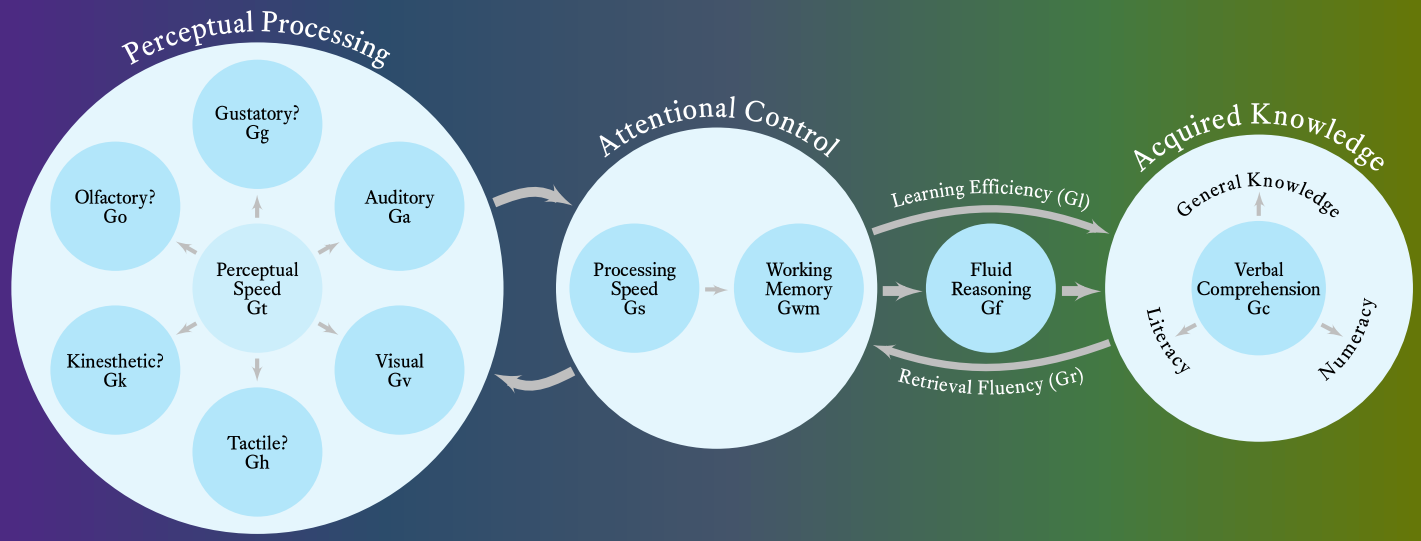
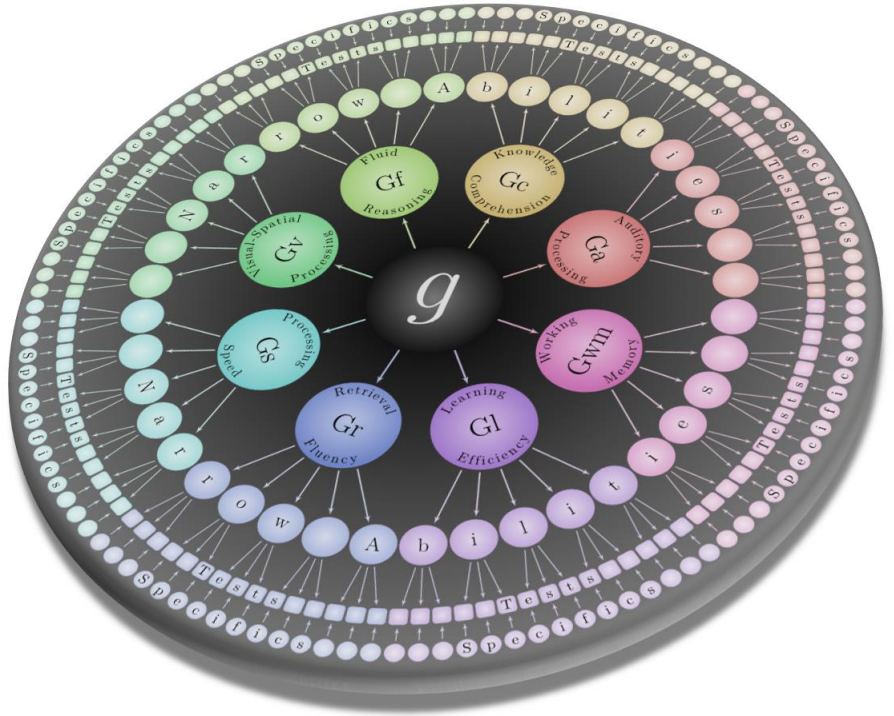
Cattell-Horn-Carroll
Theory of Cognitive Abilities



