Examining the Role of PASS Processes in Gifted Reading Performance

by

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Abstract

The purpose of the present study was twofold: (a) to examine what cognitive processes differentiate between gifted readers and controls, and (b) to examine the individual profiles of gifted readers. One hundred forty-four grade 4 to 6 elementary school children (54 grade 4, 55 grade 5, and 35 grade 6) attending enrichment programs in Edmonton (Canada) were assessed on three measures of Broad Reading (Letter-Word Identification, Reading Fluency, and Passage Comprehension), and on measures of Planning (Matching Numbers, Planned Codes), Attention (Expressive Attention, Number Detection), Simultaneous (Nonverbal Matrices, Verbal-Spatial Relations), and Successive (Word Series, Sentence Repetition) processing. The results of multivariate analyses indicated that the gifted readers performed significantly better than controls in planning, simultaneous, and successive processing, and the differences were independent from the reading task used to select them. In addition, the gifted readers exhibited diverse individual profiles of cognitive assets. The most dominant type of cognitive asset was in simultaneous processing, followed by successive processing. The psychoeducational implications of these findings are discussed.

Preface

The research conducted for this thesis forms part of a research project initiated by Dr. George Georgiou at the University of Alberta. The literature review, data analysis, and concluding discussion are the original work of Kristy Dunn.

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First and foremost, this thesis would not have been possible without the guidance, tenacious support, and friendship of my advisor Dr. George Georgiou. Thank you for your level of expectation, expertise, and encouragement to push myself beyond my preconceived capabilities. As well, thank you to my thesis committee members, Dr. Rauno Parrila and Dr. Heather Brown for your professional insights and questions. To my lab mates Angeliki Atani, Helle Ottosen, Krystle-Lee Turgeon, Dominique Gadsden, and Megan Hebert, thank you for your feedback and friendship throughout the past year. Furthermore, this entire graduate experience would not have been possible without the support of my family and friends. You lifted my spirit when I felt like giving up, offered to watch my children when I needed time to study, and surprised me with care packages to keep me calm. Last and most importantly, thank you to my husband Lorne and my children Dain and Kale. I will be forever grateful for your love and support, and the sacrifices you have made in order for me to pursue my passion.

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Chapter 1: Introduction

In 2014, 6, 416 children from grades 1 to 12 were coded as gifted and talented throughout Alberta, Canada; a number that has doubled in less than a decade (Alberta Education, 2014). Despite the increase in children identified as gifted in our schools and nationwide concerns that these children are one of the most neglected groups in education, very little research has been done to better understand what processing skills help these children perform at a high level. Researchers have also argued that without the accurate identification and understanding of the cognitive strengths of gifted children, many would be left with underdeveloped talents and abilities (e.g., Benbow & Stanley, 1996; Castejón, Gilar, Minano, & González, 2016; Kell, Lubinski, & Benbow, 2013). Not only could this equate to an increase in the underachievement of gifted children but it could also pose a consequential detriment to the future of our society (Reis & McCoach, 2000). Thus, the purpose of this study was to examine the role of different cognitive processes in a specific group of gifted children, namely that of gifted readers.

The cognitive processes we selected for the purpose of this study are based on the Planning, Attention, Simultaneous, and Successive (PASS) theory of intelligence (Das, Naglieri, & Kirby, 1994; Naglieri & Otero, 2011; see also Papadopoulos, Parrila, & Kirby, 2015). PASS theory of intelligence is rooted in Luria's (1966, 1973) work on cognition, according to which human cognition consists of three operational systems that support four cognitive processes (planning, attention, simultaneous and successive processing). The first system is planning which is responsible for controlling, organizing, and monitoring behaviour. The second system, attention, ensures sufficient arousal levels and focus on specific stimuli. The third is an information processing system that facilitates simultaneous and successive processing. It enables the encoding, transformation, and retention of information. These cognitive processes are interrelated and interact with an individual's base of knowledge to process information (Das et al., 1994).

To better understand the cognitive profiles of gifted readers, we will not look into reading as a composite score, but we will compare the performance of children who are gifted in reading accuracy, reading fluency, and reading comprehension against that of chronological-age controls on each of the PASS processes. Naglieri (2000) argued that PASS theory – operationalized with the Das Naglieri Cognitive Assessment System (D-N CAS; Naglieri & Das, 1997) – provides a reliable alternative to traditional measures of IQ and that PASS profile analysis is an effective measure for the identification of cognitive strengths or weaknesses related to special education placement (including that of giftedness).

Previous studies have shown that different PASS processes may exert a varied role in different reading outcomes (e.g., Das, Georgiou, & Janzen, 2008; Georgiou & Das, 2014; Papadopoulos, 2001; Wang, Georgiou, & Das, 2012). For example, Papadopoulos (2001) found that successive processing was a unique predictor of reading accuracy (Word Identification and Word Attack) in Greek-speaking grade 1 children. Wang et al. (2012) found that simultaneous processing was a unique predictor of reading fluency in grades 3-5 Chinese-speaking children. Finally, Das, Snart, and Mulcahy (1982) found that planning and simultaneous processing were significant predictors of reading comprehension in a group of fourth and sixth grade English-speaking children. Studies that have also examined the cognitive profiles of children with reading difficulties (e.g., Das, Janzen, & Georgiou, 2007; Das, Mok, & Mishra, 1994; Deng, Liu, Wei, Chan, & Das, 2011) have shown that these children experience deficits in simultaneous and successive processing.

Based on the findings of previous studies that have examined the role of PASS processes in intellectually gifted children (e.g., Abougoush, 2014; Naglieri & Das, 1997) as well as the findings of previous studies examining the role of information processing, attention, and problem solving[1] in gifted children (e.g., Ackerman, Beier, & Boyle, 2005; Johnson, Im-Bolter, & Pascual-Leone, 2003; Shi et al., 2013; Steiner & Carr, 2003), we hypothesized that children who are gifted in reading accuracy and reading fluency will perform significantly better than controls in simultaneous and successive processing. In addition, we hypothesized that children who are gifted in reading comprehension would perform significantly better than controls also in planning. Finally, we hypothesized that gifted readers (irrespective of the task used to select them) would exhibit diverse cognitive profiles, with simultaneous and successive processing emerging as dominant assets.

[1] We mention this line of research because of its transparent connection with PASS processes. For example, problem solving involves planning (Das & Misra, 2015) and information processing is the second processing unit in PASS theory (Das et al., 1994).

Chapter 2: Literature Review

Theories of Giftedness

Decades of research on intelligence have resulted in numerous theories and diverse definitions of giftedness (see Sternberg, Jarvin, & Grigorenko, 2011, for a review). Although these theories continue to play a significant role in shaping our current conception of giftedness, there is still no consensus as to a global definition or process for identifying gifted children (Flanagan & Harrison, 2012; Nagc.org, 2015; Silverman, 2013; Sternberg et al., 2011). For the purpose of this study, the main contemporary theories of giftedness are explored. Provided is a brief overview of these theories chosen because of their inclusion in Alberta Education's current definition and coding criteria for the identification of gifted children. A feature shared by all theories is a shift towards a broader definition of giftedness that includes at least one or more exceptional abilities or talents across multiple domains (e.g., Flanagan & Harrison, 2012; Gagné, 2000, 2005; Renzulli, 2005; Sternberg, 1985, 2010; Sternberg et al., 2011).

