Functional Cattell-Horn-Carroll (F-CHC) Nomenclature and Its Relationship to Selective Assessment

Presenters:
Drs. Daniel C. Miller, Denise E. Maricle, & Richard W. Woodcock,
Texas Woman’s University

Purpose of Presentation
• Introduce participants to the functional CHC (F-CHC) nomenclature.
• Illustrate how the F-CHC nomenclature can be used to identify selective assessment batteries for the identification of reading, writing, or mathematics disorders and use that information to maximize evidence-based interventions.
• Illustrate the use of F-CHC nomenclature in everyday practice to simplify explaining cognitive strengths and weaknesses to parents and teachers.

Evolution of CHC Nomenclature
• Cattell-Horn-Carroll (CHC) theory grew out of Gf-Gc theory.
• CHC theory is the dominant theory today defining the structure of cognitive abilities.
• CHC nomenclature (Gf-Gc broad and narrow ability labels) has become more complex as some scholars have elaborated upon the theory, introducing their additions and revisions into the taxonomy.

Evolution of CHC Nomenclature
• For many, a shift toward more “scientific” and less “functional”, or clinician/consumer friendly, nomenclature.
• The scientific nomenclature is difficult for consumers, such as parents, clients, or educators to understand and act upon.

Presenters
Co-authors of the Evidence-based Selective Assessment for Academic Disorders (2017)
• Dr. Richard W. Woodcock, senior author of the WJ, WJ-R, WJ-III. Senior Scholar, Department of Psychology and Philosophy, Texas Woman’s University.
• Dr. Daniel C. Miller, Executive Director, Woodcock Institute, Professor Emeritus, Department of Psychology and Philosophy, Texas Woman’s University.
• Dr. Denise E. Maricle – Professor, School Psychology Doctoral Program, Texas Woman’s University
• Dr. Ryan McGill – Assistant Professor, College of William and Mary.

Scientific taxonomies provide greater precision and guide scientific investigation, but the more “functional” or user-friendly nomenclature benefits consumers.
Evolution of CHC Theory in the WJ IV

- WJ III (2001): CHC Theory
- WJ IV (2014): Beyond CHC Theory (scientific)
- WJ IV & Other Measures (2017): Functional CHC (f-CHC)

Scientific Broad Abilities

Scientific CHC Narrow Abilities

- Fluid Reasoning (Gf)
  - IR: Inductive reasoning
  - RG: General sequential reasoning
  - IQ: Quantitative reasoning
- Comprehension-Knowledge (Gc)
  - CM: Communication ability
  - ED: General (verbal) information
  - LD: Language development
  - LS: Listening ability
  - WF: Working memory capacity
- Short-Term Working Memory (Gsm)
  - AC: Attentional control
  - MS: Memory span
  - WM: Working memory capacity
- Fluency (Gf)
  - PP: Perceptual speed
  - PF: Phonetic coding
- Comprehension-Speed (Gq)
  - Gv: Vocabulary
  - Gm: General information
  - Gw: General knowledge

Domain-Specific Knowledge (Gsk)

- Reading and Writing (Grs)
  - EU: English usage
  - BS: Reading speed
  - WS: Writing speed
  - WA: Writing ability
- Quantitative Knowledge (Gqk)
  - A3: Mathematical achievement
  - Wk: Mathematical knowledge

Functional CHC (f-CHC)

- General science
  - Geography achievement
- Sensory/Motor Linked Abilities
  - Auditory Processing (VP)
  - Speech sound discrimination
  - Foreign language proficiency
- Delivery Efficiency (Gme)
  - AC: Attentional control
  - LS: Listening ability
  - EM: Emotional expression
- Processing Speed (Gps)
  - SF: Speed of lexical access
  - SP: Speed of lexical access
  - SS: Visual speed
- Retrieval Efficiency (Grt)
  - UC: Understanding of language
  - UC: Understanding of language
  - RS: Reading speed
  - WR: Writing speed
- Spatial Scanning (Gss)
  - SL: Spatial scanning
  - RS: Reading speed
  - WR: Writing speed
- Learning Efficiency (Gle)
  - LF: Language efficiency
  - LE: Listening efficiency
  - LW: Learning efficiency
- Motor Efficiency (Gme)
  - EA: Visual motor
  - EM: Emotional expression
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- Scientific CHC
  - Gf: Fluid reasoning
  - Gc: Comprehension-knowledge
  - Gsm: Short-term working memory
  - Gf: Fluid reasoning

