THE ASIAN EDUCATIONAL THERAPIST

ISSN: 2972-4104, Volume 3, Issue 1, Page 26 - 37

CASE REVIEW

A Psychoeducational Evaluation of a Preschooler with Cognitive Weakness based on Cognitive Hypothesis Testing (CHT) Model

Arnold Chee Keong, CHUA[a1] and Harjit SINGH[b2]

[a]Private Practice
[b]Merlion Academy, Singapore
[1]Educational Therapist
[2]Associate Educational Therapist

Article DOI: https://doi.org/10.64663/aet.46

Corresponding author's email: arnoldchuacheekeong@yahoo.com

Cite as: *Chua, A. C. K., & Singh, H. (2025). A psychoeducational evaluation of a preschooler with cognitive weakness based on cognitive hypothesis testing (CHT) model. The Asian Educational Therapist, 3(1), 26-37.*

ABSTRACT

This article highlights a preschooler named GW, who struggles academically and has not responded well to previous intervention efforts due to cognitive weakness (weak cognitive processing). The authors performed a psychoeducational evaluation using Cognitive Hypothesis Testing Model from his previous assessment data (intellectual and academic) and then interpreted the results using the Cross-Battery Assessment approach. This approach allows the authors of this paper to measure a wider range of abilities that can only be represented by a single assessment battery by identifying GW's patterns of strengths and weaknesses. Finally, targeted interventions are recommended based on the Cattell-Horn-Carroll (CHC) theory on human cognitive abilities to help GW cope with his academic weaknesses in school.

Keywords: *Cognitive hypothesis model, CHC theory, Cross-battery assessment, Patterns of strengths and weaknesses*

1. A BRIEF INTRODUCTION TO THE COGNITIVE HYPOTHESIS TESTING (CHT) MODEL

The CHT model utilizes a scientific method approach for interpreting cognitive and neuropsychological processes together with the evaluation of ecological and treatment validity data to develop targeted interventions for students who do not respond to standard academic interventions. Numerous studies had been conducted using the CHT model in the area of reading problems (Fiorello et al., 2006) and specific learning disabilities (Flanagan et al., 2010; Hale & Fiorello, 2004; Hale, et al., 2008).

The CHT model is encouraged to be used with response to intervention (RtI) as an intervention program based on the CHC theory. With the advancement of neuroscientific research (e.g., neuroimaging studies), assessment results can thus link to interventions for children exhibiting academic and behavioral difficulties (Fiorello & Wycoff, 2018).

In this model, the presenting problem, history, and prior intervention data are examined to develop an initial theory about the child's problem. When it is hypothesized that a cognitive problem is contributing to a child's difficulty, a standardized cognitive/intellectual test is administered as a screening tool, with hypotheses derived from the verification of subtest profiles or refuted by the use of additional measures, or what is also known as the flexible battery assessment as compared to using a fixed battery test (a standard set of tests). According to Hale and Fiorello (2004), the usage of flexible battery tests is gaining popularity as it is more time- and cost-effective, and also different measures and techniques can be employed to address hypotheses generated after the process of initial data collection. Additionally, the need to examine a certain domain during assessment in depth calls for more than one measure in order to gain a better understanding of the presenting problem(s) and help to plan for targeted intervention.

Hale & Fiorello (2004) proposed combining two approaches in the CHT Model: (1) individual psychoeducational assessment, and (2) intervention development and monitoring, using both behavioral interventions and problem-solving consultation. This model has four major components of theory, hypothesis, data collection, and data interpretation that traverses 13 steps which are briefly described below (see Figure 1).

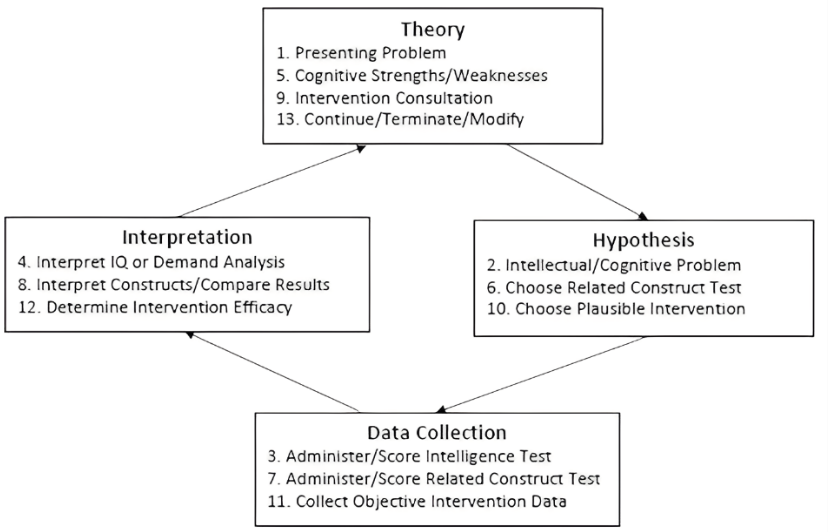

Figure 1. The Cognitive Hypothesis Testing (CHT) Model (Adapted from Hale & Fiorello, 2004)

