure that they use multiple assessments and not just an IQ score alone when classifying individuals as gifted (Newman et al., 2008; Pfeiffer, 2002; Thompson & Morris, 2008). Furthermore, standard error should be taken into account; as such, confidence intervals should be examined and taken into consideration when making

academic placement decisions (Sparrow et al., 2005). Moreover, while many professionals state that intelligence tests can provide a large amount of valuable information in the assessment of giftedness, they also have a number of limitations. Clinicians need to be cautious when using intelligence tests to assess children with giftedness as such children tend to think divergently and may be penalized on standardized measures which reward convergent responses (Newman et al., 2008). Additionally, rewards for performance speed on such tasks may penalize individuals with reflective cognitive styles or perfectionist tendencies (Newman et al., 2008). Finally, while intelligence tests have been found to be good predictors of academic and occupational success, creative and practical intelligence are also predictors of future success. Unfortunately, creative intelligence and practical intelligence are not assessed by conventional tests of intelligence (Sternberg, 1997).

Despite the limitations of using intelligence tests in the identification of gifted children, they are an important part of the process and no other measure has been demonstrated to be superior in the identification of gifted individuals (Sparrow et al., 2005; Volker & Phelps, 2004). Furthermore, IQ scores have been demonstrated to be the best single predictors of a number of life outcomes including academic and occupational success (Gottfredson, 2008; Kaufmann & Harrison, 1986). Intelligence tests are also the most reliable and valid measures commonly used in the assessment of gifted children (Sparrow et al., 2005). Finally, intelligence tests may allow children with behavioural problems, ADHD, or Learning Disabilities to be identified as gifted. Without the use of intelligence tests, these gifted individuals may go undetected due to poor academic

performance or classroom behaviours (Kaufmann & Harrison, 1986; Sparrow et al., 2005).

The Wechsler Intelligence Scales

The WISC-IV (Wechsler, 2003a) is the most popular measure used in the assessment of gifted children (Rimm, Gilman & Silverman, 2008; Sparrow et al., 2005). The WISC-IV (Wechsler, 2003a) is comprised of 10 core subtests and yields a Full Scale Intelligence Quotient (FSIQ) and four index scores measuring different cognitive domains. The Verbal Comprehension Index (VCI) measures verbal reasoning abilities, the Perceptual Reasoning Index (PRI) measures visual spatial reasoning abilities, the Working Memory Index (WMI) measures the ability to mentally manipulate information in memory, and the Processing Speed Index (PSI) measures the ability to quickly process visual information. The FSIQ is the most informative and comprehensive representation of overall cognitive ability when there is little variability across subtests and indices (Saklofske, Prifitera, Weiss, Rolfhus, & Zhu, 2005). However, when there are large discrepancies between indices, the FSIQ loses its clinical utility and it has been suggested that it should not be reported (Saklofske et al., 2005). A general rule of thumb suggested by test developers is that discrepancies of 20 points or larger between indices should be examined carefully and a decision should then be made as to whether the FSIQ should be reported (Saklofske et al., 2005). Research indicates that gifted children tend to have higher variability among their scores on intelligence tests compared to the population mean (Lovett & Lewandowski, 2006; Volker & Phelps, 2004). Therefore, 20 point discrepancies between indices are likely found more often among this population.

The general ability and cognitive proficiency indices.

The General Ability Index (GAI) provides a broad measurement of cognitive ability that is less sensitive to the basic cognitive processes measured by the WMI and PSI (Raiford, Weiss, Rolfhus, & Coalson, 2005). The GAI correlates highly with FSIQ and can be used as a substitute for determining eligibility for special education services among children with deficits in cognitive processing (e.g., children with Learning Disabilities and ADHD) (Raiford et al., 2005). The GAI has excellent psychometric properties with reliability coefficients ranging from 0.94 to 0.97.

One of the reasons the GAI was initially developed was due to the fact that many school districts employed an ability-achievement discrepancy analysis process when diagnosing learning disabilities. In other words, a significant discrepancy has to exist between FSIQ and the specific academic area of disability (Saklofske, Zhu et al., 2005). However, children with learning disabilities often have deficiencies in their cognitive processes which in turn lowers their FSIQ and may reduce the amount of discrepancy between FSIQ and academic achievement. In fact, among the special group samples on the WISC-IV, over 70% of individuals with a learning disorder had a higher GAI than FSIQ (Saklofske, Zhu et al., 2005). Therefore, the GAI was suggested to be used as an alternate to the FSIQ when conducting ability-achievement discrepancies in order to determine diagnoses or access to services (Saklofske, Zhu et al., 2005).

The GAI has also been recommended to be used in place of the FSIQ when there is a large discrepancy, usually 23 points or more, between one of the indices comprising the GAI, and the WMI or PSI (Flanagan & Kaufman, 2004; Saklofske, Zhu et al., 2005). Additionally, test publishers suggest that the statistical significance of any difference

between the GAI and FSIQ be examined. Generally, the difference is statistically significant when the GAI is nine points or higher than the FSIQ (Saklofske, Zhu et al., 2005). It is important to note that a discrepancy of nine or more points between GAI and FSIQ was only reported in 6.5% of the overall Canadian standardization sample. Comparatively, 16% of the gifted and talented students in the Canadian standardization sample had a GAI> FSIQ discrepancy of nine points or more (Saklofske, Zhu et al., 2005). Therefore, the GAI may be a more accurate representation of general intellectual ability among certain gifted children.

The Cognitive Proficiency Index (CPI) was first suggested by Dumont and Willis resulting from concerns that the Working Memory and Processing Speed indices determined 40% of the FSIQ score despite the fact that they are somewhat poorer measures of general intelligence (Dumont & Willis, 2002). They instead suggested the Dumont Willis indices (DWI), with the DWI-1 score comprising the VCI and PRI subtests and the DWI-2 comprising the WMI and PSI subtests. The DWI-1 was considered parallel to the GAI which had been previously suggested with the WISC-III (Saklofske, Zhu et al., 2005). The DWI-2 was extended by the WISC-IV publisher and renamed the Cognitive Proficiency Index (Weiss, Beal, Saklofske, Alloway, & Prifitera, 2008). The CPI is a measure of how efficiently one is able to process cognitive information. Specifically, it is the speed at which an individual is able to process information as well as their ability to remember and mentally manipulate information in immediate memory. The more efficiently one is able to process information, the better able they are to fluidly reason and acquire new material as efficient processing reduces the cognitive load of novel and complex tasks (Weiss et al., 2008). The CPI also has

excellent psychometric properties with reliability coefficients ranging from 0.92 to 0.94 for the different age groups in the WISC-IV standardization sample.