The triarchic theory of successful intelligence. A theoretical conception of intelligence that views giftedness as three collaborative features is Sternberg's triarchic theory of successful intelligence (Sternberg, 1985, 1988; Sternberg et al., 2011). This theory is an extension of Sternberg's view that giftedness consists of three distinct intelligences: analytical, creative (synthetic), and practical intelligence. Analytic giftedness refers to the ability to analyze, critique, and evaluate information. Creative (synthetic) giftedness refers to the ability to insightfully create. Practical giftedness is the ability to skillfully implement skills that have been learned in a formal setting to everyday practical situations. Sternberg (1985) argued that successful intelligence is governed by three interrelated aspects: how intelligence relates to the internal world, to experience, and to the external world (Sternberg et al., 2010). The first part of his theory emphasizes three independent information processing components: the executive processes used to plan, monitor, and evaluate a problem; performance components (i.e., lower order processes) that underlie the strategies needed to solve a problem; and the knowledge-acquisition processes which are used to build strategy knowledge for future application to a task. In the second part, Sternberg (1985) claimed that individuals come with varying levels of prior experience to an information processing task. Novel tasks, such as mastering a new subject, place larger demands on the information processes compared to that of a task for which automatic procedures have been developed. The third part of his theory proposes that gifted individuals may not naturally excel in all aspects of intelligence; rather, they are those who can successfully find ways to capitalize on their strengths and compensate for their weaknesses. Sternberg (1985) further argued that gifted children have an advantage over their peers in executive functioning. Their reflective cognitive styles enable them to successfully self-monitor, evaluate, and implement multiple strategies to solve problems in various contexts (Sternberg, 1988, 1998, 2010).

The three ring conception of giftedness. A well-known theory of giftedness is Renzulli's three ring conception of giftedness (Renzulli, 2002, 2011; see also Reis, 2008, 2016, for a review). Renzulli argued that giftedness is not only the function of exceptional IQ, but rather a combination of three representative traits: above-average intellectual ability, high levels of task commitment, and creativity. These traits intersect at varying levels to form gifted behaviours. A child could have an exceptionally high IQ, but not be identified as gifted because of lower levels of task commitment or creativity. Reis (2016) suggested that in order for gifted children to reach their fullest potential, they must be stimulated by multiple tiers of authentic enrichment instruction that introduces new interests, facilitates critical and creative thinking, and develops higher level research skills.

The theory of multiple intelligences. Another view of intelligence is Gardner's theory of multiple intelligences (1983, 1993, 1999). Gardner (1983) argued that individuals are born with a collection of eight specific intelligences that function independently from one another: logical-mathematical, linguistic, spatial awareness, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalistic. Moral and existential areas have also been cited. According to Gardner (1999), individuals possess a unique range of talents and skills that are reflected in the way they interact with their environment. In addition, Gardner (1983) argued that gifted children are further developed in one or several domains compared to their peers with average intellect and that capitalizing on developed intellectual strength can help support development in weaker areas.

The differentiated model of giftedness and talent. A theoretical conception of intelligence that has been used to define giftedness is Gagné's differentiated model of giftedness and talent (Gagné, 1985, 1995, 2004). According to this theory, giftedness is viewed as two distinct abilities: gifts (innate aptitudes) and talents (systematically mastered skills). Gagné argued that there are four main natural abilities: intellectual, creative, socio-affective, and sensorimotor. The development of these gifts into talents are dependent on positive intrapersonal and environmental factors such as parental nurturing and educational opportunities. Based on Gagné's theory, gifted and talented children are those who are among the top 10% of their chronological-age peers in at least one natural domain or talent (Gagné, 1985).

Marland's report. Marland's (1972) report provided one of the first definitions of giftedness to be implemented as part of federal and state educational policy in the United States. Marland (1972) argued that gifted children were those who demonstrated high achievement and/or potential ability in one or more of the following areas: general intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, visual and performing arts, and psychomotor ability. The National Association of Gifted Children (NAGC) has adopted a similar definition proposing that "gifted individuals are those who demonstrate outstanding levels of aptitude (defined as an exceptional ability to reason and learn) or competence (documented performance or achievement in top 10% or rarer) in one or more domains. Domains include any structured area of activity with its own symbol system (e.g., mathematics, music, language) and/or set of sensorimotor skills (e.g., painting, dance, sports)" (NAGC, 2010, p. 1).

The Alberta Education definition of giftedness. Directly relevant to our study and similar to NAGC's definition of giftedness is Alberta Education's definition of Gifted and Talented students. The Alberta Education Special Education Coding Criteria (2014/2015) code 80: Gifted and Talented (terms given equal weight) defines giftedness as individuals with "exceptional potential and/or performance across a wide range of abilities in the following areas: intellectual, specific academic, creative thinking, social, musical, artistic and kinesthetic" (Alberta Education, 2014, p. 5).

The aforementioned theories of giftedness address a wide range of domains including intellectual ability. With the exception of Gagné's (1985) theory, the rest of the theories do not differentiate between gifted and talented children and rely heavily on the assumption that intelligence predicts academic achievement. In addition, Gardner's (1983) theory of multiple intelligences does not articulate how we can reliably assess all of them or which one of the eight intelligences is the most critical in giftedness. To bypass these problems and the criticism surrounding the use of IQ tasks for the identification of gifted children, we used PASS theory of intelligence, which is operationalized by the D-N CAS (Naglieri & Das, 1997) and examines a broad scope of cognitive functions.

PASS Theory of Intelligence and Giftedness

Rooted in the neuropsychological work of Luria (1966, 1973), PASS theory of intelligence is a view of human cognition that is organized into three processing units and four cognitive processes (planning, attention, simultaneous, and successive) (e.g., Das et al., 1994; Naglieri & Das, 1990). Planning is the cognitive process responsible for organizing and regulating behavior, selecting and constructing strategies, and monitoring performance. The second process, attention, is responsible for maintaining arousal levels and alertness to focus on relevant stimuli over a sustained period of time while inhibiting response to irrelevant stimuli. Simultaneous and successive processing are part of the information processing system that is accessed to encode, transform, and retain information. Successive processing aids in holding information active in working memory. It is required for organizing individual items sequentially, such as recalling an arrangement of words or events exactly in the order in which they were presented. In turn, simultaneous processing relates to combining and relating separate units of information to form a conceptual whole. It occurs when the relationship between individual items and their integration into whole units is required as in, for example, the analysis and synthesis of logical-grammatical relationships in a sentence (Das et al., 1994).

