
Why do some individuals obtain markedly different scores on the various WJ IV *Ga* tests?

Data and theory-based hypotheses for evaluating differences between scores on the WJ IV *Ga* tests


Dr. Kevin McGrew, coauthor of the WJ IV, is responsible for the content of this PPT module.

The information, hypotheses, and opinions expressed in this PPT module do not necessarily represent the opinions of the other WJ IV authors or HMH (the publisher of the WJ IV)

*I recently evaluated a fourth grader with a history of dyslexia and phonics remediation, who scored at the 5th percentile on the WJ IV Phonological Processing test but who did very well on the Segmentation and Sound Blending tests (in the advanced and average range respectively). Can anyone give me an explanation as to why Phonological Processing would be significantly lower? Can reading remediation affect the Segmentation and Blending tests more than the Phonological Processing tests?*

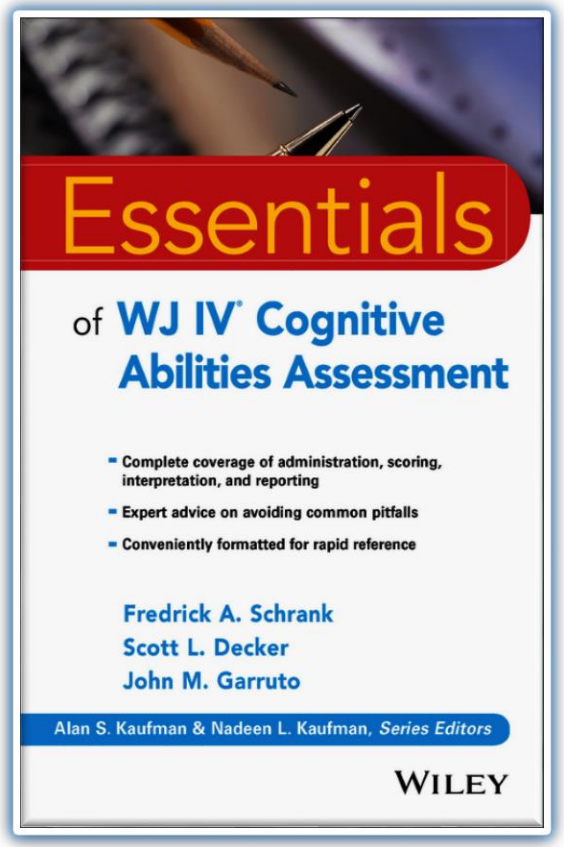
# Recent WJ IV *Ga*-test related interpretation question posted to the IAP CHC listserv

(8-13-16; some edits made to original for clarity)

*The WJ IV Phonological Processing score is what I call a "forced composite" score. It combines several subscores but does not tell you how well the person did on each subscore, just the combined score. Two of the tasks would likely function well as retrieval fluency tasks and the other is more like a traditional Ga task like segmentation and sound blending paradigms. It is possible that Ga is fine and retrieval fluency is not.*

*I would try giving the Verbal Fluency subtests from the DKEFS to see if naming words that start with a specific letter is a problem and if divergent processing tests in general are a problem. Gs tests might help you know if speeded tasks in general are a problem, too.*

A number of others responded. One response, by Dr. Joel Schneider, provides an important insight into a possible answer. His response indicates that it is important to know what the three subtests that comprise the Phonological Processing test measure.



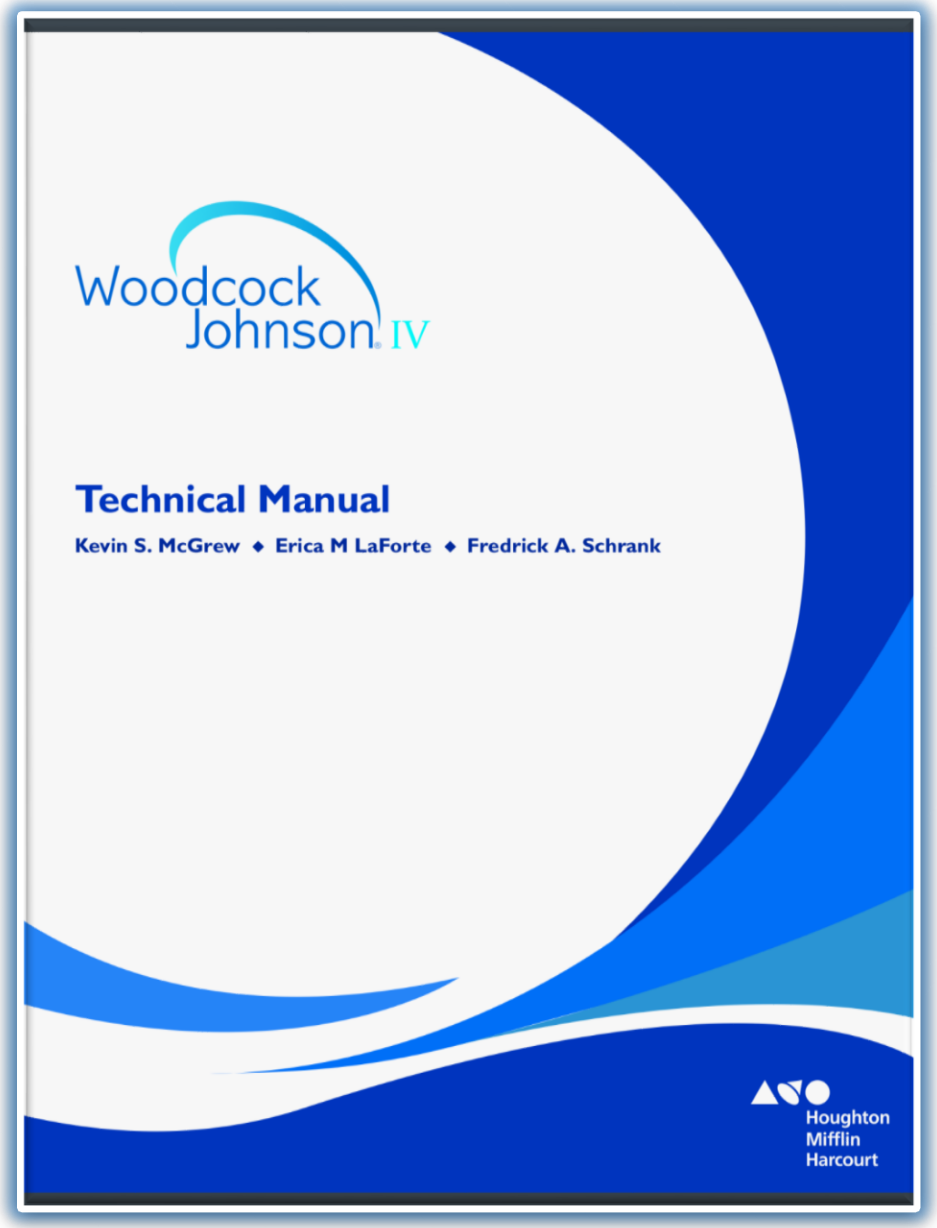

# What the Phonological Processing test/subtests measure (Schrank, 2016)

- Word Access subtest: "the depth of word access from phonemic cues"
- Word Fluency subtest: "the breadth and fluency of work activation from phonemic cues"
- Substitution subtest: "lexical substitution from phonemic cues in working memory"

- "This test is also cognitively complex because it invokes multiple cognitive operations and parameters of cognitive efficiency in phonological processing"

- Inferred cognitive processes: "Phonological activation and access to stored lexical entries; speeded lexical network activation; phonological working memory"

The fact that the PP test measures multiple cognitive operations is consistent with Schneider's designation of this test as a "forced composite" –that is, it is a test deliberately constructed to measure multiple abilities. It is not a "pure" narrow ability test indicator as is conceptualized in CHC-driven assessment




The technical manual can be your friend !

A good technical manual frequently includes information to help answer interpretation questions

McGrew, LaForte & Schrank (2014)

**Table 5-10.**
*WJ IV and Research Test Names and Abbreviations Reported in the WJ IV Technical Manual*

| Battery/Test Name | Test Name Abbreviation | Battery/Test Name | Test Name Abbreviation |
|---|---|---|---|
| **Tests of Cognitive Abilities** | | **Tests of Achievement** | |
| 1: Oral Vocabulary | ORLVOC | 1: Letter-Word Identification | LWIDNT |
| 2: Number Series | NUMSER | 2: Applied Problems | APPROB |
| 3: Verbal Attention | VRBATN | 3: Spelling | SPELL |
| 4: Letter-Pattern Matching | LETPAT | 4: Passage Comprehension | PSGCMP |
| 5: Phonological Processing | PHNPRO | 5: Calculation | CALC |
| 6: Story Recall | STYREC | 6: Writing Samples | WRTSMP |
| 7: Visualization | VISUAL | 7: Word Attack | WRDATK |
| 8: General Information | GENINF | 8: Oral Reading | ORLRDG |
| 9: Concept Formation | CONFRM | 9: Sentence Reading Fluency | SNRDFL |
| 10: Numbers Reversed | NUMREV | 10: Math Facts Fluency | MTHFLU |
| 11: Number-Pattern Matching | NUMPAT | 11: Sentence Writing Fluency | SNWRFL |
| 12: Nonword Repetition | NWDREP | 12: Reading Recall | RDGREC |
| 13: Visual-Auditory Learning | VAL | 13: Number Matrices | NUMMAT |
| 14: Picture Recognition | PICREC | 14: Editing | EDIT |
| 15: Analysis-Synthesis | ANLSYN | 15: Word Reading Fluency | WRDFLU |
| 16: Object-Number Sequencing | OBJNUM | 16: Spelling of Sounds | SPLSND |
| 17: Pair Cancellation | PAIRCN | 17: Reading Vocabulary | RDGVOC |
| 18: Memory for Words | MEMWRD | 18: Science | SCI |
| | | 19: Social Studies | SOC |
| | | 20: Humanities | HUM |