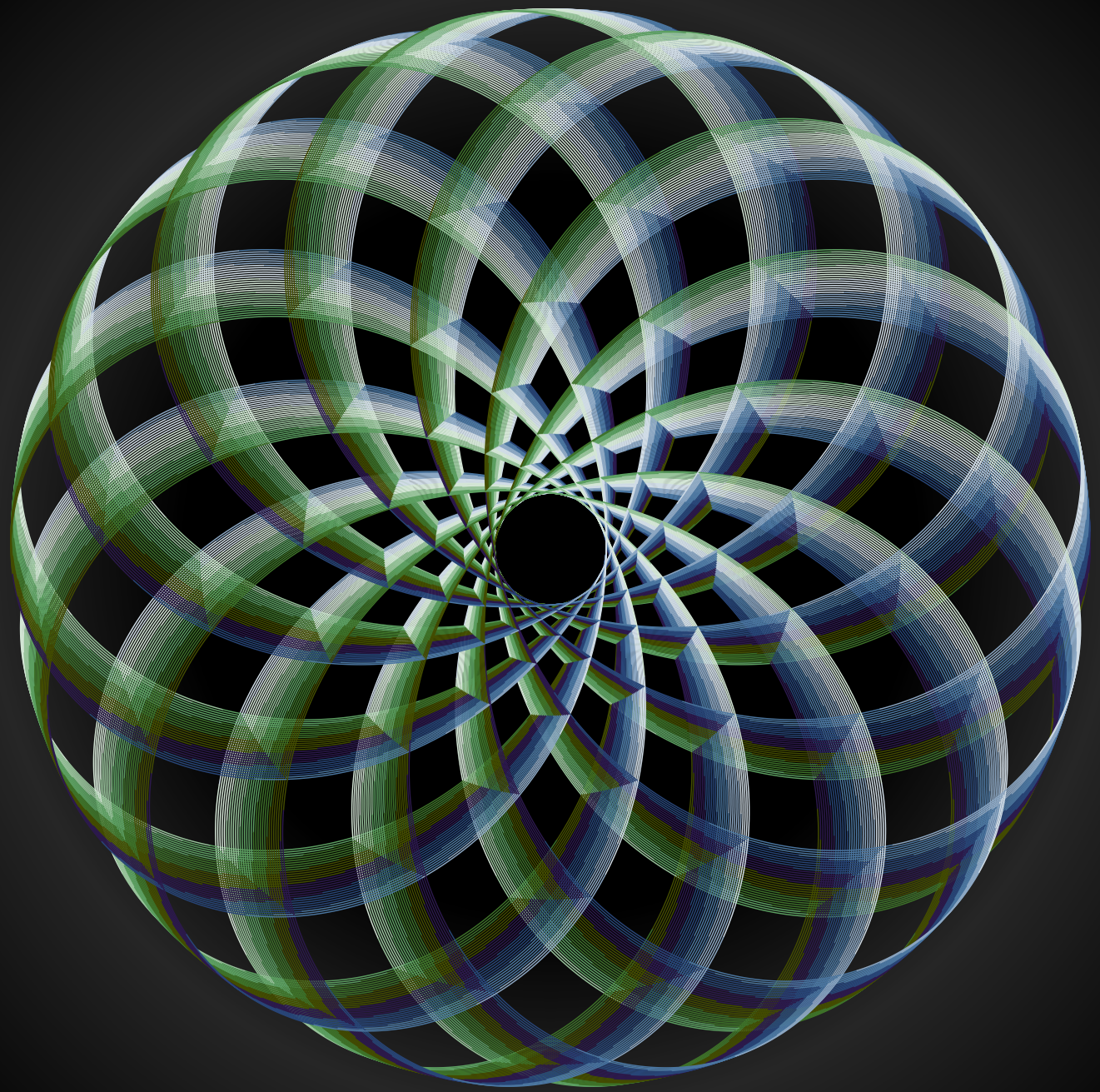


W. Joel Schneider

schneider@temple.edu

assessingpsyche.wordpress.com

TEMPLE UNIVERSITY College of Education & Human Development



Clear, Important, Legitimate Exceptions Can Be Found

For Every Statement I Will Make.

Including This One

[Empathy] means entering the private perceptual world of the other…being sensitive, moment by moment to the changing felt meanings which flow in this other person. … It means sensing meaning of which he or she is scarcely aware.