A few studies have examined the connection between PASS processes and giftedness (e.g., Abougoush, 2014; Naglieri & Das, 1997; Naglieri & Kaufman, 2001; Schofield &

Ashman, 1987). In an early study that used Luria's simultaneous/successive model as the basis for investigation, Schofield and Ashman (1987) examined the processing performance of 323 grade 5 and 6 children. Seventy-five gifted children (IQ > 124), 146 above average children (IQ = 105-123), and 102 below average children (IQ < 105) were compared on simultaneous, successive, and planning processes. Results showed that the gifted group performed significantly better than the other two groups in simultaneous and complex planning tasks (Backwards Digit Span, Digit Span Strategy, and Verbal Maze). However, the gifted group did not perform significantly better than the above average group in successive processing or in basic planning tasks (Trail-making, Clustering, and Verbal Fluency).

Naglieri and Das (1997) also examined the performance of gifted children as part of the standardization process of D-N CAS. Based on state and federal definitions of giftedness, teacher referrals, achievement, and intelligence test scores, 173 gifted children (ages 8 to 15) were selected and tested on PASS processes. Results showed that, as a group, the gifted children obtained a standard score of 111.9 in planning, 111.0 in attention, 117.7 in simultaneous processing, and 115.8 in successive processing. Naglieri and Das (1997) argued that the higher scores in simultaneous and successive processing scales were expected given that they strongly correlate to most traditional IQ tests that are used to identify gifted children. However, the performance of this group of gifted children was not in the superior range (standard score higher than 120) in any of the PASS processes.

Finally, Abougoush (2014) identified 26 gifted children (IQ > 125 on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 2011)) and 26 controls (IQ 85-124 on WASI) from 81 grade 4, 5, and 6 children. These children were tested on measures of Broad Reading (Letter-Word Identification, Reading Fluency, and Passage Comprehension) and Broad

Mathematics (Calculation, Math Fluency, and Applied Problems), as well as on the D-N CAS basic battery (8 subtests – 2 tasks per PASS scale). Group comparisons revealed that the gifted group performed significantly better than controls in simultaneous and successive processing. In addition, results of individual profile analysis showed that the gifted children exhibited diverse cognitive profiles. A PASS processing asset on a task was defined as a standard score of 120 (superior range) or higher. Of these children, 42.31% displayed no cognitive assets, whereas 26.92% of gifted children showed an asset in at least one PASS process, 19.23% a double asset, 7.69% a triple asset, and 3.85% (only one child) a quadruple asset. The most dominant single asset was in successive processing (15.38%) and both simultaneous and successive processing were the dominant double asset of the gifted children.

The aforementioned studies on PASS processes and giftedness have some important limitations. First, the gifted children selected for these studies were identified as gifted using a variety of criteria. Schofield and Ashman (1987) used IQ scores obtained from the short form of Wechsler Intelligence Scale for Children – Revised and/or teacher nomination for selection. Likewise, Naglieri and Das (1997) allowed schools to nominate students using varying definitions of giftedness and assessment measures. Second, the measures used to examine the PASS processes in Schofield and Ashman's (1987) study were different from the other studies; and since the D-N CAS had not been developed at that time, it did not report on attention (one of the processing skills in PASS theory of intelligence). Finally, Naglieri and Das (1987) did not include a control group in their study.

PASS Theory of Intelligence and Reading

According to Das et al. (1994), PASS processes also underlie reading performance (see Figure 1). Within the framework of proximal and distal processes, successive and simultaneous processing can be explained as skills distal to reading, whereas phonological processing and orthographic coding are proximal to reading. Planning and attention exert an auxiliary role in that they enable the deployment of proximal cognitive skills.

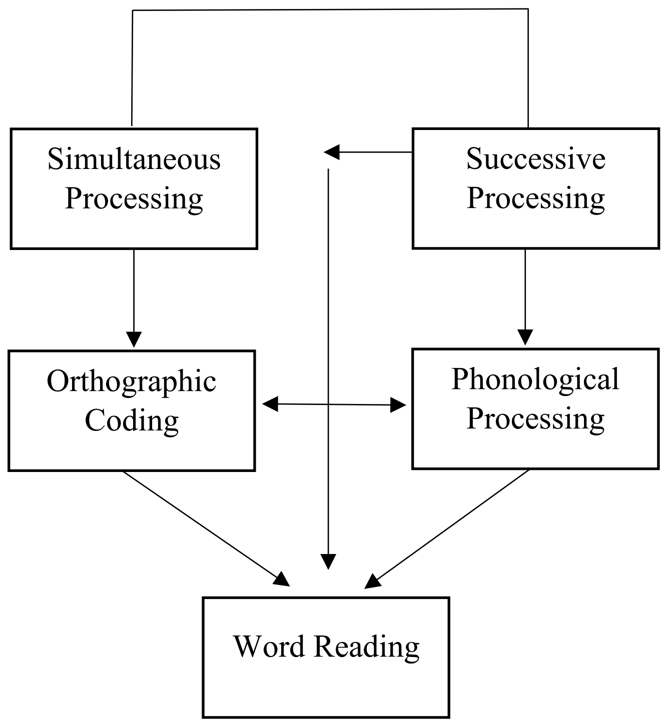

Figure 1. PASS processes underlying word recognition.

The effects of successive processing on word reading are both direct and indirect through the effects of phonological recoding of unfamiliar words and pseudowords (Das et al., 1994). This process involves the identification of individual letters, the retrieval and storage of corresponding sounds in short-term memory, and the blending of sounds into serial order for the assembly of pronunciation. In turn, the effects of simultaneous processing on word reading are mediated by orthographic processing of familiar words. Via this direct visual route, words are coded as holistic units with the use of visual and orthographic knowledge. Given that unfamiliar words or pseudowords may also contain familiar orthographic patterns, both simultaneous and successive processing play an integrated role during word reading. Arguably, if simultaneous and successive processing underlie word reading (see Das et al., 2007; Wang et al., 2012, for empirical evidence in support of the model), both processes should also differentiate between gifted word readers and controls.

The Present Study

The objective of the present study was twofold: (a) to examine if the performance of gifted children in reading accuracy, reading fluency, and reading comprehension differs from that of chronological-age controls in Planning, Attention, Simultaneous and Successive (PASS) processing, and (b) to examine the cognitive profiles of gifted readers.

Based on the findings of previous studies that have examined the cognitive processes of gifted children (see Abougoush, 2014; Naglieri & Das, 1997; Schofield & Ashman, 1987), the theoretical links between PASS and reading (Das et al., 1994), and the studies examining problem solving and information processing in gifted children (e.g., Alexander, Carr, & Schwanenflugel, 1995; Alloway & Elsworth, 2012; Anderson, 1986; Swanson, 1992), we hypothesized that gifted children in reading accuracy, reading fluency, and comprehension would perform significantly better than controls in simultaneous and successive processing, and second, that simultaneous and successive processing skills would emerge as predominant assets that influence superior reading performance in gifted readers.

The findings of this study add to the existing literature in a number of important ways. First, to our knowledge, this is the first study to examine all four PASS processes in gifted readers. Notably, to control for the possible effects of school environment and instruction, we selected the children for the control group from the same classes as gifted children. Second, the findings of this study will fill a gap in the literature of PASS theory since most previous research on PASS has focused on children with cognitive weaknesses (see studies on dyslexia; Das et al., 1994; 2007; Deng et al., 2011) rather than on cognitive strengths. Finally, given that these findings will reveal the cognitive skills in which gifted readers excel, educators will know which processing strengths to target in the development and service of intervention programs for gifted readers.

