APPLIED PSYCHOMETRICS 101:

AP 101

#4: Cluster analysis of the WJ III Battery: Implications for CHC test interpretation and possible CHC model extensions

The WJ III Battery is comprised of both cognitive (intelligence) and achievement components. As reported in the technical manual, the Cattell-Horn-Carroll (CHC) theory of cognitive abilities organizational structure of the WJ III has been validated. The current investigation analyzed the cognitive and achievement tests for all WJ III norm subjects from ages 6-18 years of age. Cluster analysis of the 50 WJ III tests provides additional validity for the CHC structure of the WJ III. More importantly, the analyses provide support for a significant number of narrow ability classifications for many WJ III tests, classifications that (to date) have largely been based on expert consensus task analysis. The results also suggest possible new interpretative clusters and intermediate CHC dimensions warranting future research regarding the CHC taxonomy of human cognitive abilities.

> Kevin S. McGrew, Ph.D. Educational Psychologist Director Institute for Applied Psychometrics (IAP)

> > $\ensuremath{\mathbb{C}}$ Institute for Applied Psychometrics $_{\ensuremath{\text{lc}}}$ (IAP) 11-16-09 ver1

Author information and conflict of interest disclosure

Dr. Kevin S. McGrew, Ph.D., is an Educational Psychologist with expertise and interests in applied psychometrics, intelligence theories and testing, human cognition, cognitive and non-cognitive individual difference variables impacting school learning, models of personal competence, conceptualization and measurement of adaptive behavior, measurement issues surrounding the assessment of individuals with disabilities, brain rhythm and mental timing research, and improving the use and understanding of psychological measurement and statistical information by professionals and the public. Prior to establishing IAP, Dr. McGrew was a practicing school psychologist for 12 years. McGrew received his Ph.D. in Educational Psychology (Special Education) from the University of Minnesota in 1989.

Dr. McGrew is currently Director of the <u>Institute for Applied Psychometrics</u> (IAP), a privately owned applied research organization established by McGrew. He is also the <u>Research Director for the Woodcock-Munoz Foundation</u> (WMF), Associate Director for <u>Measurement Learning Consultants</u> (MLC), and a <u>Visiting Professor in Educational Psychology</u> (School Psychology) at the University of Minnesota.

Dr. McGrew authored the current document in his role as the Director of IAP. The opinions and statements included in this report do not reflect or represent the opinions of WMF, MLC, or the University of Minnesota.

More complete professional information, including his professional resume, can be found at www.iapsych.com.

<u>Conflict of Interest Disclosure</u>: Dr. McGrew is a co-author (with a financial interest) in the *Woodcock-Johnson Battery—Third Edition* (*WJ III; 2001*) as well as the *Batería III Woodcock-Muñoz (BAT III, 2005)*, published by <u>Riverside Publishing</u>. He was a paid consultant, but was not a co-author, for the <u>Woodcock-Johnson Psychoeducational Battery—Revised</u> (WJ-R; 1989).



Cluster analysis of the WJ III Battery: Implications for CHC test interpretation and possible CHC model extensions

Kevin S. McGrew, PhD.

Educational & School Psychologist

Director Institute for Applied Psychometrics (IAP)

Author information and conflict of interest disclosure

Dr. Kevin S. McGrew, Ph.D., is an Educational Psychologist with expertise and interests in applied psychometrics, intelligence theories and testing, human cognition, cognitive and non-cognitive individual difference variables impacting school learning, models of personal competence, conceptualization and measurement of adaptive behavior, measurement issues surrounding the assessment of individuals with disabilities, brain rhythm and mental timing research, and improving the use and understanding of psychological measurement and statistical information by professionals and the public. Prior to establishing IAP, Dr. McGrew was a practicing school psychologist for 12 years. McGrew received his Ph.D. in Educational Psychology (Special Education) from the University of Minnesota in 1989.