—Carl Rogers (1980)
A Way of Being

SPECIAL ARTICLE

How important are the common factors in psychotherapy? An update

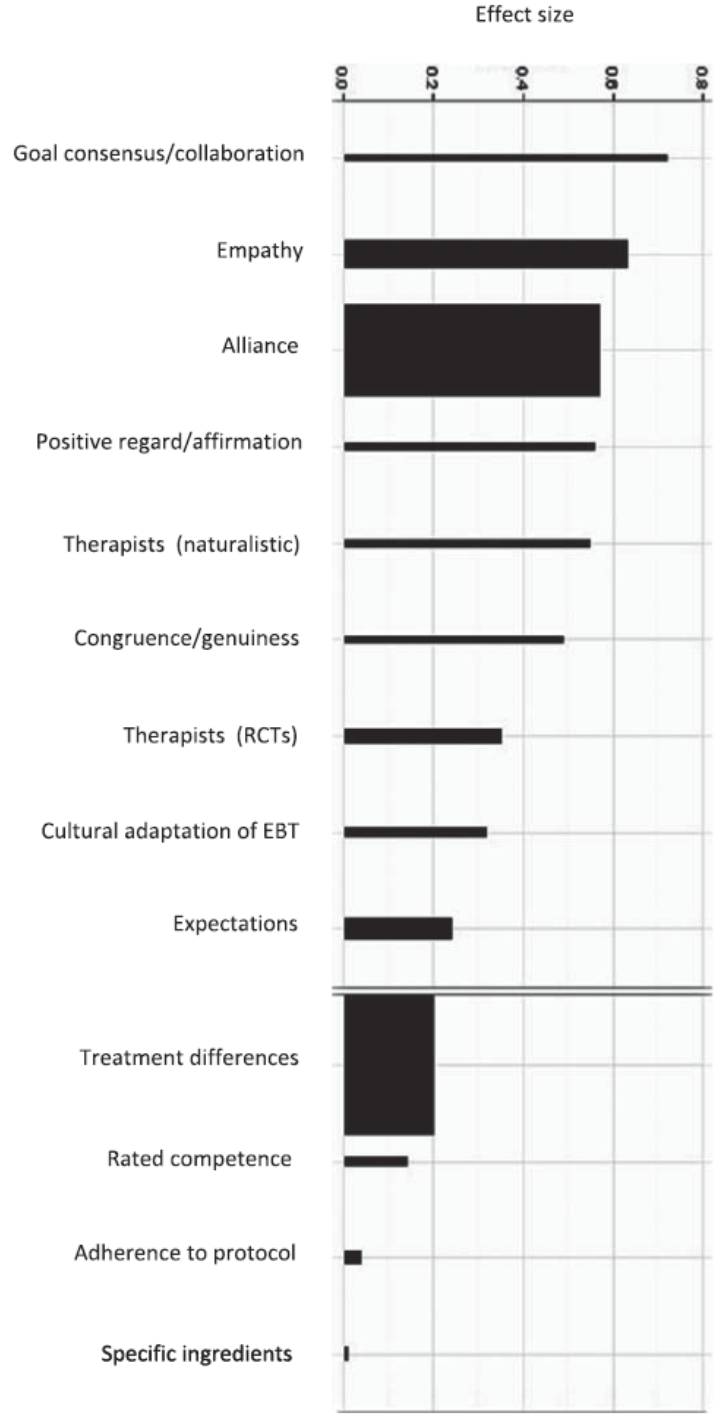
Bruce E. Wampold

Department of Counseling Psychology, University of Wisconsin, Madison, WI, USA; Modum Bad Psychiatric Center, Vikersund, Norway

The common factors have a long history in the field of psychotherapy theory, research and practice. To understand the evidence supporting them as important therapeutic elements, the contextual model of psychotherapy is outlined. Then the evidence, primarily from meta-analyses, is presented for particular common factors, including alliance, empathy, expectations, cultural adaptation, and therapist differences. Then the evidence for four factors related to specificity, including treatment differences, specific ingredients, adherence, and competence, is presented. The evidence supports the conclusion that the common factors are important for producing the benefits of psychotherapy.