Chapter 3: Method

Participants

Letters of information describing the study were sent to the parents of all 165 children attending enrichment programs in grades 4, 5, and 6 in three elementary schools in Edmonton (Canada) area. One hundred forty-six children with parental consent were subsequently invited to participate in the study. Two children did not assent to participate and thus our final sample consisted of 144 children (57 grade 4, 52 grade 5, and 35 grade 6). All children were native speakers of English and none were experiencing any sensory or behavioral difficulties[2].

All children were first assessed on three measures of reading (Letter-Word Identification, Reading Fluency, and Passage Comprehension) from the Woodcock-Johnson III (WJ-III; Woodcock, McGrew, & Mathers, 2001). Children with a standard score equal to or higher than 130 in each reading measure were considered to be gifted. Using this criterion, we found 33 children (22 girls, 11 boys; 14 from grade 4, 11 from grade 5, and 8 from grade 6; mean age = 10 years and 5 months, SD = .92) who were gifted in reading accuracy, 32 children (18 girls, 14 boys; 12 from grade 4, 13 from grade 5, and 7 from grade 6; mean age = 10 years and 6 months, SD = .82) who were gifted in reading fluency, and two children who were gifted in reading comprehension. Given the small sample of children who were gifted in reading comprehension, we did not pursue further analyses with this group. Finally, we identified 26 children (17 girls, 9 boys; 11 from grade 4, 8 from grade 5, and 7 from grade 6; mean age = 10 years and 5 months, SD =.84) with a standard score equal to or higher than 130 in both Letter-Word Identification and Reading Fluency.

[2] This is based on anecdotal information we collected from teachers.

To select the subjects for our control group, we checked for children in the initial group of 144 children with a standard score in Letter-Word Identification and Reading Fluency between 85 and 115. Thirty children (12 girls, 18 boys; 13 from grade 4, 13 from grade 5, and 4 from grade 6; mean age = 10 years and 5 months, SD = .73) comprised the control group in Letter-Word identification. In turn, 17 children (9 girls, 8 boys; 8 from grade 4, 7 from grade 5, and 2 from grade 6; mean age = 10 years and 6 months, SD = .82) comprised the control group in Reading Fluency. Finally, 15 children (7 girls, 8 boys; 7 from grade 4, 6 from grade 5, and 2 from grade 6; mean age = 10 years and 6 months, SD = .84) comprised the control group in both Letter-Word Identification and Reading Fluency.

Materials

Reading Achievement. Children completed the Letter-Word Identification, Reading Fluency, and Passage Comprehension subtests from the Woodcock-Johnson Tests of Achievement Third Edition standard battery (Woodcock et al., 2001). McGrew and Woodcock (2001) reported strong psychometric properties for each subtest.

Letter-Word Identification. In Letter-Word Identification, children were asked to read individual words aloud smoothly (e.g., *and*, *together*, *acrylic*, *gouache*). The test consisted of 76 items and was discontinued after six consecutive errors. A child's score was the total number of correct responses. The test-retest reliability for Letter-Word Identification has been reported to be .85 (McGrew & Woodcock, 2001).

Reading Fluency. In Reading Fluency, children were given three minutes to silently read a series of sentences as quickly as possible (e.g., "A book has pages. Y N "). Understanding of the statement was indicated by circling "Y" if the sentence was true, or "N" if the sentence was false. The test consisted of 98 items. A child's score was determined by subtracting the number of incorrect responses from the number of correct responses in a 3-minute time limit. The test-retest reliability for Reading Fluency has been reported to be .78 (McGrew & Woodcock, 2001).

Passage comprehension. In Passage Comprehension, children were asked to read a short passage and then provide the missing word to correctly complete the sentence in a sensible manner (e.g., The man ran over and began to _______. He dug and dug.). The test consisted of 47 items and was discontinued after six consecutive errors. A child's score was the total number of correct responses. The test-retest reliability for Passage Comprehension has been reported to be .86 (McGrew et al., 2001).

Cognitive Measures. The Planning, Attention, Simultaneous, and Successive (PASS) cognitive processes were assessed with the Das-Naglieri Cognitive Assessment System basic battery (Naglieri & Das, 1997), which included two measures for each subscale.

Planning. Planning was assessed with Matching Numbers and Planned Codes. In Matching Numbers, children were presented with four pages comprised of eight rows of numbers that increased in length. For each row, children were instructed to underline the two numbers that looked alike, as quickly as possible. In Items 1-3, children were allowed 150 seconds to complete the task and in item 4 180 seconds. One point was given for each correct pair of matching numbers with a maximum score of eight on each item. The time and number of correct matches for each item was added and converted to a ratio score to obtain a subtest score. Naglieri and Das (1997) reported test-retest reliability for Matching Numbers to be .75. In Planned Codes, children were asked to fill in as quickly as possible, and by using any strategy of choice (e.g., left to right, top to bottom, randomly), empty boxes with a combination of O's and X's printed on top of an empty box that each corresponded to a letter (e.g., A=XO, B=XX, C=OX, D=OO). The task contained two pages, each with a distinct set of codes arranged in seven rows and eight columns. A legend located at the top of each page indicated the combination of O's and X's that corresponded to each letter. Children were given 60 seconds to fill in as many empty boxes as possible. The time and number correct for each page were recorded and combined to obtain a ratio score. The ratio score was then converted to a subtest scaled score. Naglieri and Das (1997) reported test-retest reliability for Planned Codes to be .82.

Attention. Attention was assessed with Expressive Attention and Number Detection. In Expressive Attention, children were given 180 seconds to complete each item on three consecutive pages of increasing difficulty. On the first page, children were asked to read a sequence of colour words (i.e., Blue, Yellow, Green, and Red) arranged in quasi-random order. On the next page, children were asked to name the colour of a series of blocks printed as the colours mentioned on the previous page. On the final page, colour words were printed in a colour different from the word's name (e.g., the word green may appear in yellow ink). Children were then required to name the colour of ink in which the word was presented (e.g., Blue appearing in red ink is read as "Red"). The time and number correct for each page were recorded and combined to obtain a ratio score. The ratio score was then converted to a subtest scaled score. Naglieri and Das (1997) reported test-retest reliability for Expressive Attention to be .80. In Number Detection, children were asked to identify as quickly as possible target numbers (i.e., the numbers 1, 2, and 3 printed in an open font) among distractors (i.e., the same numbers printed in a different font). The task contained two pages each with a 150 seconds time limit to complete. On the first page, children were asked to underline the target numbers 1, 2, and 3 arranged on a page that contained numbers 1 through 6 written in various fonts. Those numbers that were different from 1, 2, and 3 or the incorrect font were to be ignored. On the second page, children were required to underline the same numbers among distractors - 4, 5, and 6 written in bold font. The time and number correct (total number correct minus the number of false detections) for each page were recorded and combined to obtain a ratio score. The subtest ratio score was then converted to a subtest scaled score. Naglieri and Das (1997) reported test-retest reliability for Number Detection to be .77.