Previous Research Examining Gifted Children's Performance on the WISC-IV

There is some evidence from the gifted standardization sample for the WISC-IV that children previously classified as gifted tend to score lower on the WMI and PSI indices which make up the CPI (Saklofske et al., 2005; Wechsler, 2003a, Wechsler, 2003b). The gifted children in the American standardization sample were 63 children aged 6 to 16-years-of-age who had had previously obtained scores of at least two standard deviations above the mean on a measure of cognitive ability (Wechsler, 2003a). The mean FSIQ on the WISC-IV for this group was 123.5. The VCI was the highest score (M = 124.7), followed by the PRI (M = 120:4), and the WMI (M = 112.5). The lowest scores were obtained on the PSI (M = 110.6). The lower FSIQ scores that these children obtained were theorized to be due to several reasons. First of all, while measures of cognitive ability tend to correlate quite highly they do not all produce the same results. Secondly, lower results on this measure may be in part due to the Flynn effect, as these children were tested with older versions of intelligence tests (Volker & Phelps, 2004). Finally, the reliable identification of gifted children tends to be difficult, especially in younger children, due to the rapid progression of developmental change which occurs during childhood (Wechsler, 2003a). In other words, children who may be identified as being gifted may just be developing skills at a faster rate than their peers and therefore perform superior to their peers at one point in time but regress towards the mean as the skill set of their peers catches up (Wechsler, 2003a).

Despite the fact that the overall gifted sample did not obtain a FSIQ of 130 or above, their performance still demonstrates a trend, which has been identified by a number of researchers, for gifted children to score higher on the subtests which make up the GAI and poorer on the subtests which make up the CPI (Newman et al., 2008). In fact the GAI among this sample is roughly 126.7 while the CPI is roughly 113 which represents a discrepancy of over 12 points between the two indices.

A similar trend was observed among the 25 gifted children, aged seven to 16-years of age, which were in the Canadian standardization sample; however the GAI versus CPI discrepancy was not as extreme. The average FSIQ among this group was 124.9. Although, scores on the VCI were highest ($M = 122.5$) and scores on the PRI were slightly lower ($M = 118.1$), scores on the WMI ($M = 116.9$) and the PSI ($M = 117.3$) were the poorest. Finally, the GAI among the Canadian sample was 124.5; while, the CPI was roughly, 121 (Wechsler, 2003b).

Finally, among the 34 gifted adults, aged 17 to 64, which made up the Wechsler Adult Intelligence Scale - Fourth Edition (WAIS-IV) American standardization sample, lower performance was observed on the subtests which made up the PSI, but not for the subtests which made up the WMI. The average FSIQ for the gifted population was 126.5, with the highest scores being obtained on the VCI ($M = 127.2$), followed by the WMI ($M = 123.3$), and the PRI ($M = 119.6$), while the PSI ($M = 112.4$) was again the lowest index score among this sample (Wechsler, 2008). Overall, across the gifted standardization samples for the WISC-IV and WAIS-IV, individuals score highest on the VCI and lowest on the PSI. The lower scores on the PSI are consistent with previous research demonstrating that individuals classified as gifted tend to score lower on subtests

measuring processing speed compared to their performance on subtests measuring other cognitive abilities (Newman et al., 2008; Watkins, Greenawalt, & Marcell, 2002; Wechsler, 2008).

There is a paucity of published studies examining the performance of gifted children on the WISC-IV; however, several investigations have been conducted by researchers working at gifted centres and interest groups for gifted individuals. For example, several researchers reported that the gifted children in their clinic demonstrated a similar trend to have higher PRI and VCI scores compared to PSI and WMI scores. In this particular study 103 children referred for a gifted assessment at the Gifted Development Centre in Denver were recruited. The researchers reported that, on average, the children scored highest on the VCI (M = 131.69) and slightly lower on the PRI (M = 126.42) (Falk, Silverman, & Moran, 2004). The children in this sample scored much lower on the subtests which make up the CPI. Across the sample lower scores were seen on the WMI (M = 117.65) and the sample scored in the average range on the PSI (M = 104.33) (Falk et al., 2004). The discrepancy between GAI and CPI among this sample is much larger than that found among the gifted children and adults in the WISC-IV and WAIS-IV standardization samples. In fact, the average discrepancy between indices was 27.36, indicating that the GAI would likely have been a better measure of general intellectual ability among most of the children in this sample, provided they did not have large discrepancies between the VCI and PRI. In fact the average GAI of this sample is 132 while the FSIQ is only 127.2 (Silverman, Gilman, & Falk, 2004). Based on a program cut-off of 130, use of the FSIQ would likely have resulted in many of the children in this sample being rejected. However, most of the children would have met

the 130 IQ cut-off if the GAI was used. If the FSIQ is to be used as a cut-off for acceptance to gifted programs the researchers recommend that a cut-off of 123 rather than 130 will enable most children who scored in the Superior range on the VCI or PRI to gain entrance into gifted programs (Falk et al., 2004).

Similar results were seen among a sample of 42 gifted children from the Family Achievement Clinic in Cleveland. The VCI (M = 130.0) was once again the highest index score among this sample with the PRI being the next highest index score (M = 126.7). The Working Memory Index was lower than the VCI and PRI (M = 119.9). The PSI among this sample was once more the lowest index score (M = 111.9). Moreover, in 74% of the sample there was a discrepancy of 23 points or more between two indices and the FSIQ was therefore not reported (as cited in Rimm et al., 2008).

In 2006, the National Association for Gifted Children set up a task force for gifted IQ interpretation. They recruited 334 gifted children from eight different states across the United Sates to further examine how they scored on the WISC-IV (Gilman, Falk, & Havens, 2009). The results demonstrated a similar trend. Again the highest scores were seen on the VCI (M = 133.17) with the next highest scores seen on the PRI (M = 127.84). Consistent with previous studies examining gifted children, the lowest scores were found on the WMI (M = 121.58) and PSI (M = 112.02) (Gilman et al., 2009). The mean discrepancy between the VCI and PSI was roughly 21 points; furthermore, 70% of the children in the sample had discrepancies of 23 points or more. Finally, based on an FSIQ cut-off of 130, only 57.2% of this sample would have qualified for gifted programming; however, if the GAI was used in place of the FSIQ then 69.5% of the sample would have met the 130 IQ cut-off (Gilman et al., 2009). However, it is important to consider that

some of the children that would qualify for gifted programs based on the GAI may have had CPI scores in the Low Average to Average range and therefore a gifted program may not be the best fit for them. Overall, while the GAI may allow more children to meet gifted program cut-offs CPI scores should be examined as well, as low scores on these domains may limit the amount of success that children may achieve in a gifted program.