Dr. McGrew is currently Director of the <u>Institute for Applied Psychometrics</u> (IAP), a privately owned applied research organization established by McGrew. He is also the <u>Research Director for the Woodcock-Munoz</u> <u>Foundation</u> (WMF), Associate Director for <u>Measurement Learning Consultants</u> (MLC), and a <u>Visiting</u> <u>Professor in Educational Psychology</u> (School Psychology) at the University of Minnesota. Dr. McGrew authored the current document in his role as the Director of IAP. The opinions and statements included in this report do not reflect or represent the opinions of WMF, MLC, or the University of Minnesota. More complete professional information, including his professional resume, can be found at <u>www.iapsych.com</u>.

<u>Conflict of Interest Disclosure</u>: Dr. McGrew is a co-author (with a financial interest) in the *Woodcock-Johnson Battery—Third Edition (WJ III; 2001)* as well as the *Batería III Woodcock-Muñoz (BAT III, 2005),* published by <u>Riverside Publishing</u>. He was a paid consultant, but was not a co-author, for the <u>Woodcock-Johnson Psychoeducational Battery—Revised (WJ-R; 1989)</u>.

Contemporary psychometric research has converged on the <u>Cattell-Horn-Carroll (CHC) theory</u> of cognitive abilities as the consensus working taxonomy of human intelligence

	Intelligence 37 (2009) 1–10	
	Contents lists available at ScienceDirect	x T
5-22	Intelligence	Antelligence Anteligence
ELSEVIER		
Editorial		
CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research		
Kevin S. McGrew*		
Woodcock-Muñoz Foundation, University of Minnesota, United States		

McGrew, K. (2009). Editorial: CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research, *Intelligence*, *37*, 1-10.



CHC Broad (Stratum II) Ability Domains

- *Gf* Fluid reasoning
- Gc Comprehension-knowledge
- *Gsm* Short-term memory
- Gv Visual processing
- Ga Auditory processing
- *Glr* Long-term storage and retrieval
- Gs Cognitive processing speed
- *Gt* Decision and reaction speed
- *Grw* Reading and writing
- *Gq* Quantitative knowledge

- Gkn General (domain-specific) knowledge
- Gh Tactile abilities
- Gk Kinesthetic abilities
- Go Olfactory abilities
- *Gp* Psychomotor abilities
- Gps Psychomotor speed

(see Table 1 for definitions)

Complete CHC model and description of abilities can be found in:

McGrew, K. (2009). Editorial: CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research, *Intelligence*, *37*, 1-10.





CFA studies provide solid empirical support for CHC internal (structural) validity of WJ III battery



(Measurement domain)



Cluster Analysis

Cluster analysis is an set of exploratory (structure discovering) data analysis tools for solving classification problems. Sometimes it has been called a "poor mans" factor analysis. Its object is to sort cases (people, things, events, tests, etc) into groups, or clusters, so that the degree of association is strong between members of the same cluster and weak between members of different clusters. Each cluster thus describes, in terms of the data collected, the class to which its members belong; and this description may be abstracted through use from the particular to the general class or type.

CA often helps confirm EFA results and similar to MDS (multidimensional scaling), can spatially represent the degree of similarity of tests measuring a common dimension (dimension cohesion). Its hierarchical sequential structure is often useful in suggesting higher-order dimensions/factors.



Cluster Analysis

The strength of cluster analysis (discovering structure in data with more relaxed statistical assumptions and mathematics than data reduction methods such as exploratory factor analysis) is also one of its <u>major limitations</u>. CA will find groups or clusters in random data. The algorithms are designed to find any structure, even if structure is not present. As a result, the later clusters in a hierarchical approach are often "necessary evils or by products"--CA must end with one grand cluster. Thus, often in CA a point is reached where the further collapsing of meaningful groupings ceases to make substantive sense. It is important to recognize this in the resultant cluster dendogram.