Simultaneous processing. Simultaneous processing was measured with Nonverbal Matrices and Verbal-Spatial Relations. In Nonverbal Matrices, children were presented with a variety of shapes and geometric designs that were spatially and logically interrelated within a visual matrix. For each item, children were required to decode the relationships and choose from a list of six possible answers to complete the picture. The task consisted of 33 items and was discontinued after four consecutive errors. The subtest score was the total number of correct answers. Naglieri and Das (1997) reported split-half reliability for Nonverbal Matrices to be .89. In Verbal-Spatial Relations, children were presented with six drawings (pictures of objects and shapes) and with a printed question that was dictated by the examiner (e.g., *Which picture shows a circle to the left of a cross under a triangle above a square?*). Given a 30 second time limit to respond to each item, children were instructed to identify the correct drawing from a selection of six choices. The test consisted of 27 items and was discontinued after four consecutive errors. The subtest score was the total number correct. Naglieri and Das (1997) reported split-half reliability for Verbal-Spatial Relations to be .83.

Successive processing. Successive processing was measured by Word Series and Sentence Repetition. In Word Series, children were read a series of single-syllable, high frequency words, varying in length from four to nine words: “Book”, “Car”, “Cow”, “Dog”, “Girl”, “Key”, “Man”, “Shoe”, and “Wall”, and then asked to repeat the words in the same order.

The test consisted of 27 items and was discontinued after four consecutive errors. The subtest score was the total number of correctly repeated word series. Naglieri and Das (1997) reported split-half reliability for Word Series to be .85. In Sentence Repetition, children were read 20 sentences aloud and then required to repeat each sentence verbatim. The sentences consisted of colour words (e.g., *The blue is yellowing*) and increased in length from four to nineteen words. The number of sentences repeated correctly was recorded. The test consisted of 20 items and was discontinued after four consecutive errors. The subtest score was the total number of correctly repeated sentences. Naglieri and Das (1997) reported split-half reliability for Sentence Repetition to be .84.

Procedure

Measures for this study were individually administered by graduate students who received extensive training on test administration and scoring. Testing was completed in two sessions in a quiet private room in each school. During session one, each child was assessed on the three reading subtests (beginning with Letter-Word Identification, followed by Reading Fluency, and Passage Comprehension). Testing took approximately 40 minutes to complete. Session two involved the administration of the eight D-N CAS measures. These subtests were delivered in the order in which they are described above and took approximately 45 minutes to complete. The scoring of the tasks as well as the data entry were cross-checked by an independent rater and the interrater reliability was found to be .99.

Chapter 4: Results

Preliminary Analyses

An examination of the distributional properties of each measure separately for each group revealed some problems. In the group of gifted children in Letter-Word Identification (L-WID), there was an outlier in Nonverbal Matrices. In the group of gifted children in Reading Fluency, there was an outlier in Word Series, Sentence Repetition, and Nonverbal Matrices. Finally, in the group of gifted children in both L-WID and Reading Fluency, we found an outlier in Number Detection. To normalize the distribution of these variables, we winsorized the outliers' score with that of the next non-outlier's score (+/- 1) (Tabachnick & Fidell, 2001). This resulted in normal distributions and the winsorized data were used in further analyses.

Comparisons Between Gifted Children in L-WID and Controls on PASS Cognitive Processes

Table 1 presents the descriptive statistics on the PASS processes, using L-WID for the selection of gifted readers and controls. Four separate MANOVAs were performed, one for each PASS process. Results with simultaneous processing tasks as dependent variables indicated a significant effect of group, Wilks' $\lambda = .663$, $F(2, 60) = 15.24$, $p < .001$, $\eta^2_p = .337$. Follow-up ANOVAs showed that the gifted group performed significantly better than the control group in both Nonverbal Matrices, $F(1, 61) = 8.77$, $p < .001$, $\eta^2_p = .126$, and Verbal-Spatial Relations, $F(1, 61) = 29.96$, $p < .001$, $\eta^2_p = .329$. The results with the successive processing tasks as dependent variables also showed a significant effect of group, Wilks' $\lambda = .679$, $F(2, 60) = 14.50$, $p < .001$, $\eta^2_p = .321$. Follow-up ANOVAs indicated that the gifted group outperformed the control group in both Word Series, $F(1, 61) = 18.74$, $p < .001$, $\eta^2_p = .235$ and Sentence Repetition, $F(1, 61) = 21.50$, $p < .001$, $\eta^2_p = .261$. The results with the planning tasks as dependent variables also showed a significant effect of group, Wilks' λ = .870, $F(2, 60) = 4.49$, $p < .05$. On Matching Numbers, $F(1, 61) = 6.23$, $p < .05$, $\eta^2_p = .093$, and Planned Codes, $F(1, 61) = 8.09$, $p < .01$, $\eta^2_p = .177$, the gifted group performed significantly better than the control group. Finally, the results of MANOVA with the attention tasks as dependent variables showed no significant effect of group, Wilks' λ = .926, $F(2, 60) = 2.41$, $p > .05$, $\eta^2_p = .130$.

Next, we performed a profile analysis to identify the number of gifted children with a cognitive asset, defined here as a standard score of 120 and higher, on each of the four PASS processes. We used 120 as our cut-off score because this is the score used in the D-N CAS manual to indicate superior performance in PASS processes (Naglieri & Das, 1997). Table 2 presents the results of this analysis. Of the 33 gifted readers, 33.3% (11 children) had a single asset in attention, simultaneous, or successive processing, 30.3% (10 children) had a double asset, 18.2 % (6 children) had a triple asset, and 3.0% (1 child) had a quadruple asset. The most prevalent single-asset type was in simultaneous processing (18.2%; 6 children). Simultaneous/successive processing (12.1%; 4 children) was the most prevalent double-asset type. Of the 30 controls, 73.3 % (22 children) had no asset, 22.0 % (6 children) had a single asset, and 6.7 % (2 children) had a double asset.

Table 1

Descriptive Statistics for the Selection of Gifted and Controls Using Letter-Word Identification

	Gifted Readers (n = 33)				Controls (n = 30)					
Variable	**M**	**SD**	**Min**	**Max**	**M**	**SD**	**Min**	**Max**	***F***	η^2_p
WJ-II										
Letter-Word Identification	130.30	5.26	124	148	102.83	4.19	91	108	519.20***	
CAS										
Planning	111.42	12.30	91	146	102.30	11.81	77	129	4.49*	.130
Matching Numbers	12.10	2.79	7	18	10.47	2.33	5	16	6.23*	.093
Planned Codes	11.94	2.30	9	19	10.30	2.26	5	14	8.09**	.117
Attention	113.03	12.46	94	141	109.17	11.08	88	138	2.41	.074
Expressive Attention	12.61	2.57	7	17	11.33	1.97	8	17	4.78*	.073
Number Detection	11.76	2.39	7	18	11.37	1.59	8	14	.57	.009
Simultaneous processing	124.27	15.65	88	152	106.90	11.22	85	129	15.24***	.337
Nonverbal Matrices	13.64	3.18	5	19	11.73	2.23	6	18	8.77**	.126
Verbal-Spatial Relations	14.88	3.25	7	19	10.87	2.47	5	16	29.96***	.329
Successive processing	115.55	11.41	92	137	102.13	8.24	84	120	14.50***	.321
Word Series	13.03	2.52	9	18	10.60	1.85	6	14	18.74***	.235
Sentence Repetition	12.55	2.32	8	18	10.17	1.66	7	14	21.50***	.261

Note. WJ-III = Woodcock Johnson III; D-N CAS = Das-Naglieri Cognitive Assessment System. *$p < .05$ **$p < .01$ ***$p < .001$.