Specific issues surrounding measurement of processing speed.

There are a number of reasons why gifted children tend to score lowest on subtests of processing speed. First of all, researchers such as Sternberg (1982) question whether speed of processing is a distinguishing factor of gifted individuals. Highly intelligent individuals tend to reflect on problems rather than answer them impulsively. Furthermore, research has shown that gifted individuals spend more time globally planning before they begin to solve problems (Sternberg, 1982). Therefore, it is important to note that quick responding may not be beneficial on certain tasks, especially those with high reasoning demands. Accordingly, gifted children generally do not excel at tasks measuring processing speed to the same extent as they do on tasks measuring abstract reasoning abilities (Kaufman, 1992). For example, one study comparing performance between gifted children and matched controls on a continuous performance task found that the two groups did not differ significantly on response time (Chae, Kim, & Noh, 2003). The researchers hypothesized that this may have been due to the fact that the gifted children were perfectionistic and slowed their reaction time to ensure they made few errors.

A factor analysis of WISC-III performance for 505 gifted children demonstrated that subtests with high processing speed demands, specifically coding, arithmetic, and

picture arrangement, did not contribute to the factor analysis. Rather a two factor structure emerged consisting of the perceptual reasoning subtests and the verbal comprehension subtests (Watkins et al., 2002). These results provide further evidence that the GAI may present the best representation of intellectual ability among gifted children and may be more appropriate to use when making educational placement decisions (Watkins et al., 2002).

Several aspects of the timed WISC-IV subtests themselves may also explain why gifted children tend to score lower on these subtests. First of all, children with reflective or perfectionist response styles, or mild coordination problems may be penalized on speeded tasks such as block design, symbol search, and coding (Kaufman, 1992; National Association of Gifted Children, 2008; Newman et al., 2008). Secondly, gifted children may score lower on subtests with time bonuses, such as block design, as children above the age of 12 need to obtain bonus time completion points to achieve a score in the High Average range. For example, a child aged 15 to 16 years of age who answers every block design question correctly but fails to obtain bonus points will only achieve a score at the 50th percentile (Hebben, 2004). Research examining gifted children and adolescents has reported high levels of perfectionism among this group, which among some individuals can be maladaptive. For example, among a sample of 142 gifted adolescents, 50 participants rated themselves as high on concern over mistakes and doubting of actions (Dixon, Lapsley & Hanchon, 2004). These particular individuals tended to doubt their ability to complete tasks and were overly concerned about making errors. Children and adolescents with this level of perfectionism would likely be slower to complete certain tasks, such as coding, as they would be overly concerned about making mistakes and

check their work frequently. Finally, the Coding and Symbol Search tasks are simplistic non-meaningful tasks and may be boring for children with higher intelligence; therefore, gifted children may put more effort into solving meaningful complex problems on the VCI and PRI over the tasks on the PSI and WMI (Gilman & Kearnery, 2004; National Association of Gifted Children, 2008). Accordingly, gifted children tend to score much higher on arithmetic, a supplemental working memory task which involves solving meaningful math problems (Falk et al., 2004).

Fittingly, when the gifted children in the American Standardization sample were compared to matched controls Coding, Cancellation, and Digit Span Backwards all failed to significantly differentiate the gifted children from other matched controls (Wechsler, 2003a). Moreover, among a sample of 103 children referred for gifted assessments the group scored lowest on the Coding subtest, with an average scaled score of 9.9 (Falk et al., 2004). These results suggest that the Coding subtest in particular fails to differentiate between children classified as gifted and children with average intelligence. Furthermore, Coding has been demonstrated to be the poorest measure of "g" within the subtests comprising the core battery (Flanagan & Kaufman, 2004). Finally, among a sample of 334 gifted children, only 36 children obtained a score of 130 or above on the PSI which indicates that scores in the Superior range on the PSI are infrequently seen among gifted children (Gilman et al., 2009). Taken together, there is strong evidence that the processing speed subtests on the WISC-IV tend to lower the FSIQ among gifted children and, therefore, the GAI may be a more meaningful measure of general intellectual ability among this population.

Overall, results from the WISC-IV and WAIS-IV standardization sample demonstrate that children previously classified as gifted tend to score higher on the subtests which make up the GAI, while subtests within the CPI tend to pull their FSIQ scores down. Additional examinations by researchers working at gifted centres demonstrate a similar trend; however, these studies should be interpreted with caution as they have not been published in peer review journals and lack descriptions regarding research methodology. Furthermore, the VCI and PRI subtests which measure abstract reasoning skills, are better indicators of giftedness than scores on the lower "g" loading subtests which make up the WMI and PSI (Flanagan & Kaufman, 2004; National Association of Gifted Children, 2008). Therefore, the GAI may more accurately reflect the cognitive abilities of gifted children. However, scores on the CPI should not be discounted as measurements of cognitive efficiency are important components of intelligence tests and children who have poor working memory and low processing speed are likely to have a number of difficulties in the classroom (Gilman & Kearnery, 2004; Weiss, Saklofske, Coalson, & Raiford, 2010). Deficits in working memory or processing speed can also impact the ability to effectively reason. For example, a child with slow processing speed will also have affected working memory as slow processing places a higher cognitive load on the working memory system (Weiss et al., 2010). Slow speed of processing often necessitates rehearsal of information for a longer time period to prevent losing the information before they are finished working with it. In turn deficits in working memory make problem solving as well as learning new material more difficult (Weiss et al., 2010). Therefore, if a child has deficits in processing speed and working memory, these impairments will likely affect their scores on the VCI and PRI. However,

while gifted children tend to score lower on measurements of working memory and processing speed compared to their scores on subtests measuring more abstract reasoning they still tend to score in the Average to High Average range and therefore do not have deficits in these areas.