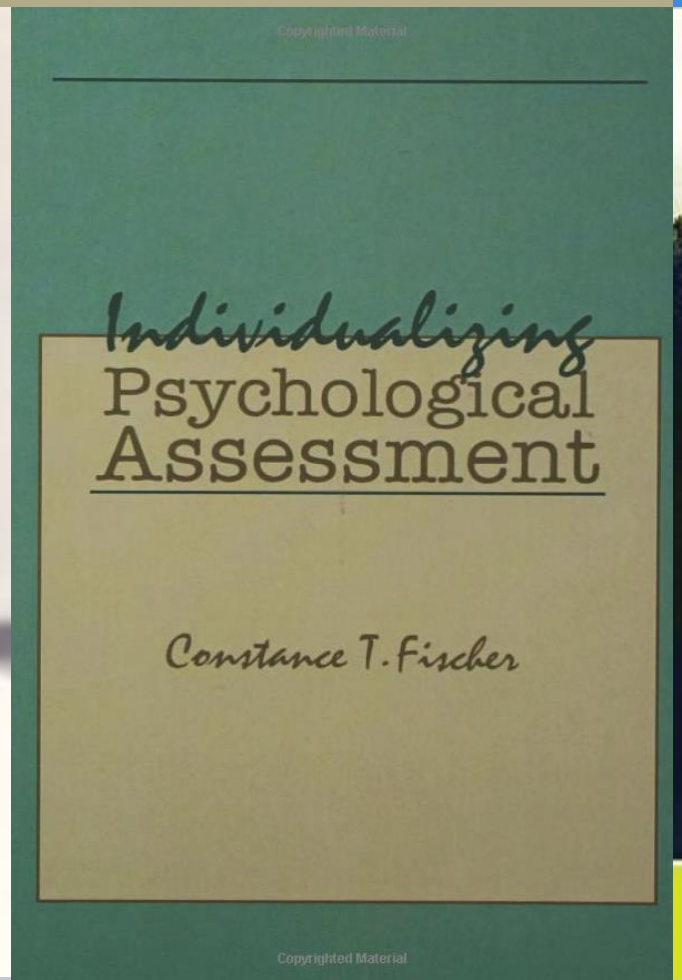
Key words: Common factors, contextual model, psychotherapy, alliance, empathy, expectations, cultural adaptation, therapist differences, specific ingredients

(World Psychiatry 2015;14:270–277)