Scientific CHC Narrow Abilities

Core CHC Cognitive Abilities

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**Functional CHC Nomenclature**

- Woodcock, Maricle, Miller, & McGill (2017)
- Suggested simplification of CHC nomenclature makes it easier for parents and teachers to understand.
- Minor revisions to CHC factor labels (e.g., Gcm instead of Gwm or Gr instead of Gf).
- Reduces the number of less meaningful narrow ability labels for clinical use.

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**Break Down of f-CHC Broad Abilities into Narrow Abilities**

**Three Conceptual Domains and 10 Broad Abilities**

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<th>Functional CHC Nomenclature</th>
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(Woodcock, Miller, Maricle, & McGill, 2017)
Scientific CHC Narrow Abilities Compared to Functional CHC Narrow Abilities

Comprehension-Knowledge: Factual Knowledge ($G_{c-K}$)

The variety and amount of information one knows (not just verbal knowledge).

Test examples:
- WISC-V: Information (KO: general verbal information)
- WJ IV ACH: Academic Knowledge (KO: general verbal information)
- WJ IV COG: General Information (KO: general verbal information)

Comprehension-Knowledge: Verbal Ability ($G_{c-VA}$)

Spoken language skills of lexical knowledge (i.e., vocabulary knowledge and language development (i.e., general development of spoken language skills that do not require reading ability)).

Test examples:
- WISC-V: Vocabulary (VL: lexical knowledge)
- WJ IV OL: Picture Vocabulary (VL: lexical knowledge)
- WJ IV OL: Oral Comprehension (LS: listening ability)
- WJ IV OL: Understanding Directions (LS: listening ability)

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Visual-Spatial Processing: Pictorial Processing ($G_{v-P}$)

Ability to identify a familiar meaningful visual object from incomplete visual stimuli, without knowing in advance what the object is.

Test examples:
- KABC-II: Gestalt Closure (CS: closure speed*)
- RIAS-2: What’s Missing (CS: closure speed*)

Scientific CHC describes these tests as including a speed factor, whereas F-CHC emphasizes the pictorial processing.
Visual-Spatial Processing: Spatial Processing (Gv-SP)

Measures spatial orientation and the ability to solve problems by using mental rotations of simple images.

Test examples:
• NEPSY-II: Arrows (Vz: visualization)
• KABC-II: Triangles (Vz: visualization)
• WISC-V: Block Design (Vz: visualization)
• WJ IV COG: Visualization (Vz: visualization)

Scientific CHC Narrow Abilities Compared to Functional CHC Narrow Abilities

Scientific CHC Nomenclature

Fluid Reasoning (GF):
- I - Induction
- RG - General sequential reasoning
- RQ - Quantitative reasoning

Reasoning (GR):
- CR (Contextual Reasoning) (replaces and elaborates upon RQ: Quantitative or Numerical Reasoning)
- ID (Inductive/Deductive Reasoning)

(Auditory Processing (GA):
- PC - Phonetic coding
- Vz - Visual discrimination
- ORF - Oral reading fluency
- WS - Sound discrimination
- UL - Sound localization
- US - Speech sound discrimination

(Auditory Processing: Phonetics (Ga-Ph)

Ability to discriminate, analyze, and synthesize phonological stimuli.

Test examples:
• CTOPP-2: Blending Words, Elision, Sound Matching (PC: phonetic coding)
• WJ IV COG: Nonword Repetitions, Phonological Processing (PC: phonetic coding)
• WJ IV OL: Sound Awareness, Segmentation, Sound Blending (PC: phonetic coding)

(McGrew, 2016; Schneider & McGrew, 2012)

(McGrew, Miller, Maricle, & McGill, 2017)

(Auditory Processing: Sound Discrimination (Ga-SD)

Ability to discriminate speech sounds, or other auditory stimuli, in quiet or noisy conditions.