CHT Phase 1, Steps 1 through 5: Procedures used in psychoeducational assessments according to GW's presenting problems, historical background, feedback from his school teachers and parents, and previous intervention data. Data were collected and results were interpreted to determine GW's cognitive strengths and weaknesses. According to Fiorello et al., (2012) and Hale & Fiorello (2004), the majority of psychoeducational evaluations usually stop at Step 5 in the CHT model by the psychologists.

CHT Phase 2, Steps 6 through 8: This phase relates to choosing a related assessment that caters to the presenting problems of GW. In this case, a WPPIS-4 was chosen to determine his cognitive functioning and WIAT-4 to determine his academic achievements. Sometimes, additional assessment data is necessary to help clarify diagnostic decisions and facilitate further intervention planning. For example, the therapist would then select another test that is designed to assess memory functions in more detail (e.g., TOMAL-2) if the GW has issues with memory. The selection of proper assessment is crucial as different intelligence tests involve different cognitive demands, different cultural and linguistic loading, and different administration procedures (Fiorello & Wycoff, 2018).

CHT Phase 3, Steps 9 through 13: Professionals from various fields who are working closely with GW such as educational therapists, speech and language therapists, occupational therapists, or others come together and decide on the choice of plausible intervention. The intervention consultation is based on the interpretation, evaluation, and analysis of assessment data which are then linked to the intervention. Therapists working with GW are required to closely monitor GW's progress by collecting objective intervention data in order to determine the efficacy of planned intervention based on the needs of GW.

The following sections outline a real case of GW, a preschooler with a cognitive weakness that affects his academic performance. Using the Cognitive Hypothesis Testing (CHT) model, the authors of this paper utilized GW's previous multiple sources of data and carefully reviewed, interpreted, analyzed, and linked these results to recommended interventions.

2. REASONS FOR REFERRAL

GW's parents requested an assessment of his current cognitive and literacy abilities to help them make decisions about his academic placement in Primary 1.

2.1 Background Information

GW is a 6-year-old boy who is currently studying in a mainstream Kindergarten 2 school. He is the elder child in the family. He has a 3-year-old sister. GW was born at 39 weeks gestation, weighing 2.35kg. He was well at birth. GW lives with his parents and a domestic helper. The family speaks English at home.

2.2 Presenting Problems

According to his parents, there were concerns about his speech and language development delay where GW spoke his first words at 24 months and short sentences at 36 months. In terms of motor milestones, he walked independently at around 16-17 months old. However, his parents noticed fine motor weakness (poor pencil grasp and handwriting). GW's preschool teacher has provided feedback that he has difficulties sustaining attention in large group activities, such as story time and individual work time. In addition, GW also has a poor pencil grip which resulted in him having difficulty in writing, poor word spacing, and uneven size letter formation.

2.3 Prior Intervention & Learning Support

GW attended Early Intervention Program (EIP) and Speech Therapy at a private center 3 times weekly since Aug 2020. When GW was 4 years and 10 months, he met the criteria of autism spectrum disorder from a local hospital. His parents stopped the EIP and transferred GW to another private EIP (twice weekly) in March 2022, where he also receives individual Speech Therapy weekly.

Table 1. Prior Assessments

Dates of Assessment	Types of Assessment/Therapy	Outcomes
Aug 2020	Speech & Language	Moderate articulation difficulty, mild oro-motor difficulty, and significant difficulty processing (auditory) language and using language to describe events. GW also showed moderate social communication and higher language difficulties.
Sep 2020	WPPSI-4 at 3:11	FSIQ in Low Average range, Average verbal reasoning abilities, Low Average visual-spatial abilities, Borderline working memory. Diagnosed with Unspecified Neurodevelopmental Disorder (F89), Communication Disorder, Unspecified (F80.9), and DCD (F82).
Aug 2020	• Received speech therapy at 3:11. • PLS-5 on May 2021 at 4:06 & CELF-P2 Feb 2022 at 5:04	CELF-P2: relative strength on receptive language (understanding of relationships between related words). Total language score is in Below Average.
Aug 2021	Psychological assessment at local hospital at 4:10	Met criteria of ASD
Feb-Mar 2022	Psychological assessment of WPPSI-4 & WIAT-4 when GW is 5:05	See below for results analysis

2.4 Assessments Administered (Feb 2022-Mar 2022)

1. Wechsler Preschool and Primary Scale of Intelligence-4th edition (WPPSI-4)
2. Wechsler Individual Achievement Test-Fourth Edition (WIAT-4)

The above two assessments on GW were administered by a certified psychologist in early 2022 and the results of each test are discussed in the following sections.