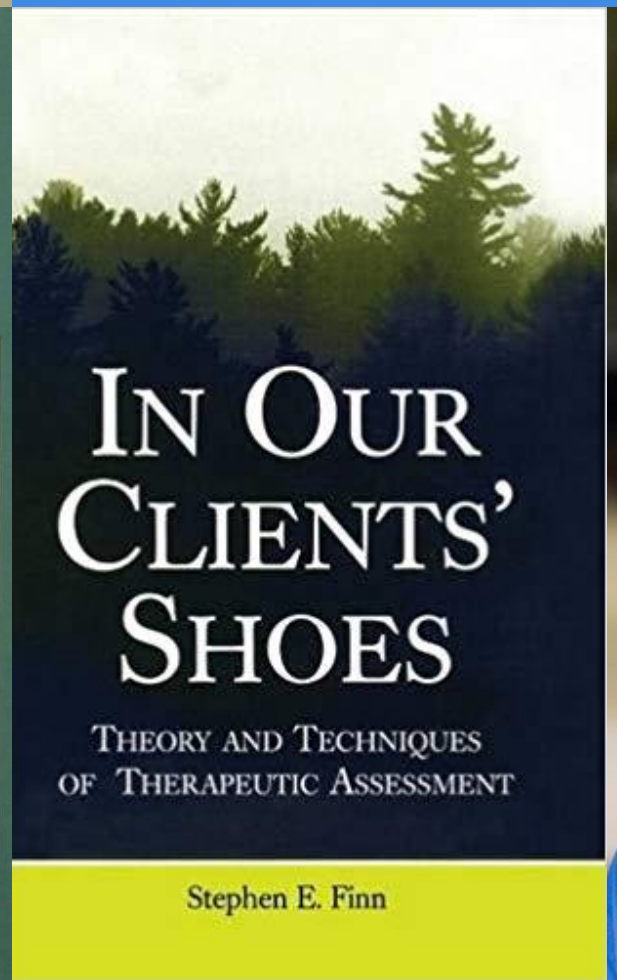
Constance T. Fischer

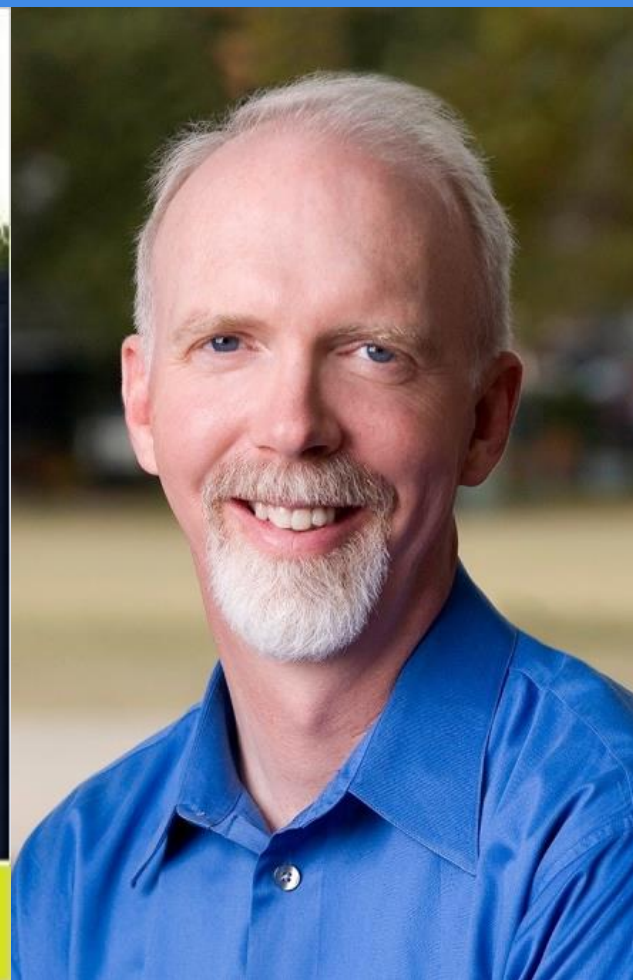
Collaborative Assessment



Stephen E. Finn

Therapeutic Assessment





Psychological Assessment
2010, Vol. 22, No. 2, 203–212

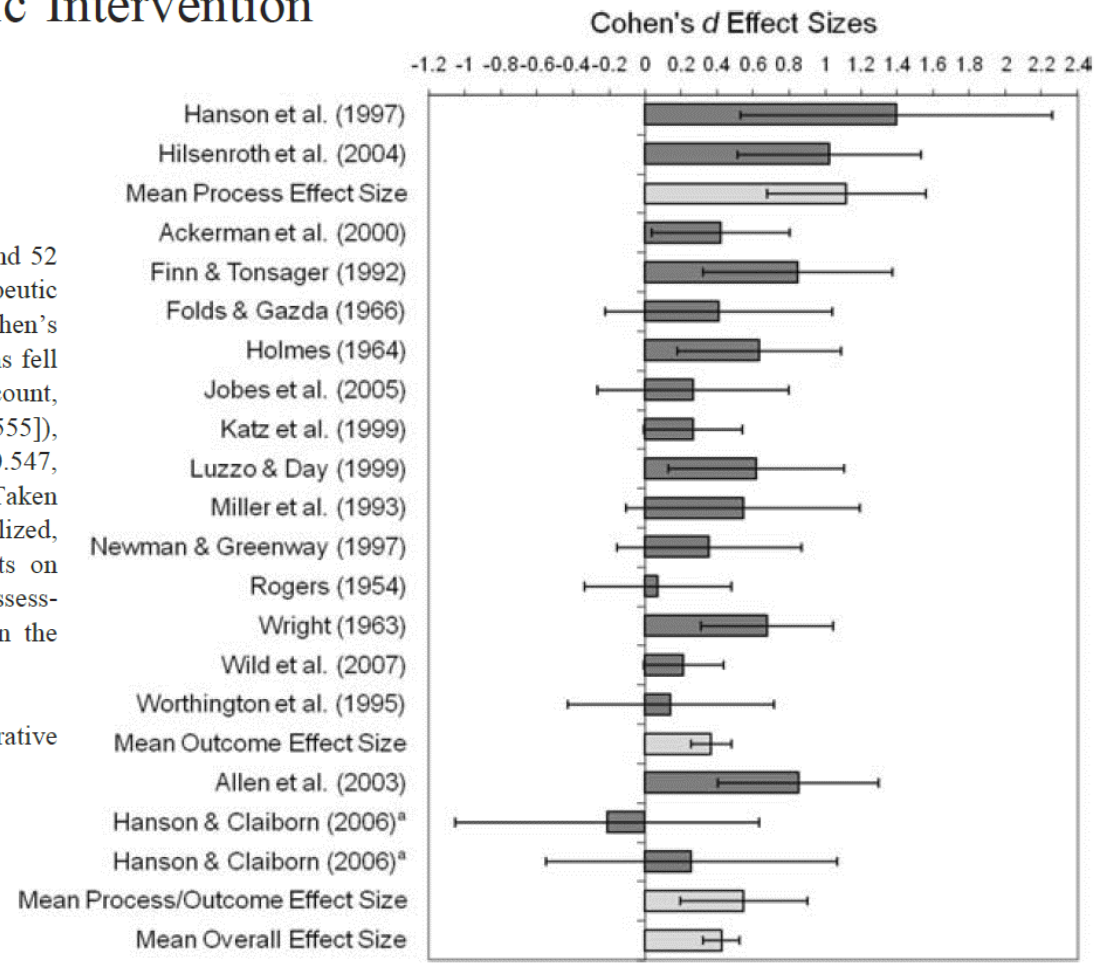
1040-3590/10/$12.00 DOI: 10.1037/a0018679