OVANT – Antonyms
OVSYN – Synonyms

PPSUB – Substitution
PPACC – Word Access
PPFLU – Word Fluency

VZSPRL – Spatial Relations
VZBLKR – Block Rotation

GIWHAT – What
GIWHER – Where

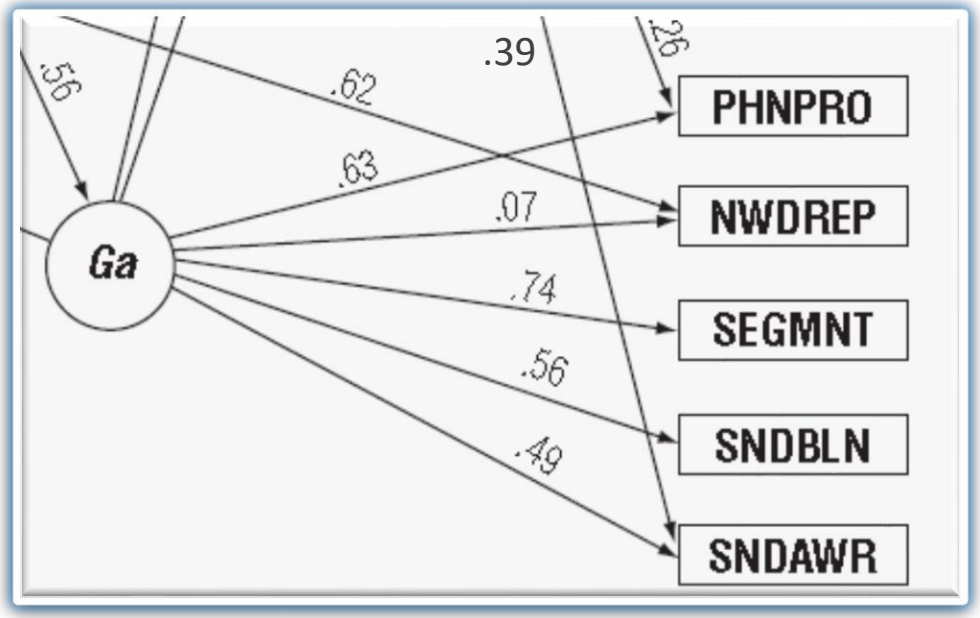
RVANT – Antonyms
RVSYN – Synonyms

Test and subtest name abbreviations used in analysis and results included in this PPT module

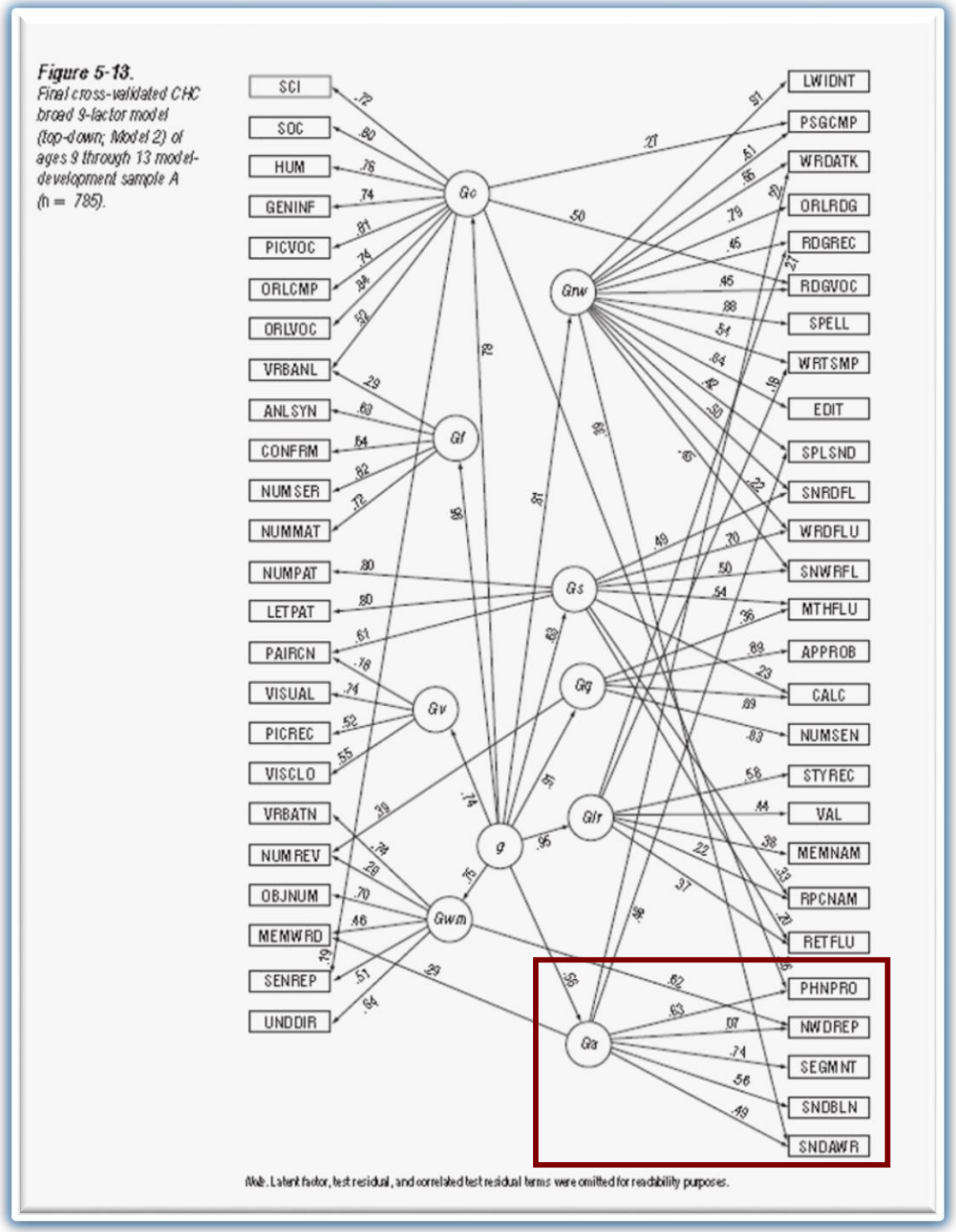
| | | | |
|---|---|---|---|
| | | 20: Humanities | HUM |
| **Tests of Oral Language** | | **Non-WJ IV Research Tests** | |
| 1: Picture Vocabulary | PICVOC | Memory for Names[a] | MEMNAM |
| 2: Oral Comprehension | ORLCMP | Verbal Analogies[a] | VRBANL |
| 3: Segmentation | SEGMNT | Visual Closure[a] | VISCLO |
| 4: Rapid Picture Naming | RPCNAM | Number Sense | NUMSEN |
| 5: Sentence Repetition | SENREP | | |
| 6: Understanding Directions | UNDDIR | | |
| 7: Sound Blending | SNDBLN | | |
| 8: Retrieval Fluency | RETFLU | | |
| 9: Sound Awareness | SNDAWR | | |

[a] Tests or subtests in WJ III COG Diagnostic Supplement.

SADELE – Deletion
SARHYM – Rhyming

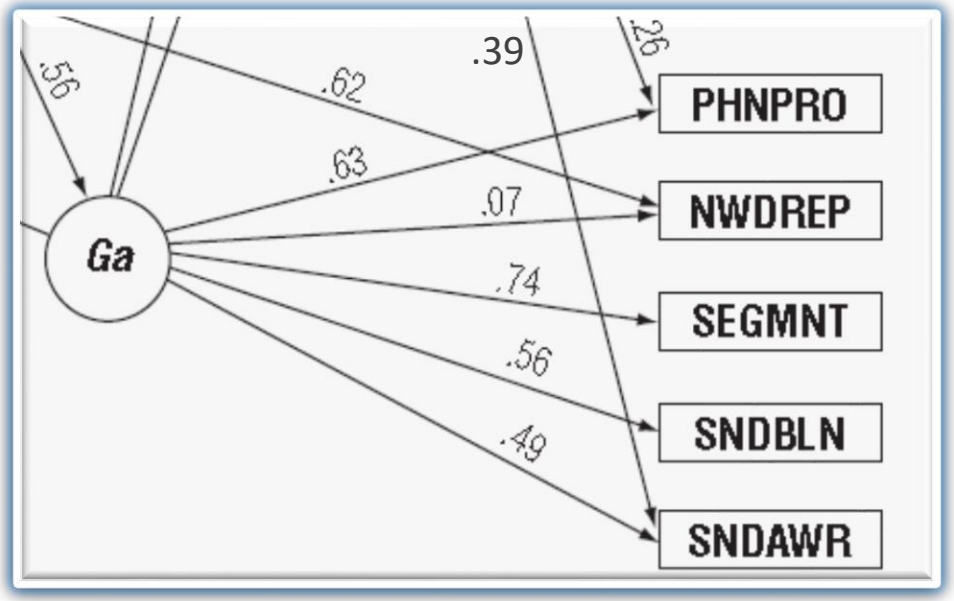



It is important to remember that just because a collection of tests load on a common factor (e.g., *Ga*) this does not mean they are measuring the same ability. This only means that the different narrow abilities measured by each test share a common latent ability trait (factor) different from other latent ability traits (factors; e.g., Gc). *Differences between tests within CHC domains are to be expected*.