2.4.1 Wechsler Preschool and Primary Scale of Intelligence-4th edition (WPPSI-4): The WPPSI-4 comprises of 10 core subtests and 5 additional subtests for children ages 4 years through 7 years and 7 months. It measures five domains of functioning: verbal comprehension, visual-spatial reasoning, working memory, fluid reasoning, and processing speed. The Primary Index scales include (1) Verbal Comprehension Index (VCI), (2) Visual-spatial Index (VSI), (3) Working Memory Index (WMI), (4) Fluid Reasoning Index (FRI), and (5) Processing Speed Index (PSI). Results of GW's scores of WPPSI-4 with five main indexes are tabulated in Table 2 below.

Table 2. Composite Scores of WPPSI-4

Index	CHC Abilities	Composite Score	%ile	95% CI	Descriptor	PSW
VCI	Gc	120	91	112-126	Superior	S
VSI	Gv	106	66	97-114	Average	
FRI	Gf	114	82	106-120	High Average	S
WMI	Gsm	103	58	95-111	Average	
PSI	Gs	75	5	69-88	Borderline	W
FSIQ		104	61	98-109	Average	

VCI: Verbal Comprehension Index, VSI: Visual-spatial Index, FRI: Fluid Reasoning Index, WMI: Working Memory Index, PSI: Processing Speed Index, FSIQ: Full Scale IQ, PSW: Patterns of Strengths & Weaknesses, S: Strength, W: Weakness

2.4.2 Analysis of WPPSI-4 Results: The analysis of WPPSI-4 results is based on the mean composite score for the 5 indices: (120+106+114+103+75)÷5=104. The deviations from mean composite scores are as follows: VCI: 120-104=16; VSI: 106–104=2; FRI: 114–104=10; WMI: 103–104=-1; and PSI: 75–104=-29 (non-unitary & uninterpretable).

According to Flanagan and Kaufman (2009), a 23-point difference between the highest score (Max) and the lowest score (Min) is used to determine if the IQ score is interpretable. From the obtained results, the point difference between the highest index (VCI) and the lowest index (PSI) is 45 (120-75 = 45). Therefore, the FSIQ is non-unitary & uninterpretable as the difference between the lowest and the highest indexes was more than or equal to 23 points. This means that the FSIQ does not summarize GW's overall intellectual ability well. Further analysis using individual subtests is also briefly discussed in Table 3 below.

Table 3. WPPSI-4 Subtests Score Summary

Subtest	**CHC Abilities**	**Scaled Score**	**%ile**	**Descriptor**	**PSW**
VCI:					
Information (IN)	Gc-KO	12	75	Average	
Similarities (SI)	Gc-VL; Gf-I	15	95	Superior	S
VSI:					
Block Design (BD)	Gv-Vz	9	37	Average	
Object Assembly (OA)	Gv-CS	13	84	High Average	S
FRI:					
Matrix Reasoning (MR)	Gf-I	12	75	Average	
Picture Concepts (PC)	Gc-KO; Gf-I	13	84	High Average	S
WMI:					
Picture Memory (PM)	Gv-MV	8	25	Average	
Zoo Location (ZL)	Gv-MV	13	84	High Average	S
PSI:					
Bug Search (BS)	Gs-P	8	25	Average	
Cancellation (CA)	Gs-P	3	1	Extremely Low	W

Bolded subtests are used to derive FSIQ

CHC: Cattell-Horn-Carroll, %ile: Percentile Rank, PSW: Patterns of Strengths & Weaknesses, S: Strength, W: Weakness

2.4.3 Verbal Comprehension Index (VCI): This index measures knowledge acquired from the environment, verbal concept formation, and verbal reasoning. Overall, GW's performance on subtests within the VCI was typical for his age but was an area of relative weakness compared to his overall level of ability (VCI=120, PR=91, Superior range, CI=112-126). GW's scores on verbal comprehension tasks were his strength than his performance on tasks that required him to figure things out by looking at them and use logic to solve problems (VCI>VSI). Overall, verbal comprehension scores suggest that GW's verbal development is currently very strong in comparison to his development of visual-spatial and logical reasoning skills.

With regard to individual subtests within the VCI, the Information (IN) subtest consists of general knowledge questions, and the Similarities (SI) subtest required GW to identify similarities between common objects and concepts. On the IN subtest, GW earned a score of 12 which placed him in the Average range. This indicated that he possessed an adequate broad range of general knowledge topics for his age. As for the subtest on SI, GW scored 15 which placed him in the Superior range which showed that he has highly developed verbal concept formation and reasoning.