Twice Exceptional Children

Discrepancies between the GAI and CPI may be even stronger among twice exceptional children. Twice exceptional children are those who have a disability along with superior performance in one or more areas (Neihart, 2008). These children may be gifted but also have a Learning Disorder, ADHD, Asperger's Disorder, a Physical Handicap, or Emotional Difficulties (Neihart, 2008). Results from the WISC-IV Special Group Standardization sample indicated that a number of disorders found in children, such as ADHD, Learning Disabilities, and Autism may affect cognitive functioning (Wechsler, 2003a). For example, research has shown that children with depression tend to have lower scores on measures of processing speed relative to FSIQ scores (Calhoun & Mayes, 2005). Furthermore, children with ADHD and Learning Disabilities tend to have lower scores on measures of working memory and processing speed compared to FSIQ (Calhoun & Mayes, 2005; Schwean & McCrimmon, 2008; Wechsler, 2003a; Weiss & Gabel, 2008).

Gifted children with learning disabilities.

Learning Disabilities are neurological disorders in which specific cognitive deficits, such as deficits in working memory, lead to lower achievement in certain academic areas than would be expected based on global cognitive abilities (Hale et al., 2008; Hale, Kaufman, Naglieri, & Kavale, 2006). However, many gifted children with

learning disabilities look like average students in the classroom as their high intellectual abilities tend to mask their learning difficulties and their learning difficulties tend to mask their high intellectual abilities (Neihart, 2008; McCoach et al., 2001). Accordingly, Learning Disabilities in gifted children often go undiagnosed until they reach Junior High or High School. Additionally, schools often fail to focus on and address the strengths that these children have. Moreover, due to the ability for gifted children with Learning Disabilities to excel in certain areas, their poor performance in other areas is often viewed by school officials and parents as being due to laziness (Neihart, 2008; Nielsen, 2002). Many years of frustration due to underachievement can lead to depression, feelings of worthlessness, low self esteem, and anger which may explain the higher rates of emotional and behavioural disorders among this group (Neihart, 2008; Nielsen, 2002). Therefore, these children represent a vulnerable group of individuals who need support in order to function academically, and socially, and emotionally (Neihart, 2008).

Gifted children with Learning Disabilities will likely benefit from individualized programs and interventions to fit their specific areas of strength and weakness. However, due to impairments in cognitive processing among children with Learning Disabilities, their CPI tends to pull down their FSIQ (Weiss & Gabel, 2008).Therefore, gifted children with Learning Disabilities may often fall through the cracks as their FSIQ will likely not be high enough to meet criteria for a gifted program (Ferri, Gregg, & Heggoy, 1997; Nielsen, 2002; Rimm et al., 2008; Winner, 1997). Furthermore, their high level of intelligence may enable them to compensate for deficits and thus their academic abilities may not be in the below average range (Ferri et al., 1997). Consequently, gifted children with Learning Disabilities will not be eligible for a diagnosis of a learning disability or

placement into a gifted program. Overall, using the GAI as a measure of general intellectual ability among gifted children with Learning Disabilities may be more appropriate due to the lower scores these individuals often obtain on the CPI.

Gifted children with ADHD.

It is possible for gifted children to also have a diagnosis of ADHD. Certain researchers claim that ADHD among gifted children is underreported as their high intellectual abilities can mask some of the deficits seen among children with ADHD (Chae et al., 2003). Rates of ADHD among gifted children may be higher than one would expect. For example, one study found that out of 107 gifted children, with an average FSIQ of 138.4, ten were diagnosed with ADHD based on parent and teacher ratings as well as behavioural observations and a continuous performance task (Chae et al., 2003).

Conversely, many professionals argue that ADHD may be over-diagnosed in gifted children as many gifted children may behave as though they have ADHD in the classroom, especially if their academic program is not challenging enough for them. What appears to be inattentiveness in gifted children may actually be due to boredom from being given tasks which are too easy for them (American Psychiatric Association, 2000; Antshel et al., 2007; Chae 2003; Hartnett, Nelson, & Rinn, 2004). Furthermore, behaviours that could be viewed as hyperactive may actually be due to over excitability which is common among gifted children, while behaviours that appear to be defiant (e.g., questioning authority) may be due to their higher intelligence level and reflective thinking style (Antshel et al., 2007; Chae et al., 2003; Hartnett et al., 2004). Finally, gifted children excel cognitively relative to other areas of development, therefore, their

social skills, motor development, and emotional regulation abilities often lag behind their cognitive abilities (Chae et al., 2003; Hartnett et al., 2004). Delayed motor development, social skills and emotional regulation are also commonly found among children with ADHD which may make the differentiation between the two more difficult (Chae et al., 2003; Hartnett et al., 2004).

Despite the debate regarding differential diagnosis between giftedness and ADHD, researchers tend to agree that it is possible to have both exceptionalities (Antshel, 2008). Importantly, two recent studies found that gifted children who also had ADHD were much more likely to have to repeat a grade compared to high IQ controls without ADHD (Antshel et al., 2007; Antshel, 2008). These results indicate that, while these children have high levels of cognitive ability, their academic performance is impaired due to their comorbid ADHD, which is inconsistent with the premise that ADHD like symptoms are simply due to boredom in the classroom (Antshel et al, 2007). Gifted children with ADHD should be identified and given proper intervention as they tend to underachieve academically, are more likely to repeat grades, and have difficulties with emotional regulation and social skills (Antshel et al., 2007; Chae et al., 2003; Moon, Zentall, Grskovic, Hall, & Strormont, 2001).

Children with ADHD have deficits in working memory which may depress their FSIQ (Antshel, 2008; Mayes & Calhoun, 2006; Schwean & McCrimmon, 2008). Furthermore, children with ADHD also tend to score lower on the subtests which make up the processing speed index (Mayes & Calhoun, 2006). Children with ADHD have been demonstrated to score lower on the Coding subtest compared to Symbol Search (Mayes & Calhoun, 2006). The motor demands required on the Coding subtest may

explain lower performance as children with ADHD often have motor skill and visual motor integration deficits due to impaired reconstitution (Schwean & Saklofske, 2005). Therefore, children with ADHD tend to have lower CPI scores than FSIQ scores and consequently the CPI tends to lower the FSIQ in children with ADHD. Accordingly, 15.2 percent of the ADHD group in the WISC-IV standardization sample had a GAI>FSIQ discrepancy of nine points or higher (Wechsler, 2003a). Thus, children who are gifted and also have ADHD will likely have an even higher discrepancy between GAI and FSIQ and use of the GAI may therefore allow more children with ADHD to meet cut-offs for gifted programs.