Also, given the above, tests (objects, etc.) that share little in common with other measures need to be assigned to some grouping and cluster. Thus, often "loner" type tests will appear in very meaningful clusters but will not be consistent with the underlying interpretation of the grouping/cluster. Sometimes this suggests new insights regarding the test. Other times these "I've got to be grouped with some cluster somewhere in the process" tests are best ignored and should not interpreted as discounting the strong communality of a grouping or clustering of tests

WJ III test abbreviations used in figures

VCL = Visual Closure PR = Picture Recognition SPR = Spatial Relations BR = Block Rotation PLN = Planning MN = Memory for Names DRM = DR: Memory for Names VAL = Visual-Auditory Learning DRV = DR: Visual-Auditory Learning AS = Analysis-Synthesis CF = Concept Formation AP = Applied Problems NS = Number Series NM = Number Matrices AWM = Auditory Working Memory NR = Numbers Reversed MW = Memory for Words MS = Memory for Sentences VC = Verbal Comprehension AK = Academic Knowledge GI = General Information OC = Oral Comprehension STR = Story Recall DRS = DR: Story Recall

CO = Cross OutPC = Pair Cancellation VM = Visual Matching RDF = Reading Fluency **REF = Retrieval Fluency** MF = Math Fluency WF = Writing Fluency DS = Decision Speed RPN = Rapid Picture Naming AA = Auditory Attention SB = Sound Blending SA = Sound Awareness SNP = Sound Patterns-Voice IW = Incomplete Words AP = Applied Problems QC = Quantitative Concepts CAL = Calculation RV = Reading Vocabulary PSC = Passage Comprehension WA = Word Attach LW = Letter-Word Identication ED = Editing SOS = Spelling of Sounds SPL = Spelling WS = Writing Samples

Test descriptions and CHC classifications can be found at: <u>http://intelligencetesting.blogspot.com/2005/10/wj-iii-chc-test-classifications.html</u>

Copy is included at the end of the PDF version of this PPT-based report



Conclusions/hypothesis of interest

Most all major CHC broad abilities are validated

• Exception was Gq. Why? Primarily because Calculation grouped with other achievement fluency tasks, including Math Fluency, while the more math "reasoning" tests (Applied Problems; Quantitative Concepts) were associated more with Gf. Since a subject can only complete Calculation items for which they have the necessary declarative and procedural knowledge, and can't "figure out" a new procedure, a major portion on the ability measured by Calculation may be the fluency of recall of stored mathematical declarative and procedural knowledge.

Cluster analysis may be a good method for validating narrow CHC test classifications that are often hard to empirically validate via three-stratum factor analysis

• For example: See MW, MS, PC, KO, LD/VL, RQ, etc. cluster interpretations figure

Potentially new/interesting findings warranting further study

• A Gf substructure differentiated by tasks that are more language-based vs those more numeric or quantitative based

• Sound Awareness (SA) and Understanding Directions (UD) are tests that require the involvement of working memory. Their placement at the core of the Gf cluster is consistent with considerable research that has suggested a causal relation between working memory and Gf.

· Separate Gs cognitive and Gs achievement abilities

• A possible Grw substructure differentiating Grw abilities/tasks that involve words, sentences and connected discourse vs Grw abilities that only involve sounds/phonemes

• The continued support for a speed of lexical access (RAN?) cluster consisting of Rapid Picture Naming and Retrieval Fluency

A possible orthographic processing grouping

• The possibility of an intermediate "temporal processing or tracking/sequential processing" dimension

• The collapsing of Gsm and Ga together is something this researcher has seen many times when using other exploratory data reduction methods with the WJ III

Revised/Updated Cattell-Horn-Carroll (CHC) Theory of Cognitive Ability Classifications of the WJ III Cognitive and Achievement Tests

Kevin S. McGrew, Ph.D. Institute for Applied Psychometrics (IAP)

(www.iapsych.com & www.intelligencetesting.blogspot.com)

The revised/updated CHC classifications included in this document are based on the author's review of a variety of published and unpublished WJ III research (since the publication of the WJ III in 2001). A large portion of the reviewed analyses are unpublished multivariate exploratory analyses (exploratory/confirmatory factor analyses; cluster analyses; multidimensional scaling) of the WJ III norm data (by this author), some results which have been posted at <u>www.iapsych.com</u> or <u>www.intelligencetesting.blogspot.com</u>. These test classifications do not necessarily represent the position of other WJ III co-authors or the publisher of the WJ III (Riverside Publishing).