Table 2

Number of Gifted Readers and Controls in Letter-Word Identification Exhibiting Assets in Planning, Attention, Simultaneous, and Successive (PASS) Processes

	Gifted Readers				Controls			
	Subtotal		Total		Subtotal		Total	
Cognitive Assets	n	%	n	%	n	%	n	%
No Asset	5	15.2	5	15.2	22	73.3	22	73.3
Single Asset			11	33.3			6	22.0
Planning (Pl)	1	3.0			1	3.0		
Attention (Att)	2	6.1			2	6.7		
Simultaneous (Sim)	6	18.2			2	6.7		
Successive (Suc)	2	6.1			1	3.0		
Double Asset			10	30.3			2	6.7
Sim + Suc	4	12.1						
Pl + Att					1	3.0		
Pl + Sim	1	3.0						
Att + Sim	3	9.1			1	3.0		
Att + Suc	2	6.1						
Triple Asset			6	18.2				
Pl + Sim + Suc	2	6.1						
Pl + Att + Sim	3	9.1						
Att + Sim + Suc	1	3.0						
Quadruple Asset			1	3.0				
Pl + Att + Sim + Suc	1	3.0						

Note. An asset on a task was defined as a standard score of 120 (superior range) and higher.

Comparisons Between Gifted Children in Reading Fluency and Controls on PASS Cognitive Processes

Table 3 shows the descriptive statistics for the measures used to compare the gifted children in reading fluency and controls. The results of MANOVA with the simultaneous processing tasks as dependent variables revealed a significant effect of group, Wilks' $\lambda = .664$, $F(2, 46) = 9.64$, $p < .001$, .336. Follow-up ANOVAs indicated that the gifted readers performed better than controls in Nonverbal Matrices, $F(1, 47) = 4.64$, $p < .05$, $\eta^2_p = .106$, and Verbal-Spatial Relations, $F(1, 47) = 19.60$, $p < .001$, $\eta^2_p = .334$. The results of MANOVA with the successive processing tasks as dependent variables also showed a significant effect of group, Wilks' $\lambda = .620$, $F(2, 46) = 11.65$, $p < .001$, $\eta^2_p = .380$. The gifted readers outperformed controls in both Word Series, $F(1, 47) = 13.91$, $p < .001$, $\eta^2_p = .263$, and Sentence Repetition, $F(1, 47) = 19.81$, $p < .001$, $\eta^2_p = .337$. The results of MANOVA with the planning tasks as dependent variables also showed a significant effect of group, Wilks' $\lambda = .813$, $F(2, 46) = 4.36$, $p < .05$, $\eta^2_p = .187$. Follow-up ANOVAs indicated that the gifted readers performed significantly better than controls in both Matching Numbers, $F(1, 47) = 8.41$, $p < .01$, $\eta^2_p = .177$, and Planned Codes, $F(1, 47) = 6.11$, $p < .05$, $\eta^2_p = .135$. Finally, the results of MANOVA with the attention tasks as dependent variables showed no significant effects of group, Wilks' $\lambda = .880$, $F(2, 46) = 2.89$, $p > .05$, $\eta^2_p = .132$.

Next, we performed a profile analysis to identify the number of gifted readers with a cognitive asset. Table 4 presents the results of this analysis. Of the 32 gifted readers, 25.0% (8 children) had a single asset, 31.1% (10 children) exhibited a double-asset, 18.8% (6 children) had a triple-asset with an equal distribution across all types, and 6.3% (2 children) had a quadruple asset. The most prevalent single-asset type was in simultaneous processing (15.6%; 5 children). In the double asset combinations, both simultaneous/successive and attention/successive were equally prevalent at 9.4% (3 children). Comparatively, the number of gifted readers who had a triple asset (6 out of 32) was equal to the number of children who did not demonstrate an asset in any of the PASS processes. Of the 17 children in the control group, 64.7% (11 children) had no cognitive asset, 29.5 % (5 children) had a single asset, and only 5.9 % (1 child) exhibited a double asset in attention/simultaneous processing.

Table 3

Descriptive Statistics for the Selection of Gifted and Controls Using Reading Fluency

	Gifted Readers (n = 32)				Controls (n = 17)					
Variable	**M**	**SD**	**Min**	**Max**	**M**	**SD**	**Min**	**Max**	**F**	η^2_p
WJ-II										
Reading Fluency	143.34	15.98	127	191	104.65	5.18	94	111	93.65***	
CAS										
Planning	112.78	12.81	91	146	101.65	12.96	77	121	4.36*	.187
Matching Numbers	12.44	2.53	8	18	10.18	2.81	5	15	8.41**	.177
Planned Codes	12.03	2.38	9	19	10.35	2.03	6	14	6.11*	.135
Attention	114.47	12.70	91	141	107.35	12.22	88	138	2.89	.132
Expressive Attention	12.69	2.71	7	17	10.94	1.71	8	14	5.39*	.122
Number Detection	12.13	2.10	8	18	10.94	1.95	8	14	3.66	.086
Simultaneous	121.75	17.97	88	152	107.94	12.35	85	129	9.64***	.336
Nonverbal Matrices	13.44	3.20	5	19	11.94	2.82	6	18	4.64*	.106
Verbal-Spatial Relations	14.28	3.60	7	19	10.94	3.03	5	16	19.60***	.334
Successive	113.81	11.86	92	137	100.47	7.07	84	114	11.65***	.380
Word Series	12.59	2.45	9	18	10.35	1.77	6	12	13.91***	.263
Sentence Repetition	12.34	2.44	8	18	9.82	1.29	8	13	19.81***	.337

Note. WJ-III = Woodcock Johnson III; D-N CAS = Das-Naglieri Cognitive Assessment System. **p* < .05 ***p* < .01 ****p* < .001.

Table 4

Number of Gifted Readers and Controls in Reading Fluency Exhibiting Assets in Planning, Attention, Simultaneous, and Successive (PASS) Processes

	Gifted Readers				Controls			
	Subtotal		Total		Subtotal		Total	
Cognitive Assets	n	%	n	%	n	%	n	%
No Asset	6	18.8	6	18.8	11	64.7	11	64.7
Single Asset			8	25.0			5	29.5
Planning (Pl)					1	5.9		
Attention (Att)	1	3.1			2	11.8		
Simultaneous (Sim)	5	15.6			2	11.8		
Successive (Suc)	2	6.3						
Double Asset			10	31.3			1	5.9
Sim + Suc	3	9.4						
Pl + Sim	1	3.1						
Att + Sim	2	6.3			1	5.9		
Att + Suc	3	9.4						
Triple Asset			6	18.8				
Pl + Sim + Suc	2	6.3						
Pl + Att + Sim	2	6.3						
Att + Sim + Suc	2	6.3						
Quadruple Asset			2	6.3				
Pl + Att + Sim + Suc	2	6.3						

Note: An asset on a task was defined as a standard score of 120 (superior range) and higher.