2.4.4 Visual-spatial Index (VSI): This index involves organizing visual information, understanding part-whole relationships, attending to visual detail, and integrating visual and motor functions. GW performed in the Average range (VSI=106, PR=66, Average range, CI=97-114) which was better than 66% of same-aged children. On the Block Design (BD) subtest, GW viewed designs and used blocks to re-create each design. The Object Assembly (OA) subtest required him to assemble the pieces of puzzles to create pictures of common objects. Assembling puzzle pieces was a strength for GW (OA=13>BD=9). However, he showed greater difficulty on BD, in which he used blocks to re-create each design (BD=9; OA>BD). This pattern of scores suggests that GW's ability to analyze and synthesize abstract visual information may be somewhat weaker than his ability to understand part-whole relationships.

2.4.5 Fluid Reasoning Index (FRI): This index measures GW's inductive reasoning skills, broad visual intelligence, simultaneous thinking, conceptual thinking, and classification ability. Overall, GW's performance on subtests within this index was in the High Average range for his age (FRI=114, PR=82, CI=106-120).

The FRI consists of two subtests: Matrix Reasoning (MR) and Picture Concepts (PC). MR required GW to select the missing pieces in incomplete patterns. On PC, he was asked to choose pictures from two or three rows to form a group with a common trait. GW performed comparably across both subtests, suggesting that his perceptual organization and categorical reasoning skills are similarly developed at this time.

2.4.6 Working Memory Index (WMI): Working memory involves attention, concentration, and mental control. The Working Memory Index (WMI) measures specific aspects of working memory such as visual working memory, visual-spatial working memory, and the ability to resist interference from previously memorized items.

In the area of working memory, GW exhibited diverse performance on the WMI. His overall performance was in the Average range (WMI=103, PR=58, CI=95-111). GW showed average recall of a series of pictures and locations of animal cards. His performance on these tasks was relatively weaker compared to his performance on language-based tasks (WMI<VCI). GW's performance on working memory tasks was also found to be weaker than other indices (WMI<VCI; WMI<FRI).

With regard to subtests within the WMI, the Picture Memory (PM) subtest required GW to memorize pictures and identify them on subsequent pages. On the Zoo Locations (ZL) subtest, he was required to memorize the location of animal cards on a map and then place the cards in the same location. GW showed uneven performance on these tasks. When he viewed the location of animal cards and was asked to place the cards in the correct location, his performance was above average for his age (ZL=13). However, GW showed greater difficulty remembering series of rapidly-presented pictures (PM=8; PM<ZL). This pattern of strengths and weaknesses suggests that he may attend more easily to information during interactive tasks, or when information is supplemented by spatial cues.

2.4.7 Processing Speed Index (PSI): The PSI measures GW's ability to quickly and correctly scan or discriminate simple visual information. GW's performance across subtests in the PSI was diverse. When compared with his scores on visual-spatial subtests, GW's performance on processing speed subtests was relatively weak (PSI<VSI). Additionally, his processing speed scores were weak compared to his performance on tasks requiring him to use logic-based reasoning (PSI<FRI). The PSI consists of two subtests in which GW scanned pictures and marked target pictures with an ink dauber. During the Bug Search (BS) subtest, he marked pictures of bugs in a search group that matched the target bug. The Cancellation (CA) subtest required him to mark target objects in a random and structured array. GW demonstrated uneven performance across subtests within the PSI. He worked quickly when scanning an array of pictures to mark target objects (CA=3). However, he showed greater difficulty on CA, where his performance was very weak in relation to his overall level of ability.

This pattern of strengths and weaknesses suggests that GW currently processes concrete, lifelike images more efficiently than abstract illustrations. His visual recognition skills may also be better developed than his visual short-term memory and visual discrimination skills. In addition to the indexes described above, GW was administered several ancillary indexes. The Ancillary Index scales include (1) Vocabulary Acquisition Index (VAI), (2) Nonverbal Index (NVI), (3) General Ability Index (GAI), and (4) Cognitive Proficiency Index (CPI). Ancillary indexes do not replace FSIQ and the primary index scores but are meant to provide additional information about GW's cognitive profile. The Vocabulary Acquisition Index could not be analyzed as subtests of Receptive Vocabulary & Picture Naming were not performed (see Table 4 for more information).