Summary

Taken together, the GAI may better represent the cognitive abilities of children identified as gifted (Newman et al., 2008). Furthermore, the use of the GAI over the FSIQ may allow more children to meet cut-offs for entrance into programs for gifted and talented students (Gilman & Kearnery, 2004; Kaufman, 1992; Saklofske et al., 2005). Moreover, the use of the GAI over the FSIQ in determining eligibility for gifted and talented programs may allow children with Learning Disabilities or ADHD a better chance of meeting entrance requirements (Saklofske et al., 2005). However, the CPI should still be examined to ensure that the child has the cognitive capabilities to succeed in a gifted program. Importantly, little research has been conducted examining how gifted children in Canada score on the WISC-IV and this area should be examined further as there was only a small discrepancy between GAI and CPI among the Canadian standardization sample.

The purpose of the present study was to examine how a sample of Canadian children with high intelligence scored on the WISC-IV. Specifically, discrepancies between the GAI and CPI as well as GAI and FSIQ were examined in order to determine if the GAI is educationally and diagnostically useful in the assessment, identification, and placement of gifted children. It was hypothesized that children in our above average and high intelligence sample would have higher GAI and lower CPI scores than FSIQ. Furthermore, it was hypothesized that our sample would score lowest on subtests measuring processing speed.

CHAPTER 2: METHODS

Participants

Participants were male and female children recruited through psychoeducational assessment clinics at two Canadian universities. The participating university clinics included the University of Calgary Applied Psychology and Educational Services (U-CAPES) clinic at the University of Calgary and the Clinic Services Centre at the University of Alberta. Both clinics specialize in psychoeducational assessment and are primarily staffed by graduate students in Applied Psychology or Educational Psychology departments.

Sample Size

A total of 26 participants between the ages of 6 years 9 months and 12 years 1 month were recruited. The sample size consisted of 18 males and eight females with an average age of 9 years 4 months. The referral question was only provided for the participants from the U-CAPES clinic. Among, the 15 participants obtained from the U-CAPES database, seven came in solely for a gifted assessment, one came in solely due to behavioural concerns, one came in for a gifted assessment as well as behavioural concerns, one came in due to concerns regarding attention, two came in for a gifted assessment as well as concerns regarding attention, one came in for a gifted assessment and to query a writing learning disability, and one came in for a gifted assessment as well as concerns regarding social skills. A specific referral question was not indicated for one participant.

A total of 18 participants did not have a DSM-IV TR diagnosis. Five participants had been diagnosed with ADHD. One participant had been diagnosed with a depressive

disorder, while another was diagnosed with an anxiety disorder. The specific anxiety disorder and depressive disorder was not provided. Finally, one participant was diagnosed with comorbid ADHD and Oppositional Defiant Disorder.

Measures

The Wechsler Intelligence Scale for Children- Fourth Edition.

All subtest scores and index scores on the WISC-IV were obtained for each participant. The WISC-IV consists of 10 core subtests and five supplemental subtests. An overall FSIQ is provided as well as four separate index scores. The Verbal Comprehension Index (VCI) consists of three core subtests that measure one's ability to reason abstractly with verbal information. The Perceptual Reasoning Index (PRI) consists of three core subtests that measure the ability to abstractly reason with visual information. The Working Memory Index consists of two subtests that measure working memory ability. The Processing Speed Index consists of two subtests that measure one's ability to quickly process visual information (Wechsler, 2003a). The GAI and CPI scores were calculated for each participant. The WISC-IV has excellent reliability, with test-retest coefficient for each index ranging from 0.86 to 0.91. The WISC-IV has also been demonstrated to have appropriate construct and concurrent validity (Wechsler, 2003a; Sattler & Dumont, 2008).

Scores on an achievement measure were also collected when one had been conducted. A total of 11 participants had complete scores from the Wechsler Individual Achievement Test - Second Edition (WIAT-II), while a further 11 participants had partial scores from the WIAT-II or Woodcock Johnson Test of Achievement - Third Edition (WJ-III ACH).

The Wechsler Individualized Achievement Test- Second Edition.

The WIAT-II is a standardized test of achievement that consists of nine subtests which examine performance in reading, mathematics, writing, and oral expression. An overall achievement score is reported as well as four composite scores (Wechsler, 2005). The WIAT-II was co-normed with the WISC-IV. The WIAT-II has adequate test-retest and inter-rater reliabilities. The WIAT-II has appropriate concurrent validity and tends to correlate well with other measures of academic achievement with validity coefficients ranging from 0.7 to 0.8 (McLoughlin & Lewis, 2008).

The Woodcock Johnson Test of Cognitive Abilities- Third Edition.

The WJ-III COG is another standardized measure of achievement that consists of 12 core subtests which also measure reading, mathematics, writing, and oral language (Woodcock, McGrew, & Mathers, 2001). The WJ-III COG has appropriate reliability, with test-retest reliability coefficients ranging from 0.69 to 0.87 for the various subtests. The WJ-III COG also had appropriate levels of construct and concurrent validity (Woodcock et al., 2001; Sattler, 2008).

Procedure

All data were obtained from previous psychoeducational assessments. Any children between the ages of 6 years and 16 years 11 months who obtained a FSIQ of one standard deviation above the mean, equal to an FSIQ of 115, were included in the sample. At the time of assessment all participants had consented to their data being used in anonymous research. As such, the researchers had no contact with participants and all data was obtained anonymously from blind research databases.

Data Analysis

Initial analyses were mainly descriptive in nature, focusing on means, standard deviations, and ranges for subtest scores, index scores, and FSIQ. Exploratory data analysis was then conducted to ensure that the data was normally distributed as well as identify any potential outliers in the data. Two one-sample t-tests were conducted examining the average discrepancy between GAI and FSIQ as well as the average discrepancy between GAI and CPI. The sample was compared to the known population mean of zero for both discrepancy analyses (Wechsler, 2003a). Following this the sample was split into two groups based on whether or not they had diagnoses from the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition- Text Revision (DSM-IV TR). Further examinations of descriptive statistics were conducted on each sample separately. Then two more one-sample t-tests were conducted examining the discrepancy between GAI and FSIQ as well as GAI and CPI among the two samples. Finally, several two-sample t-tests were conducted in order to compare the WIAT-II scores for reading, mathematics, and writing between the group with DSM-IV TR diagnoses and the group without diagnoses. Research has demonstrated that gifted children with ADHD underachieve in school (Antshel et al, 2007); therefore, one tailed tests were conducted as it was hypothesized that the no diagnosis group would have higher WIAT-II scores than the group with DSM-IV TR diagnoses. Due to the fact that the FSIQ was higher among the no diagnosis group an ANCOVA was conducted examining math achievement between the two groups using FSIQ as a covariate.