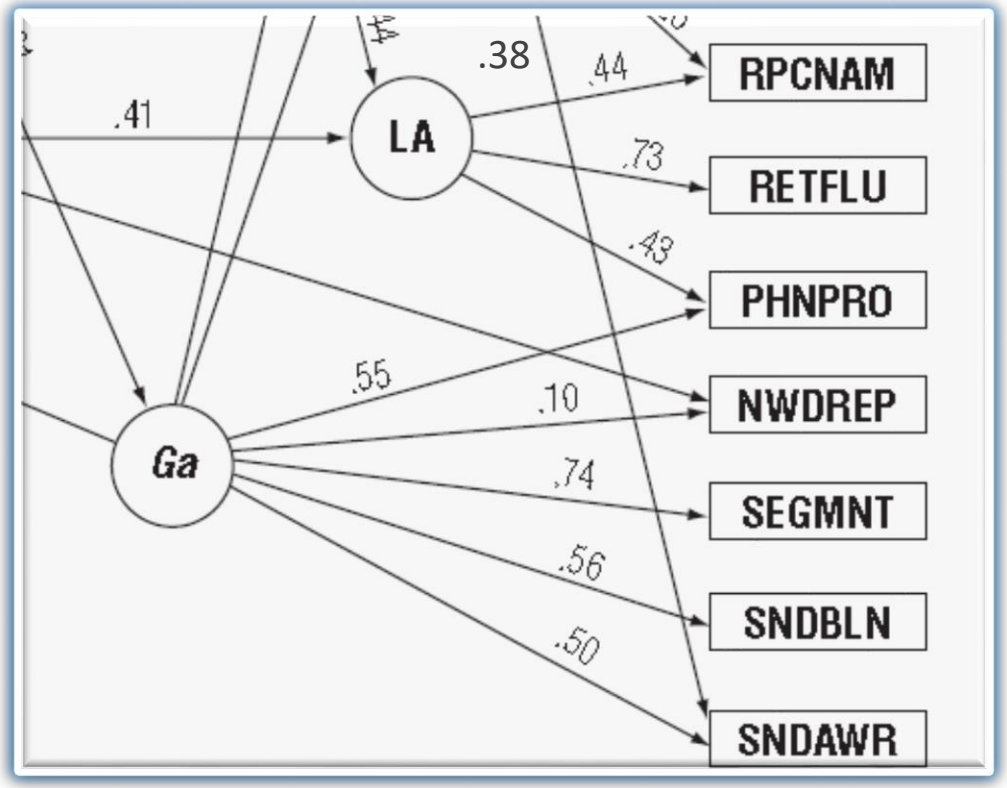



NWREP (Nonword Repetition) had .62 secondary loading on *Gwm*, suggesting that it is a mixed measure of a narrow *Ga* ability and working memory (*Gwm*)—possibly the "phonological or articulatory loop" or "phonological short-term memory" as in some classic models of working memory (McGrew et al., 2014).

SNDAWR (Sound Awareness) test had secondary loading of .39 on *Grw*—but it does not require reading to perform.




CFA of WJ IV norm data (example here is for ages 9-13) supported a single *Ga* factor. Models with *Ga* narrow factors, specified in the model-development sample, were not possible to fit.
From WJ IV technical manual (McGrew et al., 2014)




CFA of WJ IV norm data (example here is for ages 9-13) supported a single *Ga* factor. Models with *Ga* narrow factors, specified in the model-development sample, were not possible to fit. However, a narrow speed of lexical access (LA) factor was suggested in a broad+narrow ability alternative model.

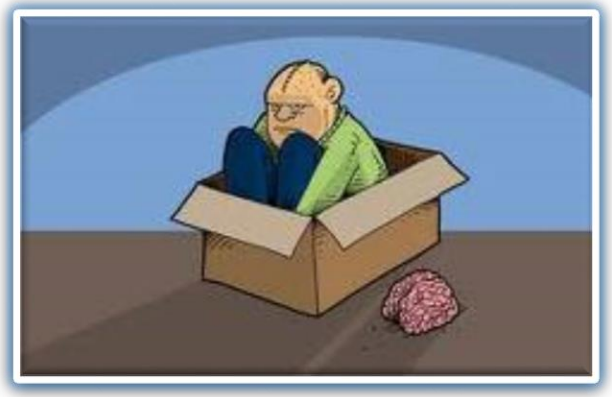
PHNPRO (Phonological Processing) had a secondary loading (.43) on the LA factor, indicating that a portion of the PHNPRO test (most likely the Word Fluency subtest) measures common abilities with the Retrieval Fluency (RETFLU) and Rapid Picture Naming (RPCNAM) tests (viz., speed of lexical access)

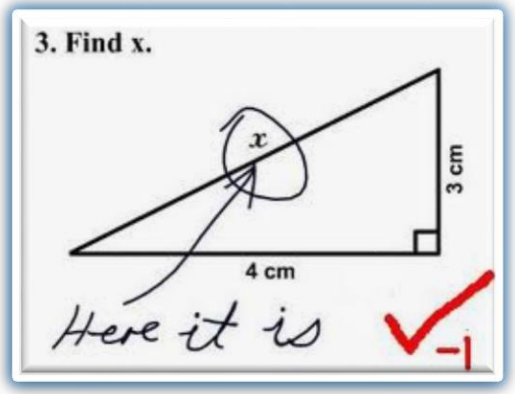


Important Reminder: All statistical methods, such as factor analysis (EFA or CFA), have limitations and constraints.

EFA/CFA methods only provide evidence of structural/internal validity and typically nothing about external, developmental, heritability, or neurocognitive validity evidence

We need to examine other sources of evidence and use other methods – looking/thinking outside the factor analysis box





INTELLIGENCE 7, 107–127 (1983)

# The Complexity Continuum in the Radex and Hierarchical Models of Intelligence*

BRACHIA MARSHALEK, DAVID F. LOHMAN, AND RICHARD E. SNOW
*Stanford University*

One of the MDS classic articles

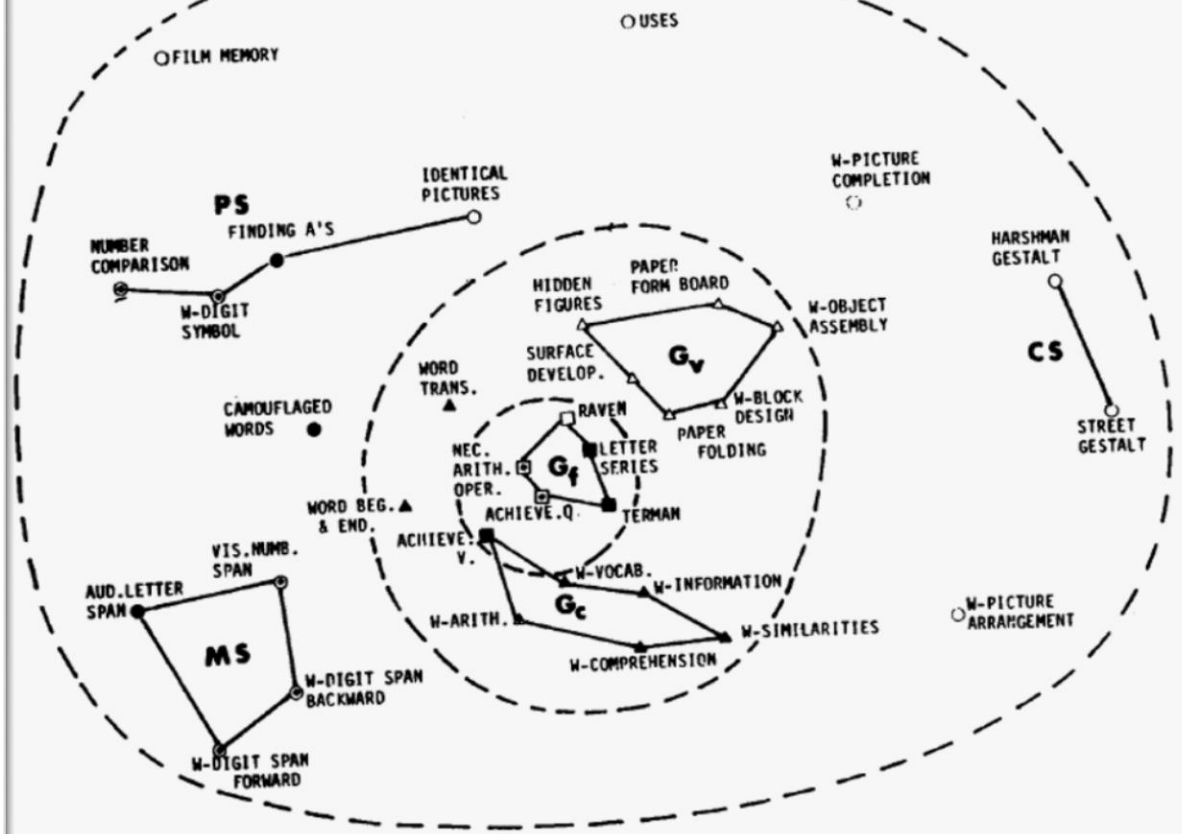



FIG. 3. A multidimensional scaling of the full test battery showing three levels of complexity and three content areas (high school sample, $N = 241$).Complex, intermediate, and simple tests are indicated as black (verbal), dotted (numerical), and white (figural-spatial) squares, triangles, and circles, respectively.