Comparisons Between Gifted Children in Both L-WID and Reading Fluency and Controls on PASS Cognitive Processes

Table 5 shows the descriptive statistics and group comparisons on DN-CAS measures using both Letter-Word Identification and Reading Fluency to identify the gifted children and controls. The results of MANOVA with the simultaneous processing tasks as dependent variables revealed a significant effect of group, Wilks' λ = .665, $F(2, 38) = 9.58$, $p < .001$, $\eta^2_p = .335$. Follow-up ANOVAs indicated that the gifted readers performed significantly better than controls in Verbal-Spatial Relations, $F(1, 39) = 19.16$, $p < .001$, $\eta^2_p = .334$. The results of

MANOVA with the successive processing tasks as dependent variables also indicated a significant effect of group, Wilks' λ = .631, $F(2, 38) = 11.09$, $p < .001$, $\eta^2_p = .369$. Follow-up ANOVAs showed that the gifted readers performed significantly better than controls in both Word Series, $F(1, 39) = 14.04$, $p < .001$, $\eta^2_p = .319$, and Sentence Repetition, $F(1, 39) = 18.30$, $p < .001$, $\eta^2_p = .319$. The results of MANOVA with the planning tasks as dependent variables also showed a significant effect of group, Wilks' λ = .813, $F(2, 38) = 4.36$, $p < .05$, $\eta^2_p = .187$. Follow-up ANOVAs indicated that the gifted readers performed better than controls in Matching Numbers, $F(1, 39) = 8.41$, $p < .001$, $\eta^2_p = .177$, and Planned Codes, $F(1, 39) = 6.11$, $p < .05$, $\eta^2_p = .135$. No significant differences between groups were found in attention, Wilks' λ = .868, $F(2, 38) = 2.89$, $p > .05$, $\eta^2_p = .136$.

Table 6 shows the results of the profile analysis of the gifted readers in both Letter-Word identification and Reading Fluency. Of the 26 gifted readers in this group, 26.9% (7 children) had a single asset in at least attention, simultaneous, or successive processes, 30.8% (8 children) had a double asset, 26.9% (7 children) had a triple asset, and 3.8% (1 child) had a quadruple asset. The most dominant single-asset type was in simultaneous processing (19.6%; 5 children) and the double-asset in simultaneous/successive (11.5%; 3 children), and one child (3.8%) demonstrated a quadruple asset in the four PASS processes. Of the 15 controls, 66.7 % (10 children) had no assets, 26.7 % (4 children) had a single asset in planning, attention, or simultaneous processing, and 6.7 % (1 child) exhibited a double asset in attention/simultaneous processing.

Table 5

Descriptive Statistics for the Selection of Gifted and Controls Using Both Letter-Word Identification and Reading Fluency

	Gifted Readers (n = 26)				Controls (n = 15)					
Variable	**M**	**SD**	**Min**	**Max**	**M**	**SD**	**Min**	**Max**	**F**	η^2_p
WJ-II										
Letter-Word Identification	129.77	5.01	124	148	100.47	4.34	91	105	356.96***	
Reading Fluency	144.42	17.27	127	191	104.40	5.49	94	111	75.41***	
CAS										
Planning	113.35	13.46	91	146	101.07	12.52	77	121	4.36*	.187
Matching Numbers	12.54	2.66	8	18	10.01	2.58	5	15	8.41***	.177
Planned Codes	12.15	2.48	9	19	10.27	2.12	6	14	6.11*	.135
Attention	114.92	12.54	94	141	107.73	12.90	88	138	3.00	.136
Expressive Attention	12.73	2.66	7	17	10.93	1.79	8	14	4.12*	.096
Number Detection	12.27	2.15	8	18	11.00	1.85	8	14	5.40*	.122
Simultaneous	126.69	15.56	88	152	108.40	13.12	85	129	9.58***	.335
Nonverbal Matrices	14.00	3.23	5	19	12.01	2.76	6	18	3.78	.088
Verbal-Spatial Relations	15.31	3.17	7	19	10.87	2.95	5	16	19.16***	.334
Successive	115.46	11.58	92	137	99.80	7.22	84	114	11.09***	.369
Word Series	12.96	2.41	9	18	10.27	1.83	6	12	14.04***	.319
Sentence Repetition	12.58	2.44	8	18	9.67	1.29	8	13	18.30***	.319

Note. WJ-III = Woodcock Johnson III; D-N CAS = Das-Naglieri Cognitive Assessment System. *$p < .05$ **$p < .01$ ***$p < .001$.

Table 6

Number of Gifted Readers and Controls in Both Letter-Word Identification and Reading Fluency Exhibiting Assets in Planning, Attention, Simultaneous, and Successive (PASS) Processes

	Gifted Readers				Controls			
	Subtotal		Total		Subtotal		Total	
Cognitive Assets	n	%	n	%	n	%	n	%
No Asset	3	11.5	3	11.5	10	66.7	10	66.7
Single Asset			7	26.9			4	26.7
Planning (Pl)					1	6.7		
Attention (Att)	1	3.8			1	6.7		
Simultaneous (Sim)	5	19.2			2	13.3		
Successive (Suc)	1	3.8						
Double Asset			8	30.8			1	6.7
Sim + Suc	3	11.5						
Pl + Sim	1	3.8						
Att + Sim	2	7.7			1			
Att + Suc	2	7.7						
Triple Asset			7	26.9				
Pl + Sim + Suc	3	11.5						
Pl + Att + Sim	2	7.7						
Att + Sim + Suc	2	7.7						
Quadruple Asset			1	3.8				
Pl + Att + Sim + Suc	1	3.8						

Note: An asset on a task was defined as a standard score of 120 (superior range) and higher.

Chapter 5: Discussion

For decades, researchers have been studying giftedness with the goal to better understand and support the learning needs of gifted children (see Silverman, 2013; Sternberg et al., 2011; Reis, 2016, for a review). However, only a handful of studies have examined the cognitive processes that support gifted children's high performance. To address this gap in the literature, our study aimed to provide a comprehensive examination of the cognitive processes underlying gifted reading using PASS theory of intelligence as a framework. Based on the findings of studies that examined the cognitive profiles of intellectually gifted children (e.g., Abougoush, 2014; Naglieri & Das, 1997), the theoretical links between PASS processes and reading (Das et al., 1994), and the information processing and problem solving abilities of gifted children (e.g., Alexander, Carr, & Schwanenflugel, 1995; Alloway & Elsworth, 2012; Anderson, 1986; Swanson, 1992), we first hypothesized that children gifted in reading accuracy and reading fluency would perform significantly better than controls in simultaneous and successive processing, and that gifted readers in reading comprehension would also show a relative strength in planning.