Table 4. Ancillary Index Scores

Ancillary Index	**Index Score**	**%ile**	**95% CI**	**Descriptor**
Nonverbal Index (NVI)	100	50	90-110	Average
General Ability (GAI)	113	81	106-119	High Average
Cognitive Proficiency (CPI)	85	16	79-94	Low Average
FSIQ	104	61	98-109	Average

Key: %ile: Percentile Rank, CI: Confidence Interval

2.4.8 Nonverbal Index (NVI): The NVI is derived from five subtests (BD, MR, PC, PM, BS) that do not require verbal responses. This index can provide a measure of general intellectual functioning that minimizes language demands for children with special clinical needs such as speech and language problems. Subtests in this index are drawn from the Visual-spatial, Fluid Reasoning, Working Memory, and Processing Speed scales. GW's performance on the NVI fell in the Average range when compared to other children his age (NVI=100, PR=50, CI=90-110).

2.4.9 General Ability Index (GAI) and Cognitive Proficiency Index (CPI): The GAI is an ancillary index that provides an estimate of general intelligence that is less sensitive to the influence of working memory and processing speed difficulties than FSIQ. The index consists of subtests from the visual-spatial (BD), fluid reasoning (MR), and verbal domains (IN & SI). GW's overall performance on this index was similar to other children his age (GAI=113, PR=81, High Average range, CI=106-119). His GAI score was significantly higher than his FSIQ score (GAI:113>FSIQ:104) with a 9-point difference between the two indices. This significant difference between GW's GAI and FSIQ indicated that the contribution of working memory and processing speed may have led to a lower overall FSIQ.

The Cognitive Proficiency Index (CPI) which consists of four subtests (PM, ZL, BS, CA) drawn from the working memory and processing speed domains was also calculated. The CPI summarizes performance on the WPPSI-4 with working memory and processing speed indices in a single score with which GW processes certain types of cognitive information.

GW's performance on CPI suggests that he exhibits low average efficiency when processing cognitive information in the service of learning, problem-solving, and higher-order reasoning (CPI=85, PR=16, Low Average range, CI=79-94). His performance on subtests contributing to the GAI was significantly stronger than his overall level of cognitive proficiency (GAI:113>CPI:85) with a 28-point difference between the two indices. Proficiency in processing through quick visual speed and good mental control helps to facilitate fluid reasoning and the acquisition of new material with the reduction of cognitive demands of novel or higher-order tasks. Of utmost importance, such efficiency in cognitive processing facilitates learning and problem-solving by "freeing up" cognitive resources in order to acquire more advanced skills (Weiss, Saklofske, Prifitera, & Holdnack, 2006). Relativeness weaknesses in mental control and speed of visual scanning may sometimes create challenges as GW engages in more complex cognitive processes, such as learning new material or applying logical thinking skills. In other words, the contributions of working memory and processing speed may have led to a lower overall FSIQ.

In class, GW's teacher shared that he appears not to pay attention when spoken to. This could be attributed to him still processing the previously given information. He also appears not to be following instructions either he doesn't remember what was told to him or he could be still processing the given verbal instructions. When answering his teachers, GW shows delayed responses to questions. This could be because he is working hard to process details or is struggling to remember the given information.

The above analysis using WPPSI-4 taps on GW's cognitive functioning in terms of his language, attention, working memory, and his processing skills. These skills have a direct impact on his academic abilities in school. Thus, the authors of this paper used a Cross-Battery Assessment (X-BA) approach to assess both his cognitive and academic abilities that are grounded in the Cattell-Horn-Carroll (CHC) theory of human cognitive abilities.

2.4.10 Cross-Battery Assessment (X-BA): The cross-battery assessment (X-BA) approach is a method to assess cognitive and academic abilities as well as neuropsychological processes that is firmly grounded in the theory and research done in the models of Cattell-Horn-Carroll (CHC) and neuropsychological theories (Miller, 2007; 2010, 2013). The CHC hierarchical model of human cognitive abilities is one of the most empirically supported and theoretically sound models of human intelligence (Carroll, 1993; 2003; Flanagan et al., 2000; McGrew & Wendling, 2010; McGrew & Flanagan, 1998). The model is the integration of research done by Raymond Cattell, John Horn, and John Carroll. Recently, it has been used to classify intelligence into 16 broad cognitive abilities (e.g., fluid intelligence, crystallized intelligence, general knowledge, short-term memory, long-term storage and retrieval, visual processing, auditory processing, processing speed, reading/writing ability, etc.) with more than 80 narrow abilities proposed by Schneider and McGrew (2012, 2018). This model provides a common nomenclature for researchers, educators, and working professionals to use as a common language when discussing areas of intelligence and their relationships with both the acquisition and maintenance of cognitive abilities and academic skills. (Flanagan et al., 2010).