As outlined in previous writings (McGrew, 1997, 2005), most all of the broad CHC classifications are based on empirical research. Most all narrow ability classifications are based on expert consensus task analysis.

The current CHC test classifications should be considered more "relaxed" or "liberal" than prior published classifications. That is, all probable hypotheses, regardless of the number of times suggested in the research reviewed, if supported by theoretical and logical task analysis considerations, are included. The author has "erred" on the side of being more inclusive (liberal) in the range of narrow abilities measured by tests. This philosophy was embraced in the spirit of stimulating additional research and to guard against the "*premature hardening of WJ III CHC test categories*." Furthermore, these classifications *do not* reflect additional test interpretations that have been offered by this author (in presentations or via the internet) in the context of contemporary cognitive information processing/neuropsychological research and theory.

The reader is strongly encouraged to read McGrew (2005) for important background information that was used in the development of this document. A critical table and figure from McGrew (2005) are included at the end of this document.

McGrew, K. S. (2005). The Cattell-Horn-Carroll (CHC) theory of cognitive abilities: Past, present and future. In D. Flanagan, & Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (p.136-202). New York: Guilford Press.

For on-line version of McGrew (2005) see http://www.iapsych.com/CHCPP/CHCPP.html

Revised/Updated WJ III CHC Test Classifications – p.2 © Institute for Applied Psychometrics, 01-20-06

Broad CHC Domain/WJ III		
Cognitive (COG) &	Hypothesized CHC Narrow Ability	Test Description
Achievement (ACH) tests	Classifications	
Short-term Memory (Gsm)		
Numbers Reversed (COG)	Working Memory (MW)	Measures the ability to repeat a series of random numbers backward. The number sequences are
	Memory Span (MS)	presented by audio tape.
	Temporal Tracking (Ga-UK)	
Memory for Words (COG)	Memory Span (MS)	Measures the ability to repeat lists of unrelated words in the correct sequence. The words are
		presented by audio tape.
Auditory Working Memory	Working Memory (MW)	Measures the ability to retain two types of orally presented information and then repeat them in a
(COG)	Memory Span (MS)	specified order. The subject is presented a mixed series of words and digits and is asked to rearrange
	Temporal Tracking (<i>Ga</i> -UK)	them by first saying the words in order and then the numbers. The task requires divided attention as
		the subject must perform two different mental operations simultaneously.
Memory for Sentences	Memory Span (MS)	Measures the ability to remember and repeat simple words, phrases, and sentences presented
(COG)	Listening Ability (<i>Gc</i> -LS)	auditorily by a tape player.
Processing Speed (Gs)		
Visual Matching (COG)	Perceptual Speed: Scanning (Ps)	There are two different versions of this test. The Early Development (Edv) version is designed for
		use with preschool children and individuals who have developmental delays or reduced functioning.
		The task requires the person to point to the two mathcing shapes in a row of four to five shapes. This
		section has a 2-minute time limit and does not require the subject to write. The second version is
		designed for individuals above the developmental level of an average 5-year-old. On this section, the
		subject is asked to locate and circle the two identical numbers in a low of sex numbers. This task
		limit
Decision Speed (COG)	Sneed of Reasoning (RE)	Measures the ability to rapidly scan a row of nictures and decide which of the two drawings are the
Decision Speed (COO)	Semantic Processing Speed (<i>Gt</i> -R4)	most related. The decisions become slightly more abstract as the test progresses. The subject is
	Semantie Processing Speed (Gr R4)	instructed to complete as many rows of drawings as possible within a three-minute time limit
Ranid Picture Naming	Naming Facility (NA)	Measures the ability to rapidly identify and orally name nictures of common objects. The stimulus
(COG)		nictures are presented in rows of five. The test has a two-minute time limit
Pair Cancellation (COG)	Perceputal Speed Complex (Pc)	Measures the capacity for sustained attention (vigilance). The subject is presented with rows that
	Sustained Attention (AC)	contain repeating pictures of a dog and a ball (in no particular sequence) and must circle all instances
		of when the "ball is followed by the dog". The test has a three-minute time limit.
Cross Out (COG)	Perceptual Speed: Scanning (Ps)	Measures the ability to guickly scan and compare visual information. The subject must mark the five
	1 Tr 5(-)	drawings in a row of 20 drawings that are identical to the first drawing in the row. The subject is
		given a 3-minute time limit to complete as many rows of items as possible.