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INTELLIGENCE

# The cylindrical structure of the Wechsler Intelligence Scale for Children — IV: A retest of the Guttman model of intelligence

Arie Cohen [a,*], Catherine A. Fiorello [b], Frank H. Farley [b]

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Received 29 November 2005; received in revised form 12 April 2006; accepted 27 May 2006
Available online 17 July 2006



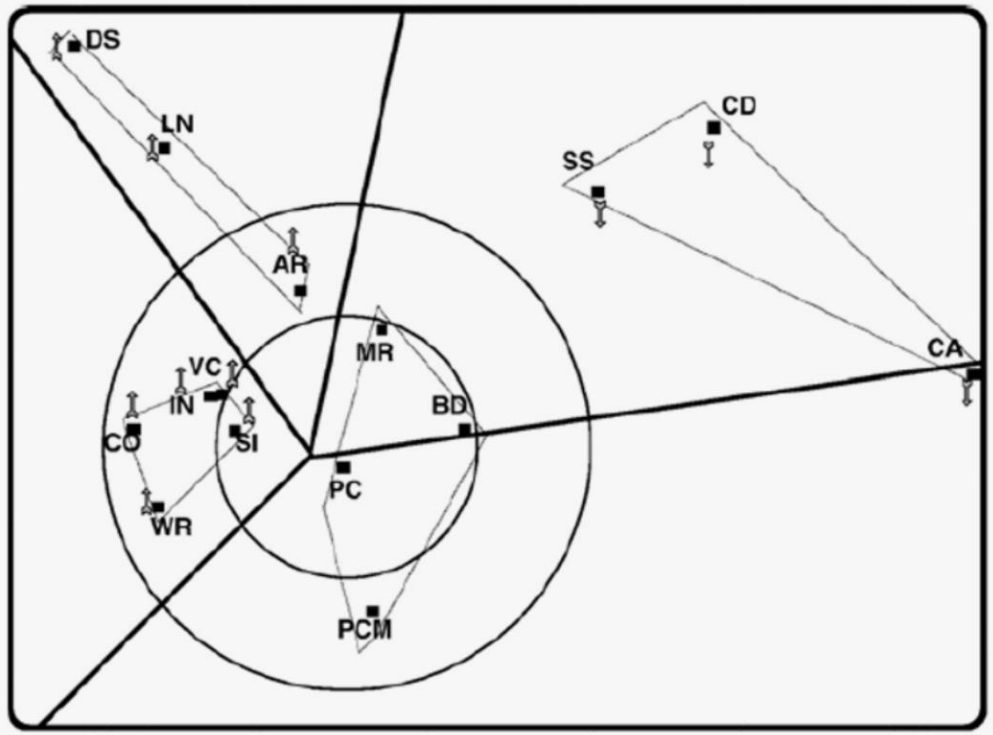


Fig. 1. Three-dimensional Guttmon model of the WISC-IV.

Another example of the usefulness of MDS method

International Journal of Behavioral Development
2009, 33 (3), 277–285
http://www.sagepublications.com

ijbd

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DOI: 10.1177/0165025409104489

METHODS AND MEASURES

# Confirmatory factor analysis and multidimensional scaling for construct validation of cognitive abilities

Elliot M. Tucker-Drob and Timothy A. Salthouse
University of Virginia, USA

A brilliant illustration of the complimentary use of CFA and MDS

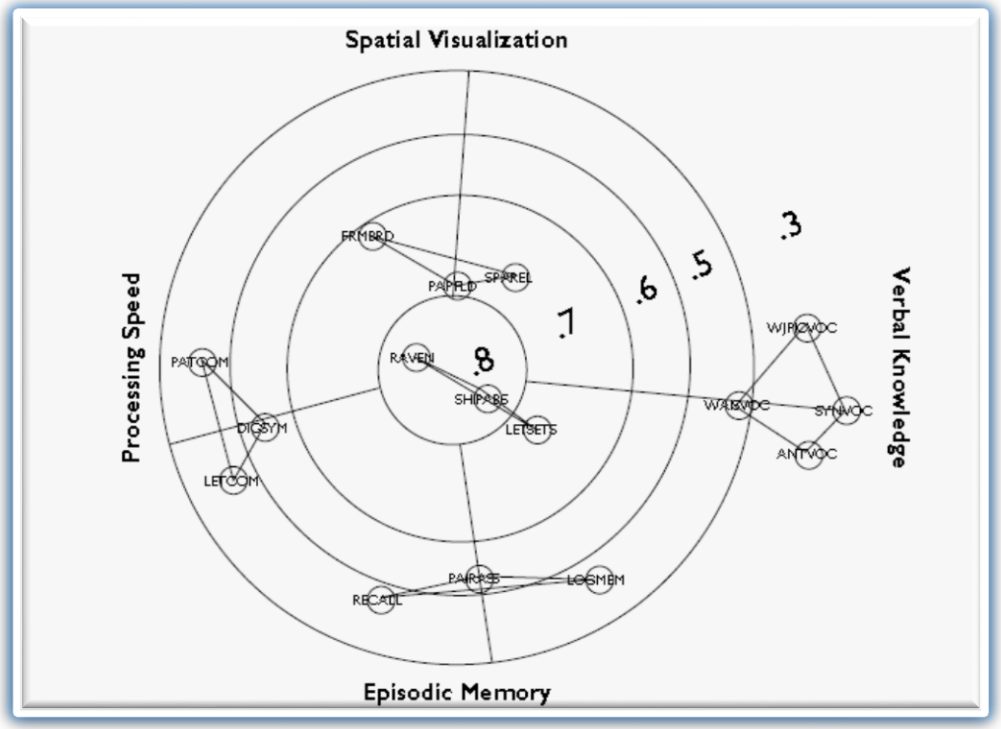



**Table 3**
*Standardized loadings from confirmatory factor analysis for total sample and (young group, middle-aged group, and old group)*

| *Variable* | *G* | *Memory* | *Space* | *Speed* | *Verbal* |
|---|---|---|---|---|---|
| Raven's | .88 (.83, .80, .78) | | | | |
| Shipley abstraction | .87 (.83, .87, .85) | | | | |
| Letter sets | .79 (.77, 78, .80) | | | | |
| Logical memory | .56 (.57, .55, .53) | .44 (44, .44, .44) | | | |
| Free recall | .56 (.47, .41, .43) | .61 (.63, .68, .70) | | | |
| Paired associates | .61 (.58, .53, .41) | .42 (.41, .43, .47) | | | |
| Spatial relations | .78 (.84, .73, .60) | | .50 (.40, .62, .59) | | |
| Paper folding | .78 (.78, .70, .63) | | .28 (.28, .29, .38) | | |
| Form boards | .70 (.65, .58, .54) | | .33 (.32, .37, .46) | | |
| Digit symbol | .69 (.50, .54, .61) | | | .42 (.42, .37, .48) | |
| Letter comparison | .59 (.41, .49, .60) | | | .57 (.63, .64, .55) | |
| Pattern comparison | .59 (.42, .42, .54) | | | .54 (.56, .53, .50) | |
| WAIS vocabulary | .53 (.76, .76, .66) | | | | .68 (.48, .43, .49) |
| WJ Picture vocabulary | .37 (.73, .71, .65) | | | | .68 (.42, .37, .24) |
| Synonym vocabulary | .35 (.68, .70, .65) | | | | .84 (.58, .58, .66) |
| Antonym vocabulary | .41 (.63, .70, .66) | | | | .76 (.59, .53, .49) |

*Notes.* Factors are uncorrelated. All loadings are significant at $p < .01$. Fit indices for total sample: $\chi^2 = 1470.5$, degrees of freedom = 91. CFI = .96. TLI = .95. RMSEA = .041.

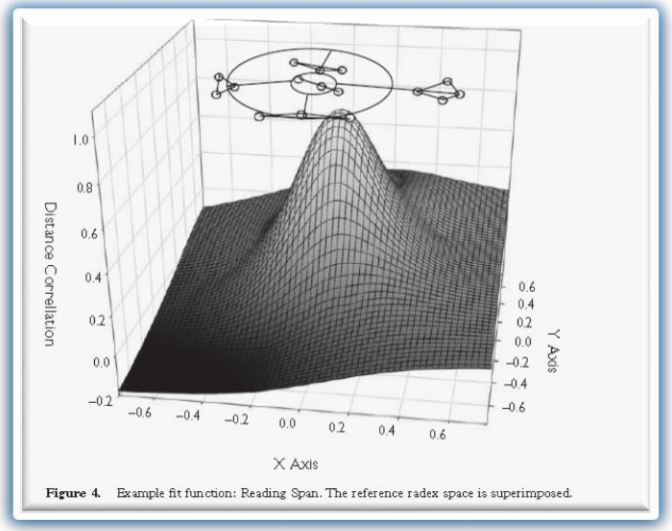
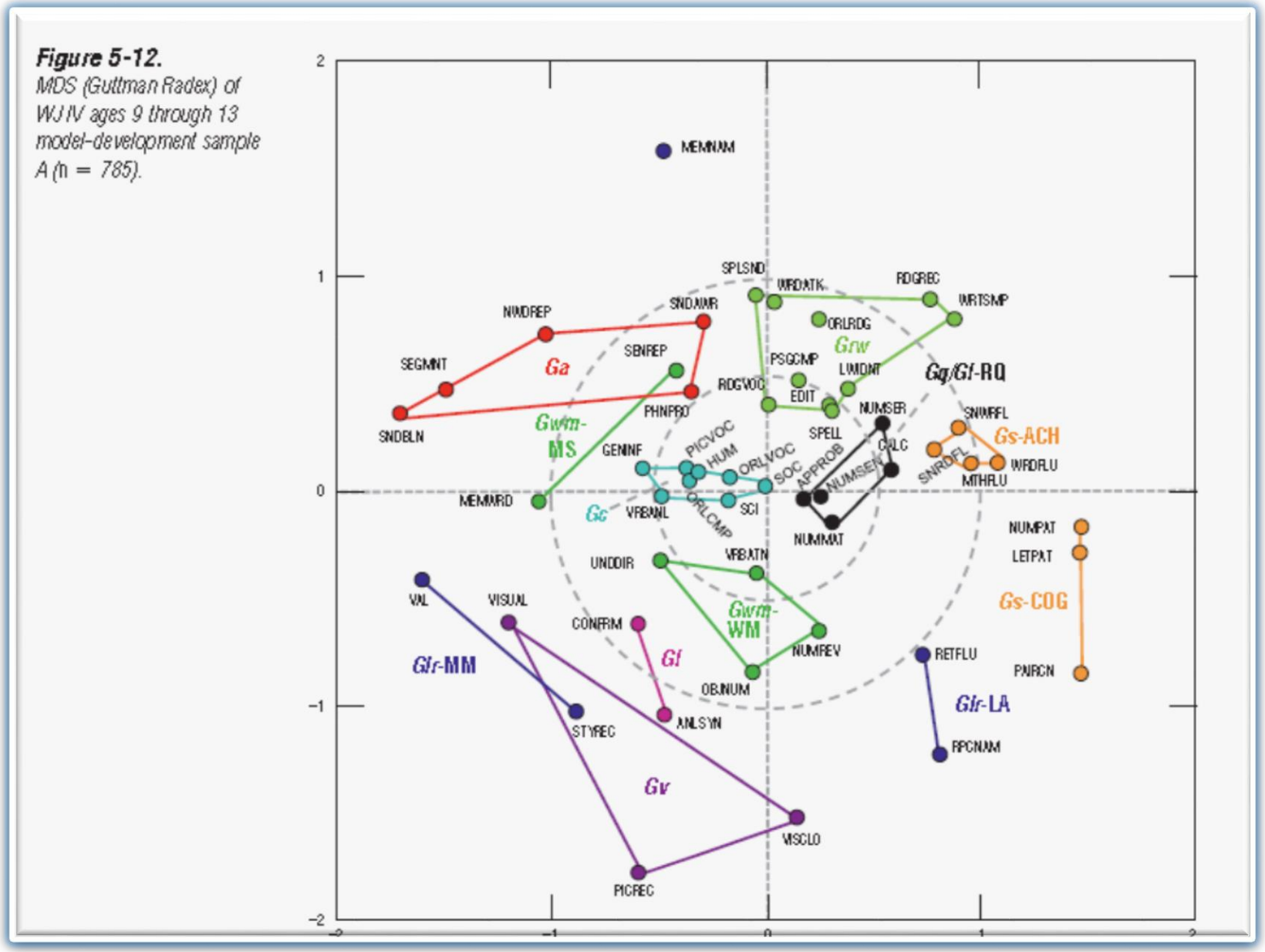