The X-BA allows practitioners to measure a selective and broader range, and thus more in-depth, of cognitive abilities and skills that are not represented in any single assessment battery in a more reliable and valid way (Flanagan et al., 2013). Another advantage of the X-BA is that it guides practitioners in the careful selection of tests (core and supplementary) that provides a measurement of cognitive abilities for the purpose of referral concerns that may have issues in learning challenges. In addition, the identification of patterns of strengths and weaknesses (PSW) is also possible for individuals with cognitive disabilities as the X-BA approach offered practitioners a psychometrically defensible method. The PSW can also lead to individualized, differentiated, and targeted intervention that is designed to meet each individual learning needs. Finally, X-BA provides valuable information on the learning process of how individuals learn (e.g., how incoming information is being received, stored, integrated, and responded to) so that therapists working with the individual can tailor his/her teaching style to match their respective learning styles (Flanagan et al., 2013).

The following paragraph links X-BA to GW's academic achievement test that was administered between February to March 2022 by a psychologist. The aim is to further identify his patterns of strengths and weaknesses as well as to provide an individualized and targeted intervention to meet his learning needs using the CHC framework with both broad and narrow abilities.

2.5 Wechsler Individual Achievement Test-Fourth Edition (WIAT-4)

The WIAT-4 measures the academic achievement of individuals ages 4 through 50. It includes 20 subtests to measure listening, speaking, reading, writing, and mathematics skills. A score of 85-115 is considered average.

Table 5. Oral Language

Composite	Std. Score	95% CI	%ile	Descriptor	PSW
Oral language	84	75-93	14	Low Average	W

CI: Confidence Interval; %ile: Percentile Rank; PSW: Patterns of Strengths & Weaknesses, W: Weakness

Table 6. Subtests of Oral Language

Subtests	CHC Abilities	Std. Score	95% CI	%ile	Descriptor	PSW
LC:	Gc-VL; Gc-LS	93	82-104	32	Average	
- RV		107	95-119	68	Average	
- ODC		82	70-94	12	Low Average	W
OE:	Gc-VL; Glr-FI	78	68-88	7	Very Low	W
- EV		89	74-104	23	Low Average	W
- OWF		81	66-96	10	Low Average	W
- SR		79	69-89	8	Very Low	W

CHC: Cattell-Horn-Carroll; CI: Confidence Interval; %ile: Percentile Rank;
PSW: Patterns of Strengths & Weaknesses, S: Strength, W: Weakness
LC: Listening Comprehension, RV: Receptive Vocabulary, ODC: Oral Discourse Comprehension,
OE: Oral Expression, EV: Expressive Vocabulary, OWF: Oral Word Fluency, SR: Sentence Repetition

GW's Oral Language composite score was in the Low Average range when compared to children his age. This performance was below what was expected of his cognitive ability. Amongst the oral language tasks, GW obtained his best performance in selecting the picture that illustrated the meaning of each target word spoken by the examiner (Receptive Vocabulary). However, he showed weaknesses in Sentence Repetition, Oral Word Fluency, Expressive Vocabulary, and Oral Discourse Comprehension subtests, performing in the Very Low to Low Average range when compared to his same-age peers.

On the Sentence Repetition subtest, GW listened to a sentence and then was required to repeat it verbatim. The sentences were longer as the task progressed. He required reminders to attend to the verbal information, especially as the task progressed. On Oral Word Fluency, GW had to name as many things as possible belonging to a given category within a stipulated time. Expressive Vocabulary required GW to say the word that best corresponded to a given picture and its definition. On Oral Discourse Comprehension, he had to listen to passages presented via audio recording and then respond aloud to comprehension questions asked by the examiner. His low average scores on these oral language subtests were commensurate with his delay in language development as compared to children his age.

Table 7. Reading, Writing, and Mathematics

Composite	CHC Abilities	Std. Score	95% CI	%ile	Descriptor	PSW
Reading		113	106-120	81	High Average	S
PP	Ga-PC; Grw-RD	87	82-92	19	Low Average	W
WR	Grw-RD	109	104-114	73	Average	
RC	Grw-RC	115	109-121	84	High Average	S
Writing Expression		98	86-110	45	Average	
AWF	Grw-WS	99	81-117	47	Average	
Spelling	Grw-SG	99	89-109	47	Average	
Mathematics		111	105-117	77	High Average	S
MPS	Gf-RQ	95	87-103	37	Average	
NO	Gs-A3	124	117-131	95	Very High	S

CHC: Cattell-Horn-Carroll; CI: Confidence Interval; %ile: Percentile Rank;
PSW: Patterns of Strengths & Weaknesses, S: Strength, W: Weakness
PP: Phonemic Proficiency, WR: Word Reading, RC: Reading Comprehension,
AWF: Alphabet Writing Fluency, MPS: Math Problem-solving, NO: Numerical Operations

2.5.1 Reading: GW demonstrated Above Average reading skills for his age. His Reading composite was in the High Average range and that it commensurate with his cognitive ability. His Word Reading and Reading 7 Comprehension showed age-appropriate performance. He also showed proficiency with identifying single-letter sounds (phonemes). Occasionally, he would confuse letter names with letter sounds but was able to self-correct. GW made visual errors in his reading ("they" as "this", "shop" as "stop", and "saw" as "sam"). His performance on the Phonemic Proficiency (PP) indicated a Low Average range when compared to children his age. The PP subtest measures the development of phonological/phonemic skills which required manipulation of the sounds within words.