Comprehension-Knowledge (Gc)		
Verbal Comprehension (COG)	Language Development (LD) Lexical Knowledge (VL)	Measures knowledge of word meanings and general language development. Test is comprised of four subtests. In Picture Vocabulary, the subject must name familiar and unfamiliar pictured objects. In Oral Vocabulary: Synonyms, the subject must say a word similar in meaning to the word presented. In Oral Vocabulary: Antonyms, the subject must say a word that is opposite in meaning to the word presented In Verbal Analogies the subject must complete phrases with words that indicate appropriate analogies.
General Information (COG)	General (verbal) Information (K0)	Measures knowledge of the common or typical characteristics of certain objects. The test has two subtest components: "what" and "where" questions. The questions are presented orally and the subject must state the answer to "where you would find" and "what you would do with" questions.
Story Recall (ACH)	Listening Ability (LS) Meaning. Memory (<i>Glr</i> -MM) Working Memory (<i>Gsm</i> -MW)	Measures the ability to recall increasingly complex stories presented orally to the subject. The subject is asked to tell back as much of the story as they can. The score is based on the number of correctly recalled story elements.
Story Recall-Delayed Recall (ACH)	Meaningful Memory (<i>Glr</i> -MM)	Measures the ability to recall (after 1 to 8 days) the stories presented in Oral Recall.
Understanding Directions (ACH)	Listening Ability (LS) Working Memory (<i>Gsm</i> -MW) Induction (<i>Gf</i> -RG)	Measures comprehension of linguistic concepts (receptive language). The subject is asked to follow oral directions by pointing to different items in a picture.
Picture Vocabulary (ACH)	Lexical Knowledge (VL)	Measures knowledge of word meanings. The subject must name familiar and unfamiliar pictured objects.
Oral Comprehension (ACH)	Listening Ability (LS)	Measures the ability to listen to a short tape-recorded passage and to verbally supply the single word missing at the end of the passage.
Academic Knowledge (ACH)	General (verbal) Information (K0) Information about Culture (K2) General Science Info (<i>Gkn</i> -K1) Geography Achievement (<i>Gkn</i> -A5)	Test is comprised of three subtests that collectively measure knowledge in various areas of the biological and physical sciences, history, geography, government, economics, art, music, and literature.
Long-term Retireval (<i>Glr</i>)		
Visual-Auditory Learning (COG)	Associative Memory (MA) Meaningful Memory (MM)	Measures the ability to associate new visual symbols (rebuses) with familiar words in oral language and to translate a series of symbols presented as a reading passage (a visual-auditory association task). This is a "learning" test where corrective feedback is provided to the subject.
Visual-Auditory Learning- Delayed Recall (COG)	Associative Memory (MA)	Measures the ability to recall and relearn (after 1 to 8 days) the symbols (rebuses) presented in Visual-Auditory Learning. This is a "relearning" task as the subject relearns forgotten associations. Corrective feedback is provided to the subject during the task.
Retrieval Fluency (COG)	Ideational Fluency (FI) Naming Facility (NA)	Measures fluency in retrieving the names of objects. The subject is asked to state as many items as they can of three different types, "things to eat or drink", "names of people", and "animals.
Memory for Names (COG)	Associative Memory (MA)	Measures the ability to learn associations between unfamiliar auditory and visual stimuli (an auditory—visual association task). The task requires learning the names of a series of space creatures. This is a "learning" test where corrective feedback is provided to the subject.