CHAPTER 3: RESULTS

WISC-IV Scores

Prior to analysis the three major index scores were examined in order to detect violations of normality and the presence of outliers. The FSIQ, GAI, and CPI were all found to be normally distributed and no outliers were found among the variables. As predicted the GAI was on average 3.80 points higher than the FSIQ. Furthermore, as predicted the FSIQ was higher than the CPI. Finally, the GAI was 14.12 points higher than the CPI, which represents a discrepancy of almost a standard deviation. Finally, as predicted the PSI was the lowest index score with performance across our sample falling in the Average range (see Table 1). Furthermore, the lowest subtest scores were obtained on Coding (see Table 1). Four participants in our sample had a FSIQ in the Superior range, while seven obtained a GAI in the Superior range. While six participants obtained a VCI in the Superior range, five participants obtained a PRI in the Superior range, one participant obtained a WMI in the Superior range, and two participants obtained a PSI in the Superior range.

Index Score Discrepancies

A one-sample t-test was conducted to compare the GAI and FSIQ discrepancy to the known population mean of zero. There was a significant discrepancy between the GAI versus the FSIQ ($M = 3.80$, $SD = 5.22$; $t\ (25) = 3.72$, $p < .01$ (two tailed). The magnitude of discrepancy between the two variables was large (mean difference = 3.80, 95% CI: 1.70-5.91; Cohen's $d = 0.73$). Another one-sample t-test was conducted to compare the GAI and CPI discrepancy to the known population mean of 0. There was a significant discrepancy between the GAI and the CPI ($M = 14.12$, $SD = 12.35$; $t\ (25) =$

5.83, $p = .000$ (two tailed). The magnitude of the discrepancy between the GAI and CPI was very large (mean difference = 14.14, 95% CI: 9.13- 19.10; Cohen's $d = 1.14$).

Table 1

Average Index Scores

Index Score	Mean	Standard Deviation
VCI	120.88	13.07
Similarities	14.04	2.31
Vocabulary	14.00	2.64
Comprehension	12.42	2.93
PRI	122.38	11.67
Block Design	13.15	2.66
Picture Concepts	12.96	1.99
Matrix Reasoning	14.23	2.93
WMI	111.65	12.38
Digit Span	12.12	2.30
Letter Number Seq	11.92	2.68
PSI	108.58	12.45
Coding	11.08	2.84
Symbol Search	11.92	2.61
FSIQ	122.46	5.85
GAI	126.27	8.75
CPI	112.15	7.74

Group with Disorders Versus Group With No Disorders

When the sample was divided into two groups based on whether they had a DSM-IV TR diagnosis or not, there were 18 individuals with an average age of 9 years 4 months in the no diagnosis group (13 males, five females). There were eight individuals with an average age of 9 years 5 months (five males, three female) in the clinical group. The average FSIQ for the no diagnosis group was higher than the FSIQ for the clinical group (see Table 2). The average GAI among the no disorder group was also higher than the GAI among the clinical group (see Table 2). The average CPI among the no disorder group was 8.53 points higher than the average CPI among the clinical group. The average VCI and PRI were similar among both groups (see Table 2). However, the no disorder group had higher WMI and PSI scores compared to the clinical group (see Table 2). Due to the lower CPI among the children in the clinical group the discrepancy between GAI and CPI among this group was much larger ($M = 18.25$) than among the children without disorders ($M = 12.28$). Additionally, the discrepancy between GAI and FSIQ was also larger for the clinical group ($M = 5.25$) versus the no disorder group ($M = 3.12$). Despite slightly higher scores among the no disorder group both groups obtained their highest scores on Matrix Reasoning and their lowest scores on Coding (see Table 2).

A one-sample t-test was conducted for the no diagnosis group and there was a significant discrepancy between the GAI versus the FSIQ (see Table 3). The magnitude of discrepancy between the two variables was large. Another one-sample t-test was conducted and there was a significant discrepancy between the GAI and the CPI (see Table 3). The magnitude of discrepancy between the two variables was large.

Two additional one-sample t-tests were conducted examining the index score discrepancies among the clinical group. There was a significant discrepancy between the GAI and the FSIQ and between the GAI and CPI among the clinical group. The magnitude of discrepancy between both sets of index scores was very large (see Table 3).

Achievement Test Scores

Achievement test scores were examined for children in each group. Reading achievement scores were available for 15 of the no disorder group and seven of the clinical group participants. There were no significant differences between scores for both groups (see Table 4). Writing Achievement scores were available for 14 of the children in the no disorder group and five of the children in the clinical group; however, there were no significant differences between the two groups (see Table 4). Finally, math achievement scores were obtained for 15 of the children in the no disorder group and six of the children in the clinical group. The no disorder group performed significantly higher than the clinical group on a measure of math achievement (see Table 4). The magnitude of the difference between the two groups in regards to math achievement was large.

Due to differences in FSIQ between the two groups a one-way between-groups analysis of covariance was conducted to compare the math achievement scores obtained by the disorder group and the no disorder group. Participants' FSIQ scores were used as a covariate in the analysis. After adjusting for FSIQ scores there was no longer a significant difference between math achievement scores for the two groups $F(1, 19) = 2.10, p = .086$ (one tailed).

Table 2

WISC-IV Index Scores for No Diagnosis Group and Clinical Group

Index Score	No Diagnosis $n = 18$		Clinical $n = 8$	
	M	SD	M	SD
VCI	121.72	13.76	119.00	12.00
Similarities	14.28	2.40	13.50	2.14
Vocabulary	14.11	2.97	13.75	1.83
Comprehension	12.5	2.79	12.25	2.92
PRI	122.78	12.84	121.50	9.18
Block Design	13.06	2.92	13.37	2.13
Picture Concepts	13.11	2.00	12.63	2.07
Matrix Reasoning	14.39	2.83	13.88	3.31
WMI	113.33	11.11	107.88	14.9
Digit Span	12.33	2.47	11.63	1.92
Letter Number Seq	12.28	1.67	11.13	4.22
PSI	111.22	10.40	102.63	15.25
Coding	11.39	2.25	10.38	3.96
Symbol Search	12.50	2.79	10.50	2.39
FSIQ	123.89	6.16	119.25	3.62
GAI	127.06	10.09	124.50	4.57
CPI	114.78	6.94	106.25	6.30