Meta-Analysis of Psychological Assessment as a Therapeutic Intervention

John M. Poston and William E. Hanson
Purdue University

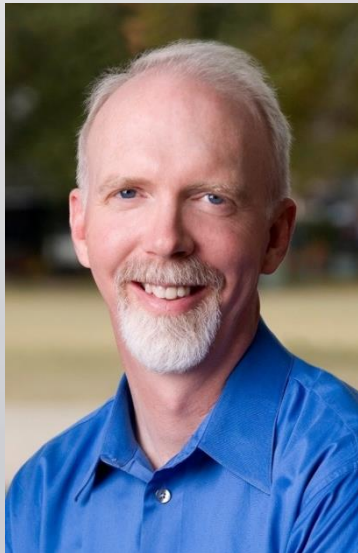
This study entails the use of meta-analytic techniques to calculate and analyze 18 independent and 52 nonindependent effect sizes across 17 published studies of psychological assessment as a therapeutic intervention. In this sample of studies, which involves 1,496 participants, a significant overall Cohen's *d* effect size of 0.423 (95% CI [0.321, 0.525]) was found, whereby 66% of treatment group means fell above the control and comparison group means. When categorical variables were taken into account, significant treatment group effects were found for therapy process variables ($d = 1.117$, [0.679, 1.555]), therapy outcomes ($d = 0.367$, [0.256, 0.478]), and combined process/outcome variables ($d = 0.547$, [0.193, 0.901]). These findings appear to be robust on the basis of fail-safe *N* calculations. Taken together, they suggest that psychological assessment procedures—when combined with personalized, collaborative, and highly involving test feedback—have positive, clinically meaningful effects on treatment, especially regarding treatment processes. They also have important implications for assessment practice, training, and policy making, as well as future research, which are discussed in the conclusion of the article.

Keywords: assessment utility, treatment validity, meta-analysis, therapeutic assessment, collaborative assessment



Therapeutic Assessment

- Build and Maintain a Working Alliance
- Collaboratively Define Assessment Goals
- Share and Explore Assessment Results



“We are lonesome animals. We spend all our life trying to be less lonesome. One of our ancient methods is to tell a story begging the listener to say—and to feel—Yes, that’s the way it is, or at least that’s the way I feel it. You’re not as alone as you thought.”