2.5.2 Writing: GW's Written Expression composite score fell in the Average range when compared to his peers and was commensurate with his cognitive ability. When tasked to write letters within a stipulated time (AWF), GW achieved age-appropriate performance. On the spelling task, he was able to write his first name, albeit with a missing "i". He was able to spell the word "cat". However, he spelled "in" as "ni". When asked to spell other single words, GW was not able to encode the word's verbal representation into written form (spelling). He was able to write from left to right with a mix of upper and lower cases. Letter reversals were noted in his writing. The letters he wrote were unevenly spaced and letter sizes were also inconsistent. His writing fluency (speed and accuracy) was also weak. GW will require more educational training and practice in spelling and writing.

2.5.3 Mathematics: GW's performance in Mathematics was in the High Average range. However, he showed carelessness in his answers (e.g., 3-1=4). He struggled to form the number "3" well and there were numbers transposition noted. For example, he wrote "31" when he meant to write "13", and "01" when he intended to write "10". He was also easily distracted as the tasks progressed, and it was difficult to redirect his focus in this 1-1 setting.

2.6 Recommended Interventions using CHC Broad and Narrow Abilities

Using the CHC framework under the interventional goals for cognitive and academic broad and narrow abilities, the following interventions are recommended based on GW's results on WPPSI-4 subtests and WIAT-4 Oral Language (see Tables 3 and 6 respectively).

2.6.1 WPPSI-4: Cancellation subtest (Gs-P):

i. Intervention goals for the broad ability of Gs (Perceptual speed):
Gs-1: To (a) automatically and (b) fluently perform relatively easy elementary cognitive tasks, especially when high mental efficiency (i.e., attention and focused concentration) is required; and/or
Gs-2: To (a) automatically and (b) fluently perform over-learned elementary cognitive tasks, especially when high mental efficiency (i.e., attention and focused concentration) is required.

ii. Intervention goals for the narrow ability of Gs-P (Perceptual Speed)
Gs-P.1: To (a) rapidly and (b) accurately search visual elements,
Gs-P.2: To (a) rapidly and (b) accurately compare (for visual similarities or differences) visual elements and Gs-P.3: To (a) rapidly and (b) accurately identify visual elements presented (i) side-by-side or (ii) separated in a visual field.

2.6.2 WIAT-4: Oral Expression with weak subtests of ODC, EV, OWF, SR:

i. Intervention goals for the broad ability of Gc (Comprehension Knowledge):
Gc-1: To acquire the (i) breadth and (ii) depth of general knowledge of the (a) language, (b) information and (c) concepts of a specific culture;
Gc-2: To apply this knowledge.
Gc-3: To store (i) verbal or (ii) language-based knowledge in terms of the following:

Gc-3.1: To store declarative (knowing what) knowledge acquired through the investment of other abilities during (a.1) formal and (a.2) informal educational and (b) general life experiences; and
Gc-3.2: To store procedural (knowing how) knowledge acquired through the investment of other abilities during (a.1) formal and (a.2) informal educational and (b) general life experiences.

ii. Intervention goals for the narrow ability of Gc-VL (Lexical Knowledge):
Gc-VL.1: To understand the extent of vocabulary – (i) nouns, (ii) verbs, or (iii) adjectives – in terms of correct word (semantic) meanings.

iii. Intervention goals for the narrow ability of Gc-LS (Listening Ability)
Gc-LS.1: To (i) listen and (ii) understand the meaning of oral communications in terms of (a) spoken words, (b) phrases, (c) sentences, and (d) paragraphs; and/or
Gc-LS.2: To (i) receive and (ii) understand spoken information.

iv. Intervention goals for the broad ability of Glr (Long-term Storage & Retrieval):
Glr-1: To store new information in long-term memory;
Glr-2: To consolidate new information in long-term memory; and
Glr-3: To later fluently retrieve the stored information (e.g., concepts, ideas, items, names) through association. Some Glr narrow abilities have been prominent in creativity research (e.g., production, ideational fluency, or associative fluency).

v. Intervention goals for the narrow ability of Glr-FI (Ideational Fluency)
Glr-F1.1: To rapidly produce a series of (a) ideas, (b) words, or (c) phrases related to a specific (i) condition or (ii) object. Quantity, not quality or response originality is emphasized.
Glr-F1.2: To think of a large number of different responses when a prescribed task requires the generation of numerous responses.
Glr-F1.3: To call up ideas.