**Figure 4.** Example fit function: Reading Span. The reference radex space is superimposed.




The WJ IV technical manual includes special MDS analysis results for all major age groups reported (McGrew et al., 2014)

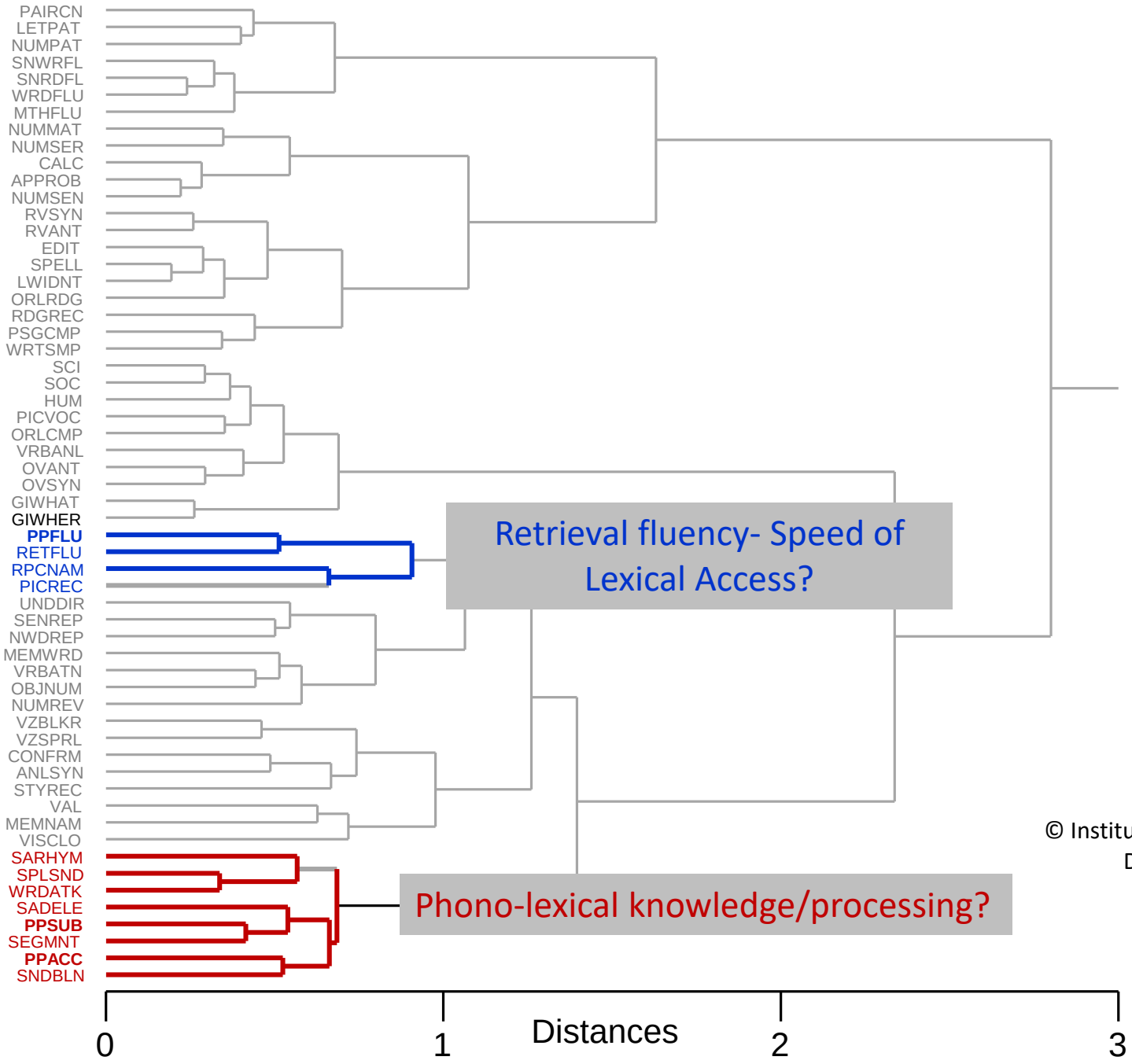
In MDS the magnitude of the relationship between tests is represented by spatial proximity. Tests that are far apart are weakly correlated. Test that are close together are more highly correlated.

However, the MDS plots in the technical manual did not include the component “subtests” of “tests” comprised of subtests (e.g., PHNPRO)

Kevin McGrew recently revisited the WJ IV norm data (ages 6-19) with EFA, cluster analysis (CA) and MDS exploratory methods and analyzed either all WJ IV tests (and subtests) (and also included the ECAD tests)

What follows are unpublished non-peer reviewed results

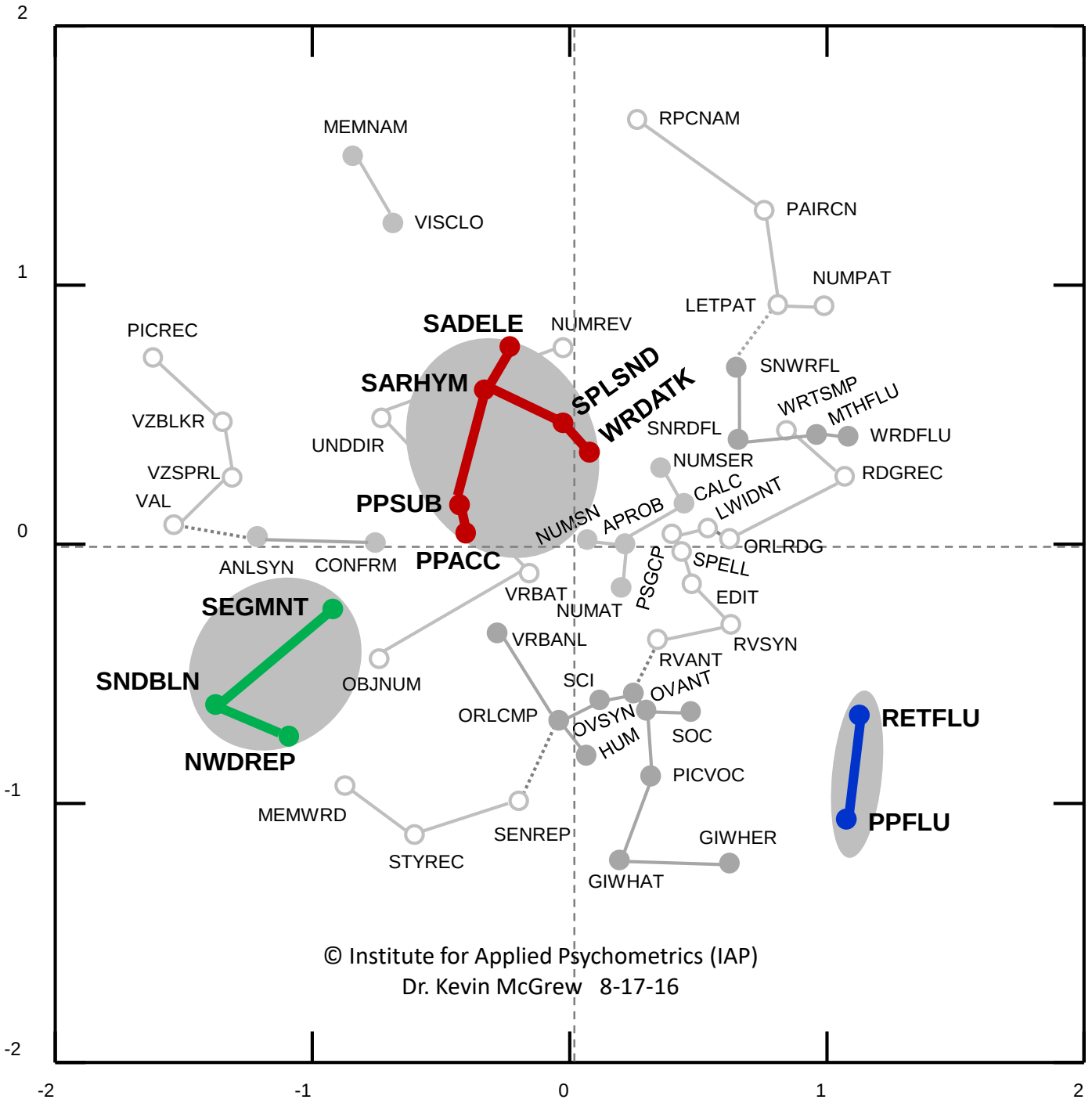
Ages 6-19 Ward's cluster analysis 3-27-16




Note that three **Phonological Processing** subtests (PPFLU, PPSUB, and PPACC) are in bold font.