Table 3

Index Score Discrepancy for No Diagnosis and Clinical Groups

Discrepancy	No Diagnosis $n = 18$				95% CI		
	M	SD	t(17)	*p*	LL	UL	*d*
GAI>FSIQ	3.17	5.92	2.27	.019†	.22	6.11	0.54
GAI>CPI	12.28	13.31	3.91	>.001†	5.66	18.90	0.93
Discrepancy	Clinical Group $n = 8$				95% CI		
	M	SD	t(7)	*p*	LL	UL	*d*
GAI>FSIQ	5.25	2.92	5.09	>.001†	2.81	7.69	1.80
GAI>CPI	18.25	9.27	5.57	>.001†	10.50	26.00	1.97

Note: CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *d* = Cohen's d; † = one tailed test

Table 4

Achievement Test Results

Composite	No Diagnosis		Clinical		Significance	CI 95%	
	M	*SD*	*M*	*SD*	*t*(df)	*p*	*d*
Reading	118.67	14.20	114.00	12.41	*t*(20)= -.747†	$p > 0.05$	--
Writing	119.71	15.73	107.60	12.07	*t*(17)= -1.40†	$p > 0.05$	--
Mathematics	127.67	15.38	114.33	15.23	*t*(19)= -1.80†	.044	0.87

Note: *d* = Cohen's d; † = one tailed test

CHAPTER 4: DISCUSSION

Overview of Results

As predicted the children in our sample did have significantly higher GAI scores than FSIQ scores. Furthermore, as predicted the children in the sample obtained lower CPI scores than FSIQ scores. Moreover, as predicted the sample obtained their lowest scores on the PSI. Finally, the average GAI>CPI discrepancy among the sample was over 14 points which is significant as discrepancies over 10 points are rarely seen.

Among our sample there were six individuals diagnosed with ADHD, which is in accordance with research demonstrating that ADHD is present among children with high levels of cognitive functioning (Antshel et al., 2007). While none of the children in our sample were diagnosed with a learning disability two participants were performing far below what would be expected based on their cognitive abilities. One participant obtained an FSIQ of 118 with a WIAT-II reading composite score of 88 and a writing composite score of 80. A further participant with an FSIQ of 117 obtained a WIAT-II writing composite score of 87. Due the fact that data were obtained anonymously, it is not possible to rule out the possibility that these participants may have obtained lower scores due to lack of educational opportunity rather than due to an LD. Nevertheless, these results indicate that children with High Average intellectual ability can still be performing academically in the Low Average range.

Clinical Versus No Diagnosis Group

Due to the presence of psychological disorders among several of our participants the sample was split into, a no diagnosis group and a clinical group. The clinical group had higher discrepancies between GAI and FSIQ as well as CPI and GAI compared to the

no diagnosis group. However, the discrepancy among the no diagnosis group maintained statistical significance. Due the fact that 75% of the clinical sample had a diagnosis of ADHD it is not surprising that they had lower CPI scores compared to the no diagnosis group, as deficits in working memory and processing speed are seen among children with ADHD (Antshel, 2008; Mayes & Calhoun, 2006; Schwean & McCrimmon, 2008). Furthermore, the much lower PSI scores among the clinical sample are also not surprising as one individual in the sample had been diagnosed with a depressive disorder and cognitive sluggishness in a common symptom among depressed individuals (American Psychiatric Association, 2000; Calhoun & Mayes, 2005). Accordingly, this participant obtained a PSI score in the Low Average range at 88 while their FSIQ was 124.

An examination of academic achievement between the no diagnosis group and the clinical group revealed that the no diagnosis group scored significantly higher on a measure of math achievement. However, the FSIQ was roughly four points higher among the no diagnosis group and, as FSIQ has been demonstrated to be a significant predictor of academic achievement, a further analysis was conducted in order to control for intelligence (Gottfredson, 2008; Kaufmann & Harrison, 1986). When intelligence was controlled for, the difference between the two groups was no longer significant. However, this is likely due to the small sample size being examined as the discrepancy between the two groups was large, with the no diagnosis group performing 13.34 points higher which is almost equivalent to a full standard deviation. Furthermore, when FSIQ was controlled for, p was equal to 0.086 which is approaching significance. Additionally, while the difference between the writing achievement scores between the two groups was not significant, the no diagnosis group still scored close to a standard deviation higher (M

= 12.11) than the clinical group. Overall, the lack of significant results between the no diagnosis and clinical groups on measures of writing and mathematics achievement may be due to the small sample size in this study. It is therefore recommended that future research examine academic achievement among gifted and high intelligence children with and without ADHD.

Comparison to Previous Research

Contrary to previous research examining gifted children, our sample obtained their highest scores on the PRI rather than on the VCI. However, the difference between the two indices was not very large. Fitting with previous research our sample scored lower on the WMI compared to the VCI and PRI, and scored lowest on the PSI.

An examination of how our sample scored at the subtest level revealed that the lowest scores were obtained on the Coding subtest which is congruent with previous research examining gifted children (Falk et al., 2004). Furthermore, only two participants, or 7.7% of our sample obtained PSI scores in the Superior range which is similar to previous research in which only 36 participants out of 334 (10.8%) obtained scores in the Superior range on the PSI (Gilman et al., 2009). It is important to note that only four participants in our sample had a FSIQ in the Superior range. However, six participants (23%) obtained a VCI in the Superior range and five participants obtained a PRI (19.2%) in the Superior range. Therefore, based on our sample, PSI scores in the superior range are not seen as commonly as VCI or PRI scores in the Superior range among children with Above Average to Superior cognitive abilities.

The children in the sample scored in the High Average range on Block Design which is a timed task and in the Average range on timed tasks on the PSI. These results

may indicate that gifted children perform lower on subtests on the PSI because they lack meaning and complexity and are boring for these children.

The highest subtest scores across the sample were found on the Block Design, Similarities, Vocabulary, and Matrix Reasoning subtests. These subtests are among the best measures of "g" on the WISC-IV (Flanagan & Kauffman, 2004). Furthermore, with the exception of Vocabulary they are all measures of fluid intelligence (Weiss, et al., 2010). Higher subtest scores were also seen for these four tests among the WISC-IV gifted standardization sample (Wechsler, 2003a).