Test examples:
• A Speech and language test such as the CELF-5 is an example.

(McGrew, 2016; Schneider & McGrew, 2012)

(McGrew, Miller, Maricle, & McGill, 2017)

Reasoning: Contextual Reasoning (Gr-CR)

Ability to use related cues from single-to multi-dimensional matrices of information to solve a problem.

Test examples:
• WISC-V: Figure Weights (RQ: quantitative reasoning)
• WJ IV ACH: Number Matrices (RQ: quantitative reasoning)
• WJ IV COG: Number Series (RQ: quantitative reasoning)*

* Most predictive cognitive test of academic achievement.
**Reasoning: Inductive/Deductive Reasoning (Gr-ID)**

Ability to use inductive and/or deductive reasoning to solve a novel problem.

Test examples:
- WISC-V: Similarities (I: induction)
- KABC-II: Rover (RG: general sequential reasoning and SS: spatial scanning)
- WJ IV COG: Concept Formation (I: induction), Analysis-Synthesis (RG: general sequential reasoning)

**Learning and Memory: Immediate Recall (Glm-IR)**

Ability to hear or learn information and be able to recall it immediately or a short time later.

Test examples:
- WRAML-2: Verbal Learning (M6: free-recall memory)
- WJ IV COG: Story Recall (MM: meaningful memory)
- WJ IV COG: Picture Recognition (MV: visual memory)
- WJ IV COG: Visual-Auditory Learning (MA: associative memory)

**Learning and Memory: Memory Retrieval (Glm-MR)**

Ability to hear or learn information and be able to retrieve it much later (days or years).

Test examples:
- WRAML-2: Verbal Learning Delayed Recall (M6: free-recall memory)
- TOMAL-2: Memory for Stories Delayed (MM: meaningful memory)
- WISC-V: Recognition Symbol Translation (MA: associative memory)
- WJ IV COG: Retrieval Fluency (FI: ideational fluency)

**Conscious Memory: Memory Span (Gcm-MS)**

Ability to listen to or see a presentation of sequentially ordered information and then recall the sequence immediately.

Test examples:
- DAS-II: Recall of Digits Forward (MS: memory span)
- WISC-V: Digit Span (MS: memory span)
- WJ IV COG: Memory for Words (MS: memory span)
- WJ IV OL: Sentence Repetition (MS: memory span)
**Conscious Memory: Working Memory (Gcm-WM)**

*Ability to hold information in consciousness long enough to perform some manipulation, such as reordering, upon it.*

**Test examples:**
- WISC-V: Digit Span Backwards (WM: working memory)
- WJ IV COG: Object-Number Sequencing, Numbers Reversed, Verbal Attention (WM: working memory)

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**Four Memory Abilities**

- Memory Retrieval (Glm - MR)
- Immediate Recall (Glm - IR)
- Working Memory (Gcm - WM)
- Memory Span (Gcm - MS)

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**Scientific CHC Narrow Abilities Compared to Functional CHC Narrow Abilities**

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<td>FT - Figural Fluency</td>
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<tr>
<td>P0 - Orality/creativity</td>
<td>- Includes academic fluency measures</td>
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<td>P &amp; F - Figural fluency</td>
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<td>SFL - Spatial fluency</td>
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<td>S - Naming ability</td>
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**Cognitive Processing Speed:**

**Perceptual Speed (Gs-PS)**

*Ability to rapidly scan and compare visual symbols.*

**Test examples:**
- WISC-V Cancellation and Symbol Search (P: perceptual speed)
- WJ IV COG: Letter-Pattern Matching and Number-Pattern Matching (P: perceptual speed)

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**Cognitive Processing Speed:**

**Thinking Speed (Gs-TS)**

*Ability to rapidly name objects, words, or symbols or to identify common semantic features between stimuli.*

**Test examples:**
- WJ IV COG: Rapid Picture Naming (NA: naming facility)
- WJ IV ACH: Sentence Reading Fluency (RD: rate of test-taking)
- WJ IV ACH: Oral Reading and Word Reading Fluency (RS: reading speed), Sentence Writing Fluency (WS: writing speed), Math Facts Fluency (N: number facility)
Summary of F-CHC Nomenclature

- Cognitive Efficiency
  - Conscious Memory (Gcm)
    - MS (Memory Span)
    - WM (Working Memory)
  - Cognitive Processing Speed (Gs)
    - PS (Perceptual Speed)
    - TS (Thinking Speed)

Functional CHC and Selective Assessment

Over 20 years of research regarding CHC cognitive and achievement relationships have provided significant evidence as to which cognitive constructs may relate to academic variables (Flanagan, Ortiz, Alfonso, & Mascolo, 2006; McGrew & Wendling, 2010).