Also note that the subtests from **Sound Awareness** are included as separate variables (SARHYM, SADELE)

Ages 6-19
2-D MDS
(Guttman
Radex)
3-27-16

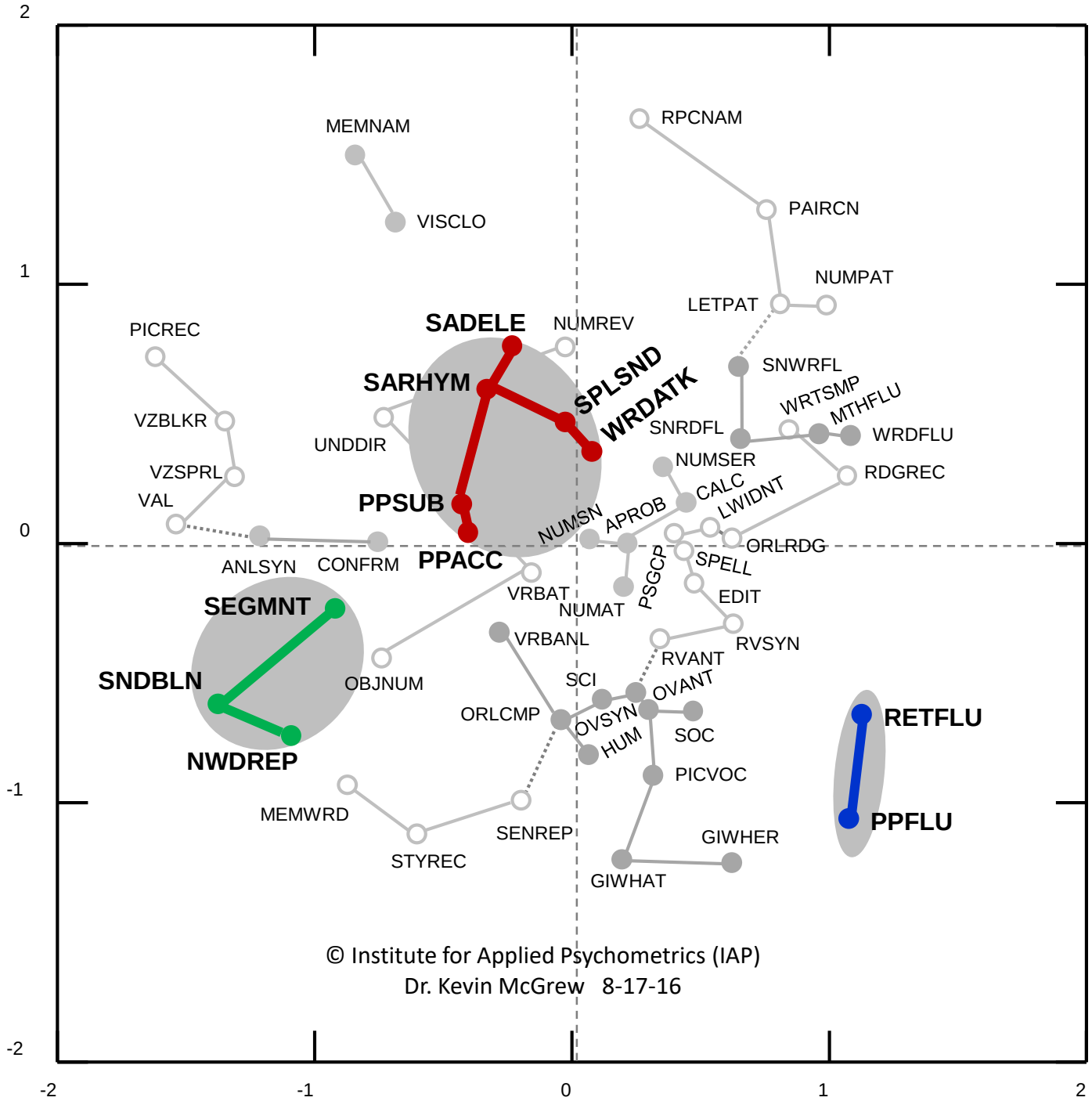



Subgroupings of *Ga* and *Glr-LA* related tests are color coded **green**, **red** and **blue** (and designated with gray shading)

All other meaningful groupings are shaded light gray or white to indicate they are distinct from each other and also distinct from the primary focus on the green, red and blue tests/subtests In this module

It is clear that the *Ga* and *Glr-LA* related test groupings are tapping different aspects of *Ga*.

Ages 6-19
2-D MDS
(Guttman
Radex)
3-27-16



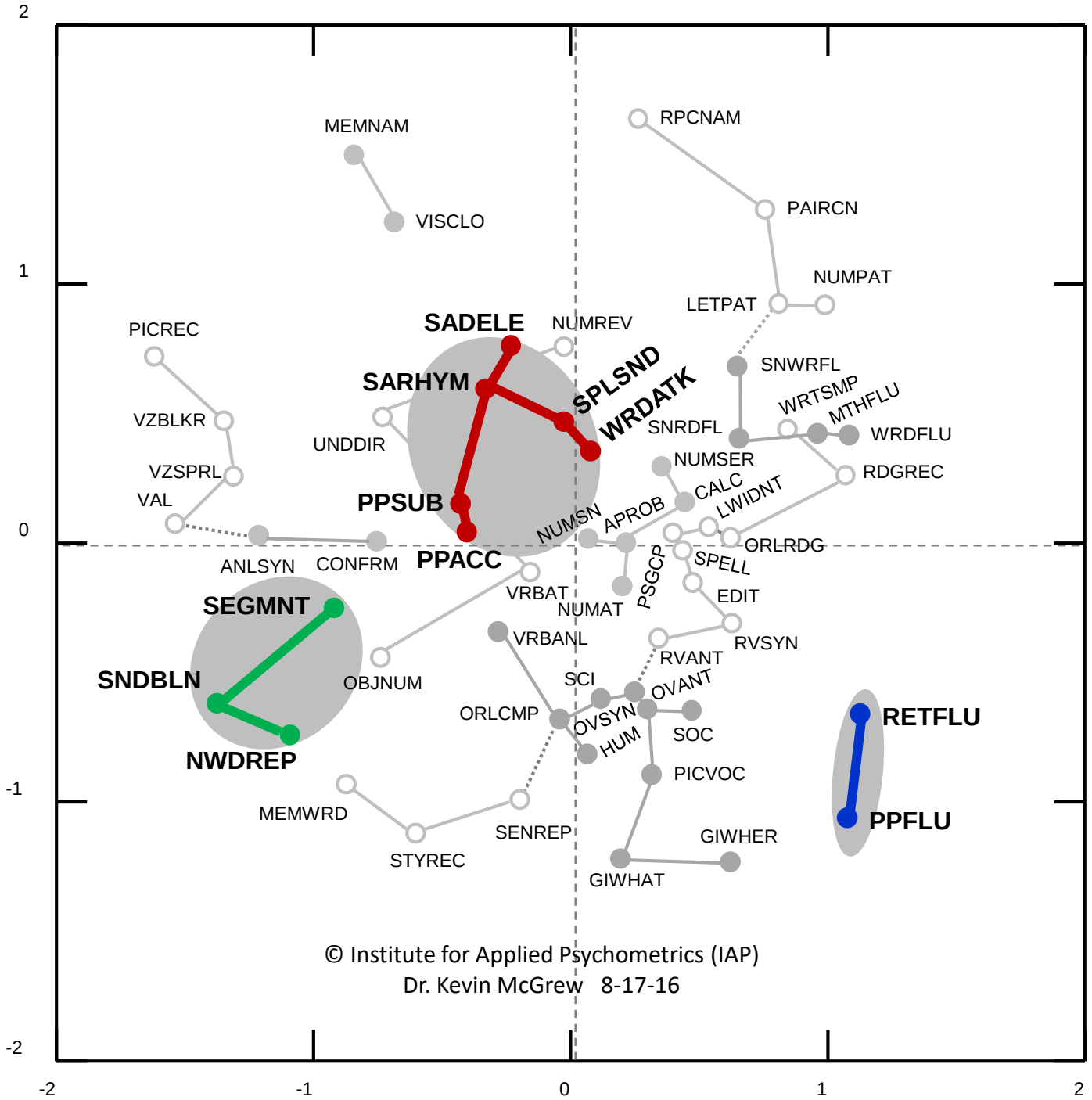

Important findings:

- Two of the Phonological Processing subtests (PPSUB; PPACC) group with the Sound Awareness subtests (SADELE; SARHYM) and the *Grw* tests of SPLSND and WRDATK

- Also, this grouping is in close proximity to other acquired knowledge groupings (*Grw, Gq*)

- **Ho These six tests/subtests measure the store of acquired phono-lexical knowledge**