Based on recommendations that the GAI be reported over the FSIQ when there are discrepancies of nine points or higher (Saklofske, Zhu et al., 2005) the GAI should be reported over the FSIQ for six participants in our sample: four in the no disorder group, and for two in the clinical group. Furthermore, based on Flanagan and Kaufman's (2004) suggestions that the GAI be reported when there is a 23 point discrepancy between one of the indices comprising the GAI and one of the indices comprising the CPI, a total of 20 participants in our sample, including all of the children in the clinical group, met criteria for the GAI to be reported. To add further complications a total of eight participants also had discrepancies of more than 23 points between their VCI and PRI scores and therefore the GAI would not have been an appropriate index to report for this group. Moreover, seven of these eight individuals also had discrepancies of 23 points of more between the VCI or PRI and the WMI or PSI. Researchers also suggest that the FSIQ not be reported when any index scores vary by 23 points or more (Flanagan & Kaufman, 2004). Based on these recommendations the FSIQ should only have been reported for six of our 26 participants.

These results are congruent with previous research indicating that gifted children tend to display large discrepancies between index scores. For example, among the children at the Family Achievement Clinic, 74% had discrepancies of 23 points or more between indices and the FSIQ was therefore not reported. Similar results were seen among our sample, as 77% of our participants obtained discrepancies of 23 points of more (as cited in Rimm et al., 2008).

The GAI may be appropriate to report in many children who are gifted or who have high intellectual abilities, especially those with a comorbid disorder. However, some children display a large discrepancy between the VCI and PRI, and therefore neither the GAI nor the FSIQ should be reported. Rather, each index score should be examined separately.

These discrepancies in performance create difficulties for gifted programs as many use a intellectual ability for entrance into programs. When a child obtains large discrepancies between index scores, the FSIQ and GAI may not be a useful interpretation of intellectual ability. Perhaps than single index scores could be used for entrance requirements. What is most important is that the child's abilities match the program they are applying for.

Finally, in regards to entrance into gifted programs a larger proportion of the sample would meet entrance criteria if the GAI was used over the FSIQ. A total of four participants in our sample obtained a FSIQ of 130 above, while seven participants obtained a GAI of 130 or above. Compared to other samples, a smaller proportion of the present sample is likely to have meet criteria for gifted programs given the FSIQ cut-off of 115 and above, resulting in a large number of individuals with FSIQs below 120.

However, the sample displayed a similar trend for children to more likely meet gifted program requirements when the GAI is used over the FSIQ (Gilman et al., 2009; Silverman et al., 2004).

Study Limitations

The primary limitation among this study is the small sample size. While, the small sample size did not impact the significant results obtained for the GAI and CPI discrepancies, this was likely due to the fact that the effect sizes were large. However, when the sample size was further split into two groups, the resulting clinical group was very small, consisting of only eight participants. Furthermore, WIAT-II and WJ-III scores were not available for all participants which further exacerbated the effects of the small sample size. Based on previous research and the large discrepancy between the two groups on math and writing achievement, it is likely that significant discrepancies would have been identified if our clinical group had been larger.

A further limitation of our study was the use of 115 as an FSIQ cut-off. This decision was made in order to increase the amount of participants in our sample as well as to ensure that any participants whose FSIQ were greatly depressed by their CPI were included in the sample. Among our sample, only 15.4% of participants had an FSIQ in the Superior range. However, previous research has examined children previously classified as gifted and therefore sample sizes have tended to include children with higher FSIQ scores. Nevertheless, the average FSIQ obtained among our sample was 122.46 which is not much lower than the FSIQ of the gifted sample in the American standardization group ($M = 123.50$) or the gifted sample in the Canadian standardization group ($M = 124.90$).

Furthermore, the earlier research examined children previously classified as gifted (Wechsler, 2003a; Falk et al., 2004; Gilman et al., 2009). The gifted participants from the WISC-IV standardization sample were selected based on a previous score in the Superior range on an intelligence test. Conversely, the individuals in our sample had not been previously classified as gifted. Therefore, our sample was somewhat different and the results may not be generalizable to children classified as gifted. However, because many children in our sample were not assessed solely for a gifted referral, our sample consisted of a number of clinical children as well as children who are underachieving in school. As previously mentioned, children with ADHD and Learning Disabilities tend not to be referred for gifted assessments. Thus, our sample consisted of children who otherwise would not have been selected if we had only included children previously classified as gifted or children who were referred for a gifted assessment.

Since the data for this study was obtained from blind databases, a number of demographic variables were not available. For example, Socio-Economic Status (SES) was not available and thus could not be controlled for. Additionally, achievement scores were not available for all participants. Furthermore, it would have been beneficial to know about the educational history for the two participants who obtained achievement scores 30 points lower than their FSIQ. If this information had been provided it may have explained their poor performance, or conversely, fail to explain it, suggesting that these children may actually have a learning disability. Moreover, referral questions were only obtained for the participants from U-CAPES and the diagnostic information that was provided was somewhat vague at times. For example, one child was diagnosed with a depressive disorder; however, it is uncertain which specific disorder this was.

Additionally, another participant was diagnosed with an anxiety disorder; however, the specific anxiety disorder was not specified.

Finally, there were no children in our sample size above the age of 12. It would have been beneficial to examine whether or not significant discrepancies were seen among children above the age of 12 as FSIQ scores tend to become more stable in the adolescent years (Wechsler, 2003a; Deary, Whalley, Lemmon, Crawford, & Starr, 2000).

Future Research

There is a lack of published research examining how gifted children score on the WISC-IV and further studies should examine performance using a larger sample size with an FSIQ cut-off of 120 or above. Future research should also be conducted using a larger sample size which includes children with no disorders as well as a group with Learning Disabilities and ADHD in order to further examine how these two groups differ on WISC-IV scores as well as on measures of academic achievement. Furthermore, children up to the age of 16 should also be examined.

It would be informative to examine gifted children's performance on other measures of processing speed which are more meaningful and more complex in order to determine if average performance on subtests of the PSI among gifted children represents actual average processing speed abilities or is rather due to other reasons. Furthermore, research studies examining processing speed among gifted children should control for perfectionism in order to determine if lower scores on subtests such as Coding are due to processing speed or slower performance due to perfectionistic tendencies.

Conclusions

Fitting with our hypotheses the children in our sample scored higher on the GAI and lower on the CPI, particularly on subtests in the PSI. These discrepancies were even greater among children with a clinical diagnosis. These results indicate that the GAI may better represent the general intellectual ability of children with high average intelligence, particularly those with clinical disorders. Therefore, the use of the GAI may allow more children with high intellectual ability to meet criteria for gifted programs. However, the CPI should still be taken into account as low scores on measures of cognitive efficiency may limited the amount of success a child will have in a gifted program. Finally, it is important that gifted programs do not base their selection criteria solely on intelligence test scores as giftedness is not defined exclusively by high intelligence.

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