Selective Assessment for Academic Disorders

- Woodcock, Maricle, Miller, & McGill (2017)
- Used a large clinical sample for analyses
- Identified the fewest tests that provided the most information for interventions for children and adults identified with reading, writing, or math disorders.

Cognitive Predictors of All Academic Areas

- Strengths
- Weaknesses

Cognitive Predictors of Reading Achievement

- Strengths
- Weaknesses

F-CHC Narrow Abilities Strengths and Weaknesses for Children and Adults with Diagnosed Reading Disorders

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Cognitive Predictors of Writing Achievement
- Both Memory Span (gcm-M5) and Working Memory (gcm-WM)
- Both Verbal Ability (gV-VK) and Factual Knowledge (gq-K)
  - Increased with age
Co-morbid reading and mathematics disorders in school-aged children.

Cognitive Predictors of Math Achievement
- Both Contextual Reasoning (gr-CR) and Deductive/Inductive Reasoning (gr-ID)
  - Working Memory (gcm-WM) deficits across age.
  - Not as many deficits as in other achievement areas.

Cross-Battery Selection of Tests
The Evidence-Based Selective Assessment for Academic Disorders book includes an appendix that listed tests from major cognitive, achievement, and neuropsychology measures that are designed to measure the f-CHC abilities.

Gr (Reasoning) Cross-Battery Test Selection
- Gr-CR (Contextual Reasoning)
  - D-KEFS: Color-Word Interference (Inhibition/Switching)
  - NEPSY-II: Inhibition (Switching)
  - WJ IV ACH: Figure Weights
  - WJ IV COG: Number Matrices
  - WJ IV COG: Number Series
- Gr-ID (Inductive/Deductive Reasoning)
  - D-KEFS: Tower, Twenty Questions
  - KABC-II: Rover
  - NEPSY-II: Animal Sorting, Clocks
  - WJ IV ACH: Comprehension, Matrix Reasoning, Similarities
  - WJ IV COG: Analysis-Synthesis & Concept Formation
Gcm (Conscious Memory)
Cross-Battery Test Selection

Gcm-M.S (Memory Span)
- KABC-II: Number Recall
- NEPSY-II: Sentence Repetition
- WRAML-2: Number/Letter
- WISC-V: Digit Forward
- WJ IV COG: Memory for Words

Gcm-WM (Working Memory)
- SB5: Verbal Working Memory
- WISC-V: Arithmetic, Digit Span Backwards, Picture Span
- WJ IV COG: Object-Number Sequencing, Numbers Reversed, Letter-Number Sequencing

Gc (Comprehension/Knowledge)
Cross-Battery Test Selection

Gc-K (Factual Knowledge)
- SB5: Nonverbal Knowledge & Verbal Knowledge
- WJ IV ACH: Academic Knowledge
- WJ IV COG: General Information

Gc-VA (Verbal Ability)
- KABC-II: Expressive Vocabulary, Listening Comprehension
- NEPSY-II: Body Part Naming, Comprehension of Instructions
- WISC-V: Vocabulary
- WJ IV OL: Picture Vocabulary, Understanding Directions

Presentation Summary

- The presenters have described a functional CHC nomenclature to improve communication and understanding with parents, teachers, and educators.
- The F-CHC classification scheme was applied to a large clinical sample of children and adults with identified learning disorders. The results were published in "Evidence-based Selective Assessment for Academic Disorders".

References


Contact Information

Please send any questions or comments about this presentation to:
Dr. Daniel C. Miller
Executive Director, Woodcock Institute
Texas Woman’s University
P.O. Box 425249
Denton, TX 76204
dmiller@twu.edu
940-898-2467