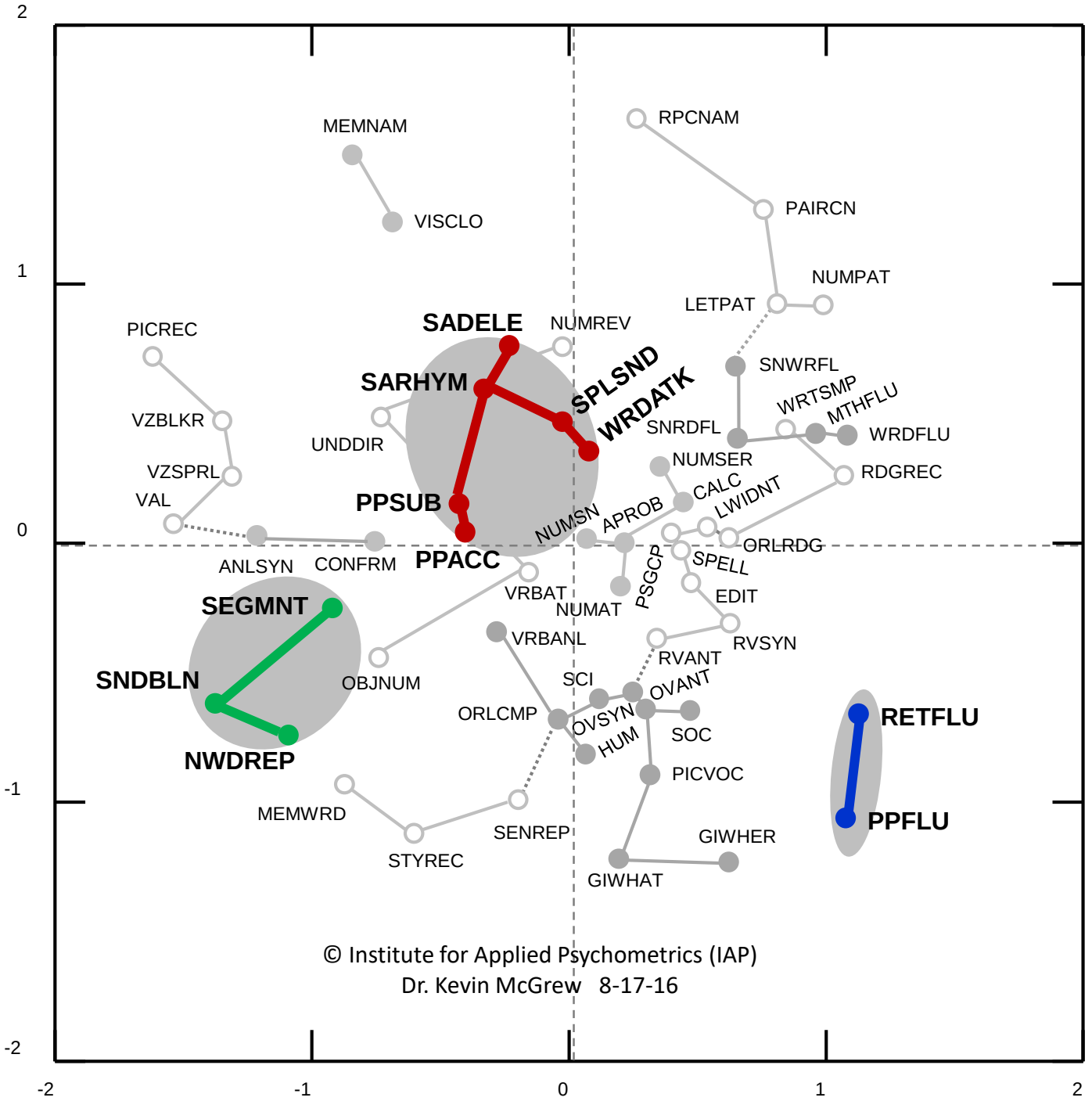
Ages 6-19
2-D MDS
(Guttman
Radex)
3-27-16




Important findings:

The third Phonological Processing subtest (PPLU: Word Fluency) groups with Retrieval Fluency (RETFLU), thus confirming the hypothesis that the Phonological Processing Word Fluency subtest is measuring fluency or speed of phono-lexical knowledge access in contrast to the breadth and depth of the store of acquired phono-lexical knowledge