— John Steinbeck

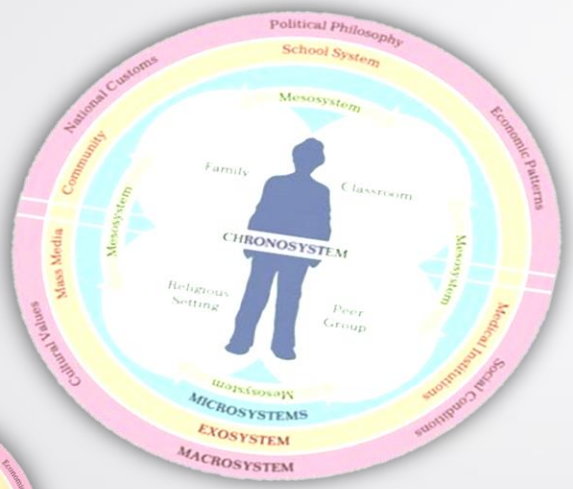
Narratives Are the Beginning

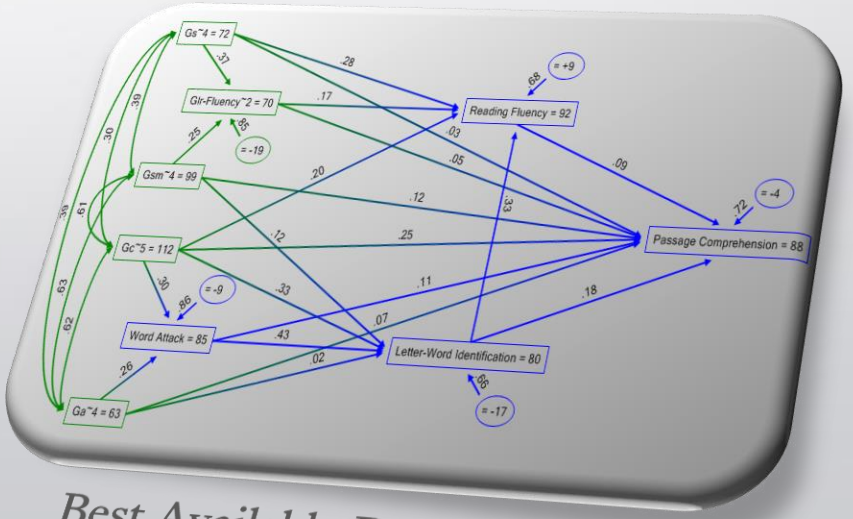
and Ending of Assessment

Current Context

Narrative ↔ Test Scores

Development & Learning History





Best Available Data and Models

To answer questions directly related to cognitive abilities

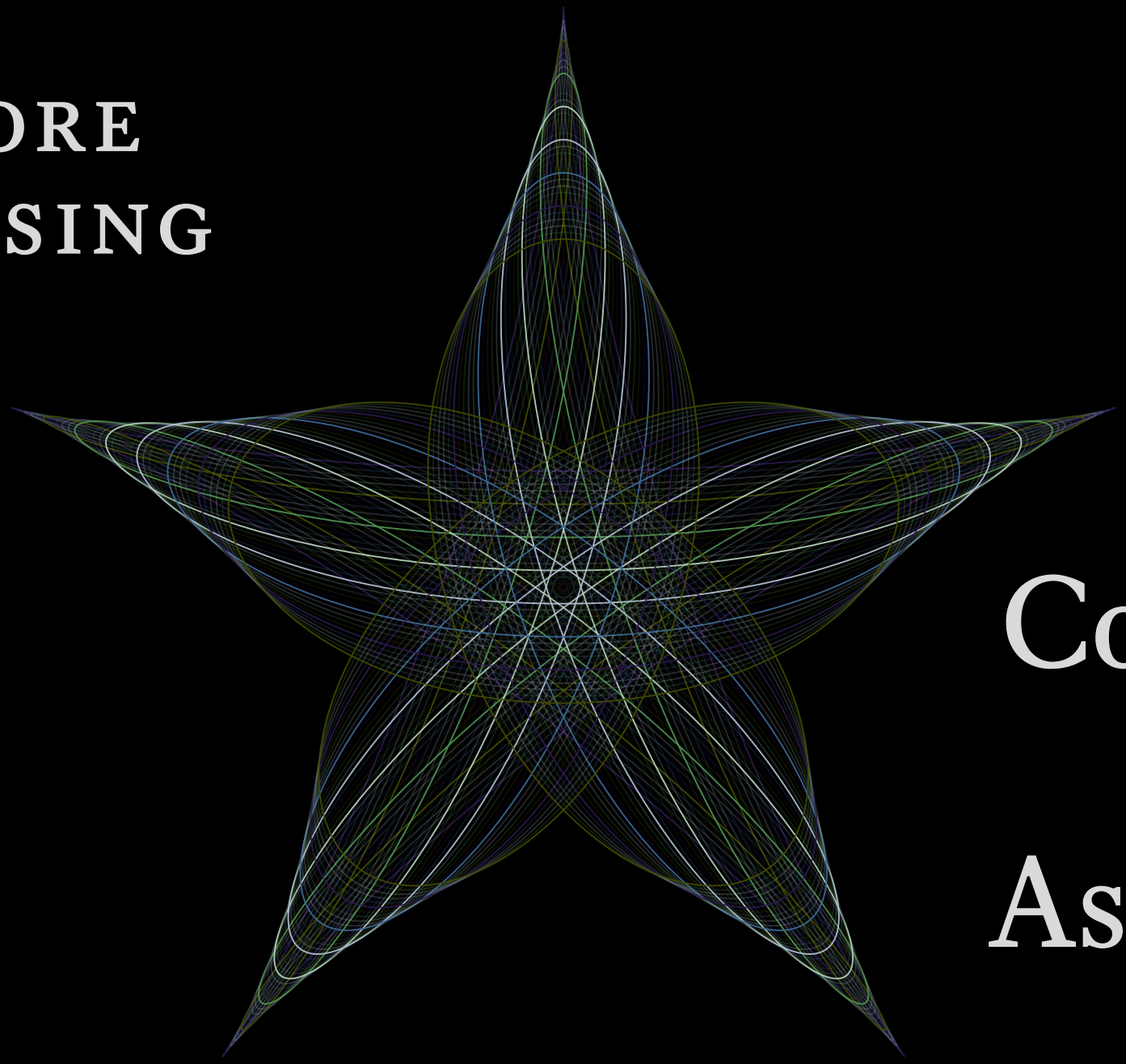
To understand difficult cases

The Proper Role of Comprehensive Individual Cognitive Assessment

Unnecessary for routine academic difficulties

Usually only indirectly relevant for diagnosis (except when cognitive abilities are explicit criteria)