Besides the above-recommended intervention goals, it is also recommended that GW's academic difficulties might also be contributed to other factors such as attention, information processing, or behavioral problems. Hence, other tests such as Conners Kiddie Continuous Performance Test-2nd edition, Sensory Profile-Caregiver Questionnaire, or the Behaviour Assessment System for Children-3rd edition are recommended to gain a more comprehensive evaluation of GW's cognitive weaknesses.

3. CONCLUSION

This article presents a preschooler, GW, with weak cognitive processing using CHT Model where psychoeducational evaluation, analyses, and linking assessment to intervention were used. The X-BA approach is used as a method to assess both the cognitive and academic achievements of GW that are grounded on CHC theory. GW's PSW was also identified so as to plan for targeted intervention based on multiple data and assessment results. GW's cognitive weakness is caused by his weak Cognitive Proficiency Index (CPI) which placed him in the Low Average range under the WPPSI-4 test. Such weak proficiency in cognitive processing can negatively impact many aspects of learning such as literacy (reading accuracy, fluency, and comprehension), numeracy (numerical operations, problem-solving, and mathematics fluency), and writing abilities of GW when he enters into mainstream Primary school next year. Interventions to support GW in weak cognitive proficiency are also recommended in this paper. Finally, it must be noted that CPI does not tap all neurocognitive processes (attention, working memory, and processing speed) and that additional measures may be required to ascertain a processing deficit that may be influencing GW's weak cognitive processing.

4. ACKNOWLEDGEMENT

None.

5. COMPETING INTERESTS

Authors have declared that no competing interests exist

6. FINANCIAL DISCLOSURE

Non funds obtained.

7. ARTIFICIAL INTELLIGENCE DISCLOSURE

No generative AI or AI-assisted technologies were used in the preparation of this manuscript.

REFERENCES

Fiorello, C. A., Hale, J. B., & Snyder, L. E. (2006). Cognitive hypothesis testing and response to intervention for children with reading problems. *Psychology in the Schools, 43*(8), 835-853. https://doi.org/10.1002/pits.20192

Fiorello, C. A., Hale, J. B., & Wycoff, K. L. (2012). Cognitive hypothesis testing: Linking test results to the realworld. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 484–496). New York, NY: Guilford Press.

Fiorello, C. A., & Wycoff, K. L. (2018). Cognitive hypothesis testing: Linking test results to the real world. In D. P. Flanagan & E. M. McDonough (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 715–730). New York, NY: Guilford Press.

Flanagan, D. P., & Kaufman, A. S. (2009). *Essentials of WISC-IV assessment* (2nd ed.). New York, NY: Wiley.

Flanagan, D. P., Fiorello, C. A., & Ortiz, S. O. (2010). Enhancing practice through application of Cattell-Horn-Carroll Theory and research: A "third method" approach to specific learning disability identification. P*sychology in the Schools, 47*(7), 739-760. https://doi.org/10.1002/pits.20501

Flanagan, D. P., Ortiz, S. O., & Alfonso, V. C. (2013). *Essentials of cross-battery assessment* (3rd ed.). NY: Wiley & Sons.

Hale, J. B., & Fiorello, C. A. (2004). *School neuropsychology: A practitioner's handbook.* New York, NY: Guilford Press.

Hale, J. B., Fiorello, C. A., Miller, J. A., Wenrich, K., Teodori, A., & Henzel, J. N. (2008). WISC-IV interpretation for specific learning disabilities identification and intervention: A cognitive hypothesis testing approach. In A. Prifitera, D. H. Saklofske, & L. G. Weiss (Eds.), *WISC-IV clinical assessment and intervention* (pp. 109–171). Cambridge, MA: Elsevier Academic Press.

Schneider, W. J., & McGrew, K. S. (2012). The Cattell-Horn-Carroll model of intelligence. In D. P. Flanagan &

P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (3rd ed., pp. 99-144). New York, NY: Guilford Press.

Schneider, W. J., & McGrew, K. S. (2018). The Cattell-Horn-Carroll theory of cognitive abilities. In D. P. Flanagan & E. M. McDonough (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 73-163). New York, NY: Guilford Press.

Weiss, L., Saklofske, D., Prifitera, A., & Holdnack, J. (2006). *WISC–IV advanced clinical interpretation*. San Diego, CA: Academic Press.