Ages 6-19
2-D MDS
(Guttman
Radex)
3-27-16

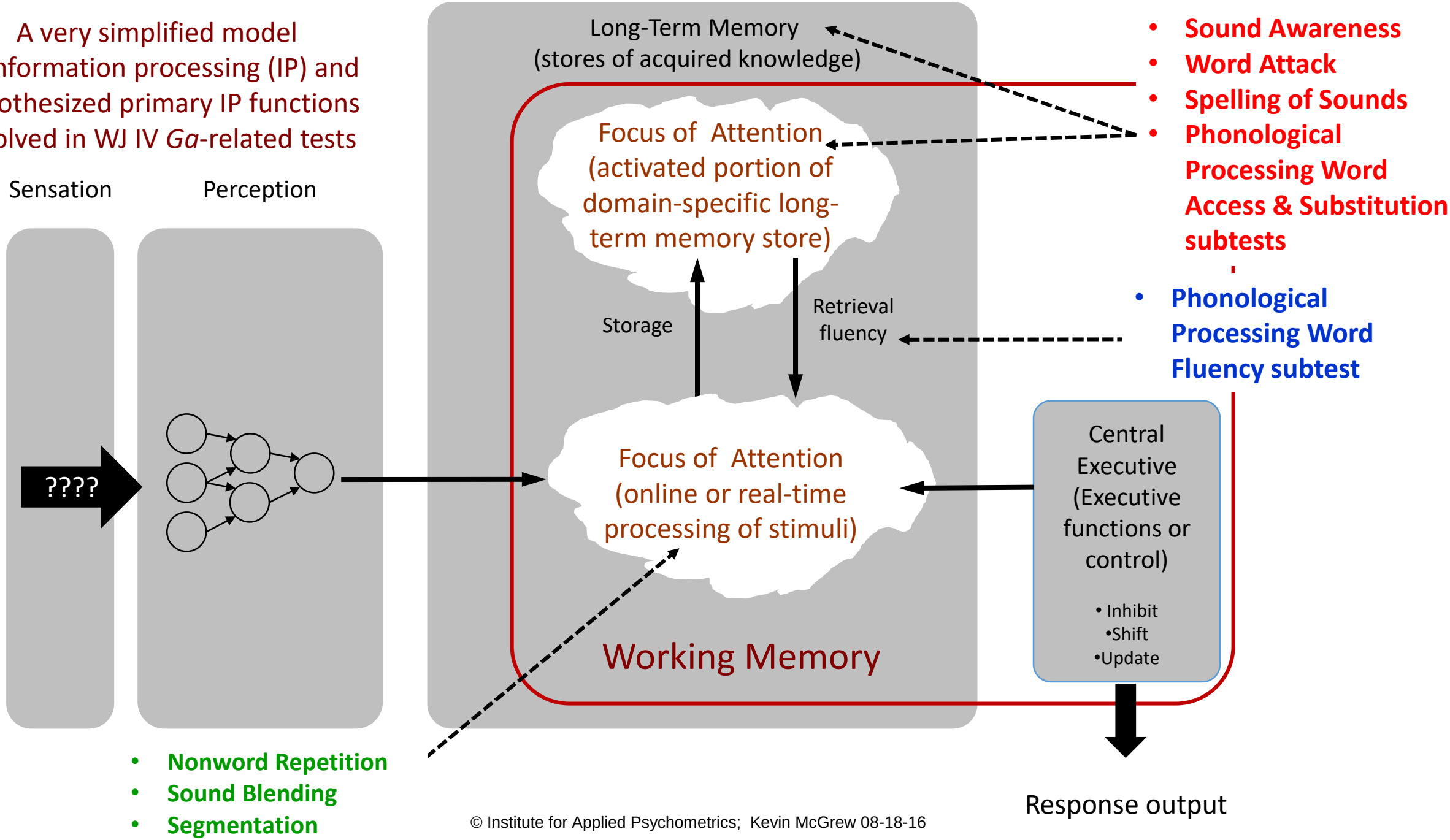


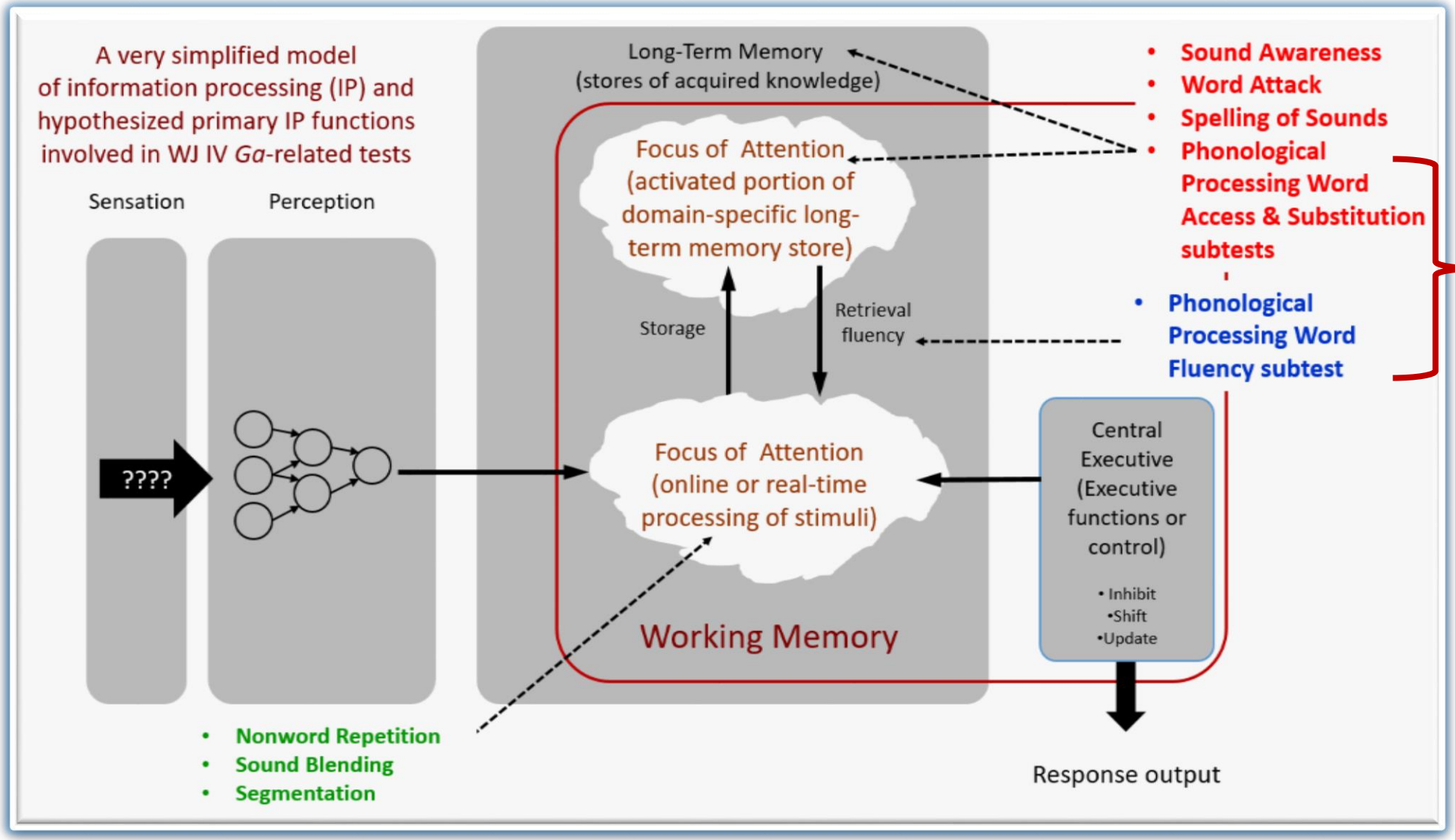

Important findings:

The Nonword Repetition (NWDREP), Sound Blending (SNDBLN) and Segmentation (SEGMNT) tests are measuring abilities distinctly different from the other two groupings.

Ho: These three tests place minimal access on an individuals store of acquired phono-lexical knowledge and the fluency or speed of access to this knowledge store, and are more measures of "on-line or real-time" processing of sound units in working memory

A very simplified model of information processing (IP) and hypothesized primary IP functions involved in WJ IV *Ga*-related tests






As per Schneider's comment and Schrank(2016), the Phonological Processing test is a mixed "composite" comprised of three subtests, two (Word Access and Substitution) that are measuring stores of acquired phono-lexical knowledge and a third (Word Fluency) that measures a different aspect of phono-lexical knowledge (viz., speed or fluency of retrieval of this knowledge)

In contrast, the Nonword Repetition, Sound Blending, and Segmentation tests require less in terms of access to (and fluent retrieval) the stores of acquired phono-lexical knowledge and measure the on-line real-time "processing" of sound elements in working memory (aka, Phonetic Coding)

# Assessment and interpretation implications

- Differences between the WJ IV Phonological Processing, Sound Awareness, and three phonetic coding tests (Nonword Repetition, Segmentation, Sound Blending) are likely to occur with regularity as they measure different aspects of phonetic coding and phono-lexical-knowledge/processing.

- Determining why a Phonological Processing (PP) test may diverge from the other two types of tests is difficult given that scores are not available for the three PP component subtests.

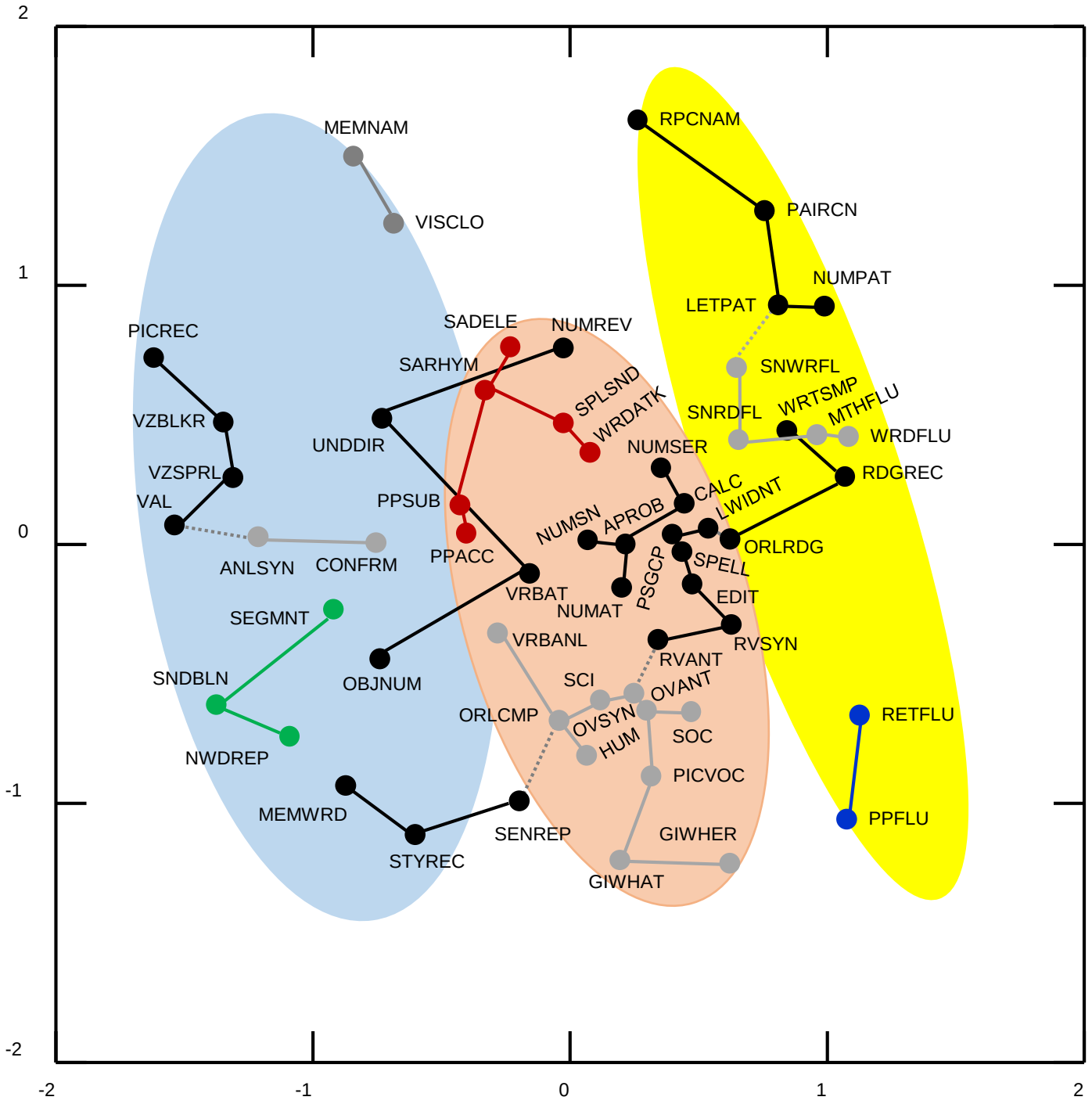
- To help determine the possible reasons for a discrepant (PP) test score, it is suggested that examiners administer the WJ IV Sound Awareness (SA; and, if possible, Word Attack-WA and Spelling of Sounds-SOS) and Retrieval Fluency (RF) tests.[1]

    - If RF is much lower than SA (and WA and SOS if administered)), then the hypothesis could be generated that the lower PP score may be reflecting a speed or fluency of access weakness (to the person's store of acquired phono-lexical knowledge), and does not necessary reflect a weakness in the breadth and depth of the person's store of this specialized network of knowledge.
    - If SA (and WA and SOS if administered) is much lower than RF, then the hypothesis could be generated that the lower PP score may be due a weak store of acquired phono-lexical knowledge and the issue is not so much related to speed or fluency of access to this specialized store of knowledge.
    - If both the RF and SA (and WA and SOS if administered) scores are comparable to PP (and is a deficit for a person), then the hypothesis could be generated that the person has a more generalized deficit in both the breadth and depth of their store of phono-lexical knowledge and ease (fluency) by which they can access and retrieve information from this store of acquired knowledge

1. As suggested by Dr. Joel Schneider, other tests of speed/fluency of verbal access (e.g., Verbal Fluency subtests from the DKEFS) may be a good idea to explore these hypotheses.


The current information can be placed in the context of two components of Ackerman's PPIK (Intelligence-as-Process, Personality, Interests, Intelligence-as-Knowledge; http://tinyurl.com/hdvafxl ) intelligence trait complex framework (and other over-arching cognitive neuroscience frameworks)... stay tuned!  Next slide is a preview

Ages 6-19
2-D MDS
(Guttman
Radex)
8-17-16




- **Intelligence-as-Process** (Ackerman)
- **System 2** (controlled deliberate cognitive operations/processes) (Kahneman)
- $g_f$ **Cattell**

- **Intelligence-as-Knowledge** (Ackerman)
- **Acquired knowledge systems**
- $g_c$ **Cattell**

- **Intelligence-as-Process: fluency/speed** (Ackerman)
- **System 1** (automatic rapid cognitive processes) (Kahneman)
- $g_s$ – **General speed factor**