Revised/Updated WJ III CHC Test Classifications – p.4 © Institute for Applied Psychometrics, 01-20-06

Memory for Names-Delayed Recall (COG)	Associative Memory (MA)	Measures the ability to recall (after 1 to 8 days) the space creatures presented in Memory for Names.
Visual-Snatial Processing (Gu))	
Spatial Relations (COG)	Spatial Relations (SR) Visualization (Vz)	Measures the ability to visually match and combine shapes. The subject must select from a series of shapes, the component parts composing a given whole shape.
Picture Recognition (COG)	Visual Memory (MV) Associative Memory (<i>Glr</i> -MA)	Measures the ability to recognize a subset of previously presented pictures within a larger set of pictures
Planning (COG)	Spatial Scanning (SS)	Measures the ability to plan a tracing route that covers as many segments of a dotted line drawing as possible without lifting the pencil or tracing over the same segment twice. The test requires "forward thinking" in that the subject is required to plan a sequence of steps prior to initializing the plan.
Visual Closure (COG)	Closure Speed (CS)	Measures the ability to name a drawing or picture of a simple object that is represented by disconnected lines. The test requires the subject to visually combine the disconnected lines into a meaningful whole.
Block Rotation (COG)	Visualization (Vz) Spatial Relations (SR)	Measures the ability to recognize two geometric designs (in a row of five) that are identical, although rotated to a different visual perspective from the target geometric design. Below the target stimulus are five pictures of geometric shapes or three-dimensional block strings that have been rotated in space. The subject must identify which two drawings are replications of the target item.
Auditory Processing (Ga)		
Sound Blending (COG)	Phonetic Coding (PC)	Measures the ability to perform auditory synthesis on segments of speech. After hearing the recorded parts (syllables and/or phonemes) of a word the subject must "blend" the parts together to make a whole word (synthesis task).
Incomplete Words (COG)	Phonetic Coding (PC)	Measures the ability to perform auditory closure on segments of speech. After hearing a recorded word with one or more phonemes missing, the subject must name the complete word (analysis task).
Auditory Attention (COG)	Speech Sound Discrimination (US) Attention/Concentration (AC)	Measures the ability to discriminate similar sounding words. An audio tape is used to present the words to the subject with increasing levels of background noise as a distracter.
Sound Patterns-Voice (COG)	General Sound Discrimination (U3)	Measures the ability to indicate whether pairs of complex sounds are the same or different. The sound patterns resemble human speech sounds. The pairs may differ in pitch, rhythm, or sound content.
Sound Patterns-Music (COG)	Musical Discrimination & Judgement (U1,U9)	Measures the ability to indicate whether pairs of musical sounds are the same or different. The pairs may differ in pitch, rhythm, or sound content.
Sound Awareness (ACH)	Phonetic Coding (PC) Working Memory (Gsm-MW)	Measures oral sound analysis skills at the preschool and primary level of development. It contains four subtests: Rhyming, Substitution, Deletion, and Reversal. The items are presented orally by the examiner, or by tape, and the subject responds orally.
1		