Our findings partly confirmed our hypothesis. To our surprise, only two children were found to be gifted in reading comprehension, which did not allow us to perform any further analyses. This is rather striking if we consider that the participants in our study were enrolled in enrichment programs and were coded as gifted. There might be two explanations for this finding. First, it may relate to the nature of the reading comprehension task administered. A closer look at Passage Comprehension reveals that above a certain point (Items 30-33) items become very difficult for even gifted readers of this age to answer, because they require background knowledge specific to certain domains (e.g., commerce). Second, it suggests that being gifted in reading accuracy or fluency does not guarantee high scores in reading comprehension because reading comprehension relies on many other skills such as knowledge base, comprehension monitoring, inferencing, knowledge of the story structure, and working memory (e.g., Cain, Oakhill, & Bryant, 2004; Oakhill & Cain, 2012; Swanson & Alexander, 1997).

In support of our hypothesis, gifted readers (either in reading accuracy or reading fluency) performed significantly better than controls in simultaneous and successive processing. This finding parallels those of previous studies with intellectually-gifted children. Both Abougoush (2014) and Naglieri and Das (1997) found that gifted children performed significantly better than average-ability children in simultaneous and successive processing. This is important because it shows that the superior performance of gifted children in simultaneous processing is not a result of the selection process alone. Our finding is also in line with the theoretical proposal linking simultaneous and successive processing with word reading (see Figure 1). Given that simultaneous and successive processing have also been found to differentiate poor readers from controls (e.g., Das et al., 1994, 2007, 2008; Wang et al., 2012), these findings suggest that simultaneous and successive processing (the two components of the information processing unit in Luria's conceptualization of cognition) support (in the case of gifted readers) or impede (in the case of poor readers) reading development. However, as indicated in Figure 1, their effects may be indirect through the effects of phonological processing and orthographic coding, respectively. Unfortunately, due to time constraints we did not assess phonological processing or orthographic coding in this study.

However, it is worth noting that only the mean performance of the gifted readers in simultaneous processing was in the superior range (124.27, 121.75, and 126.69; see Tables 1, 3, and 5, respectively). There might be three explanations for this finding. First, children in grades

4 to 6 should be at the consolidated phase of reading development (Ehri, 1997, 2005). This means that they should recognize the majority of words they encounter in print as sight words. Following the theoretical model linking PASS processes to reading, the ability to recognize words as whole units should rely more on orthographic coding, which is supported by simultaneous processing. Second, a closer look at the words included in Letter-Word Identification test reveals that above a specific point (Items 54-57) most words are irregular. To read these words, children should rely mostly on their orthographic coding, which, in turn, relies on simultaneous processing. Finally, in Reading Fluency, children had to read sentences and evaluate their truthfulness. This involves processing of logical-grammatical relationships between the components of each sentence, which is measured by the Verbal-Spatial Relations task; one of the tasks used to operationalize simultaneous processing.

In regards to the role of planning, our findings are in line with those of previous studies showing that gifted children excel in problem solving (e.g., Alexander et al., 1995; Anderson, 1986; Carr, Alexander, & Schwanenflugel, 1996; Davidson, 1986; Sriraman, 2003; Swanson, 1992; Threlfall & Hargreaves, 2008), as well as with the findings of Schofield and Ashman (1987) who used simultaneous, successive, and planning processing tasks with intellectually-gifted children. Our findings further reinforce the use of planning in the conceptualization of giftedness as done in the triarchic theory of successful intelligence and the three ring conception of giftedness (Renzulli, 2002, 2011; Sternberg, 1985, 1988, 1998, 2010). Planning is a higher-order executive functioning skill related to reading (Best, Miller, & Naglieri, 2011; Cartright, 2015; Naglieri & Rojahn, 2004; Sesma, Mahone, Levine, Eason, & Cutting, 2009; Snow, 1992). For example, Naglieri and Rojahn (2004) found that planning was a significant predictor of word identification and reading comprehension. Reiter, Tucha, and Lange (2004) further showed that dyslexic children (selected on the basis of their poor word reading skills) were performing significantly poorer than controls on a measure of planning (Tower of London).

The second goal of this study was to examine the cognitive profiles of gifted readers. Our results showed that gifted readers exhibited diverse cognitive profiles (see Castejón et al., 2016, for a similar finding). Whereas some children displayed no PASS processing assets, approximately two-thirds presented single, double, or triple assets. The most prevalent type of single asset was in simultaneous processing and the most prevalent double asset was in simultaneous and successive processing. These findings show that gifted readers are a heterogeneous group with diverse cognitive assets. At the same time, these findings suggest that some children may be gifted readers without having an asset in any of the PASS processes. Given that gifted readers have such diverse profiles, we must be mindful of each child's cognitive strengths when planning and implementing instruction. The development and study of the effects of a cognitive intervention program on the enhancement of the cognitive strengths of gifted readers should be considered.

An interesting finding in our study that warrants further discussion is that we found a group of children gifted in reading accuracy who were not gifted in reading fluency and also a group of children who were gifted in reading fluency, but not in reading accuracy. If children must be accurate in order to become fluent, the former finding simply suggests that some children reached superior performance in reading accuracy, but had not yet become fluent readers. However, the latter finding challenges the models of reading development. Can a child have superior reading fluency without having superior reading accuracy? We argue that this might be an artefact of the task used to assess reading fluency. More specifically, the reading fluency task is a sentence verification task. Because the sentences are read and answered silently, we have no way of determining if the child read each word in a sentence correctly and if his/her decision to circle yes or no was random or not. This silent component could potentially lead to higher scores in reading fluency than in reading accuracy.

Some limitations of the study are worth mentioning. First, the sample size of our control groups in Reading Fluency or in Letter-Word Identification and Reading Fluency were relatively small. Future studies should replicate these findings with a larger sample size. Second, our participants were enrolled in enrichments programs and they were already coded as gifted. Unfortunately, it was not possible to retrieve how they were coded or what they were coded for. Third, when this study was carried out, only the original edition of D-N CAS was available and its norms were developed in the US in 1997. Finally, due to time constraints, we used only one measure to assess children's performance in reading accuracy, reading fluency, and reading comprehension. This might be problematic particularly for reading fluency and reading comprehension since the task used to assess the former required silent reading (by definition, reading fluency involves reading accuracy and prosody none of which could be evaluated) and the task used to assess the latter does not require higher-level comprehension skills (Keenan, Betjemann, & Olson, 2008; Kendeou, Papadopoulos, & Spanoudis, 2012).

To conclude, the results of the present study provided evidence that gifted readers perform significantly better than average-ability children in information processing skills and planning. In addition, gifted readers are a cognitively heterogeneous group that exhibit diverse cognitive profiles. This knowledge could be used for the development of a cognitive-based intervention program. For example, the PASS Reading Enhancement Program (PREP; Das, 1999), with a heavy emphasis on improving simultaneous and successive processing, could be used as a model for developing an intervention to boost the cognitive strengths of gifted readers.

By understanding the cognitive profiles of gifted readers, we can better understand how to plan and implement differentiated instruction for gifted children in the classroom. In turn, better instruction may lead to stronger academic performance across multiple subject areas, and provide an enriched educational experience to support gifted children in reaching their highest academic potential.

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