Fluid Reasoning (Gf)		
Concept Formation (COG)	Induction (I)	Measures the ability to identify and state the rule for a concept about a set of colored geometric figures when shown instances and non-instances of the concept. This is a "learning" test with corrective feedback and reinforcement of correct answers provided to the subject.
Analysis-Synthesis (COG)	General Sequential (deductive) Reasoning (RG) Quantitative Reasoning (RQ)	Measures the ability to analyze the components of an incomplete logic puzzle and to determine and name the missing components. This is a "learning" test with corrective feedback and reinforcement of correct answers provided to the subject.
Number Series (COG)	Quantitative Reasoning (RQ)	Measures the ability to identify the quantitative principle that underlies a sequence of numbers in a series of numbers and then apply the principle to supply a missing number in the series.
Number Matrices (COG)	Quantitative Reasoning (RQ)	Measures the ability to identify the quantitative principle that underlies a series of numbers in matrices and then apply the principle to supply a missing number in the matrix.
Ouantitative Knowledge (<i>Ga</i>)	
Calculation (ACH)	Math Achievement (A3)	Measures the ability to perform mathematical calculations ranging from simple addition to calculus. The subject is not required to make any decisions about what operations to use or what data to include.
Applied Problems (ACH)	Math Achievement (A3) Math Knowledge (KM) Quantitative Reasoning (<i>Gf</i> -RQ)	Measures the ability to analyze and solve problems in mathematics. The subject must decide not only the appropriate mathematical operations to use but also which of the data to include in the calculation.
Math Fluency (ACH)	Math Achievement (A3) Number Facility (<i>Gs</i> -N)	Measures the ability to quickly perform single-digit addition, subtraction, and multiplication facts. The subject is presented a series of simple arithmetic problems on a worksheet. The subject has two minutes to complete as many problems as possible.
Quantitative Concepts (ACH)	Math Knowledge (KM) Quantitative Reasoning (<i>Gf</i> -RQ) Lexical Knowledge (<i>Gc</i> -VL)	Measures the subject's mathematical vocabulary, concepts and quantitative reasoning. The test consists of two subtests that collectively represent a mixture of number series (Number Series(items and items requiring the subject to display mathematical knowledge (Concepts). The number series items require the subject to identify the underlying numerical relation in a series of numbers and then apply this principle by supplying a missing number in the series.
Reading and Writing (Grw)		
Letter-Word Identification (ACH)	Reading Decoding (RD) Lexical Knowledge (<i>Gc</i> -VL)	Measures the subject's reading skills in identifying isolated letters and words. It is not necessary that the subject knows the meaning of any words correctly identified.
Reading Fluency (ACH)	Reading Speed (RS) Semantic Processing Speed (<i>Gt</i> -R4)	Measures the ability to quickly comprehend the correctness of simple sentences. The subject is presented a series of simple sentences and must circle whether each sentence is true or false. The subject is required to complete as many items as possible within a 3-minute time limit.
Passage Comprehension (ACH)	Reading Comprehension (RC) Cloze Ability (CZ) Verbal (lang) Comprehension (V)	Measures the subject's skill in reading a short passage and identifying a missing keyword. In this modified cloze procedure, the subject must exercise a variety of comprehension and vocabulary skills.
Word Attack (ACH)	Reading Decoding (RC) Phonetic Coding (PC)	Measures the ability to apply phonic and structural analysis skills to the pronunciation of unfamiliar printed words. The subject reads aloud letter combinations that are linguistically logical in English but that do not form actual words (nonsense word), or words that constitute low-frequency words in

Revised/Updated WJ III CHC Test Classifications – p.6 © Institute for Applied Psychometrics, 01-20-06

the English language.	
-----------------------	--

Reading Vocabulary (ACH)	Reading Comprehension (RC) Lexical Knowledge (<i>Gc</i> -VL)	Measures subject's skill in reading and understanding the meanings of words. The test consists of three subtests. In Part A: Synonyms, the subject must read a word and provide a word similar in meaning to the word presented. In Part B: Antonyms, the subject must read a word and provide a word that is opposite in meaning to the word presented. In Part C: Analogies, the subject must read an analogy and provide the missing word.
Spelling (ACH)	Spelling Ability (SG)	Measures the ability to write correct spellings of orally presented words.
Writing Fluency (ACH)	Writing Ability (WA) Speed of Writing (<i>Gps</i> -WS)	Measures the ability to formulate and write simple sentences quickly. This subtest has a 7-minute time limit.
Writing Samples (ACH)	Writing Ability (WA)	Measures the ability to write responses to a variety of demands. The subject must phrase and present written sentences that are evaluated with respect to the quality of expression. The subject is not penalized for errors in the basic mechanics of writing (spelling; punctuation).
Editing (ACH)	English Usage Knowledge (EU)	Measures the ability to identify, and indicate how to correct, mistakes in typewritten passages. The error in the passage may be incorrect punctuation or capitalization, inappropriate word usage, or a misspelling.
Spelling of Sounds (ACH)	Spelling Ability (SG) Phonetic Coding (<i>Ga</i> -PC)	Measures the ability to listen to a nonsense word and produce a written response representing the likely spelling of that word if it were a real English word. It is a measure of the subject's comprehension of the "alphabetic principle." The subject is presented the nonsense word from an audio tape and is asked to write it.
Punctuation and Capitalization (ACH)	English Usage Knowledge (EU)	Measures knowledge of punctuation and capitalization.