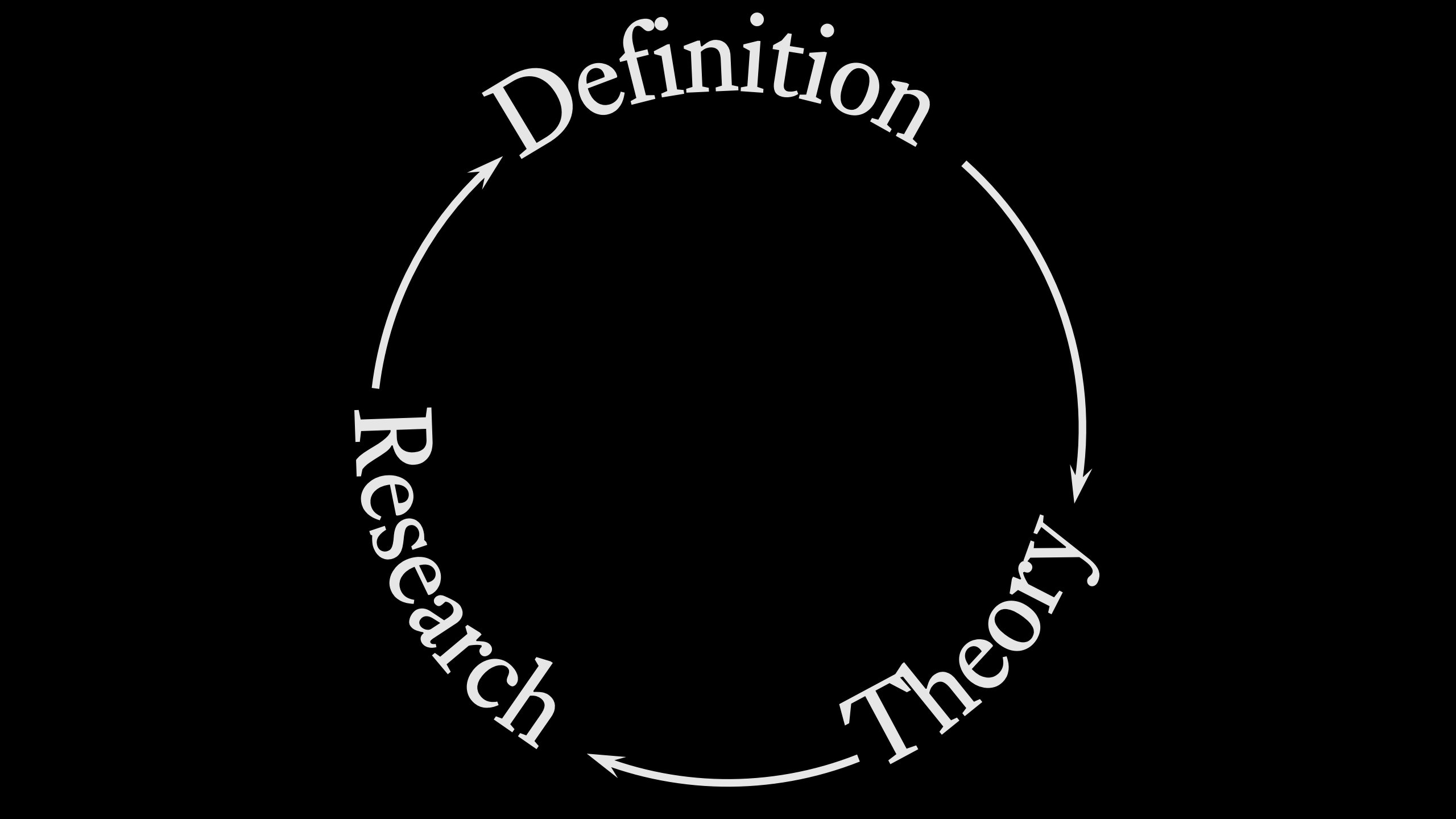
Before Assessing



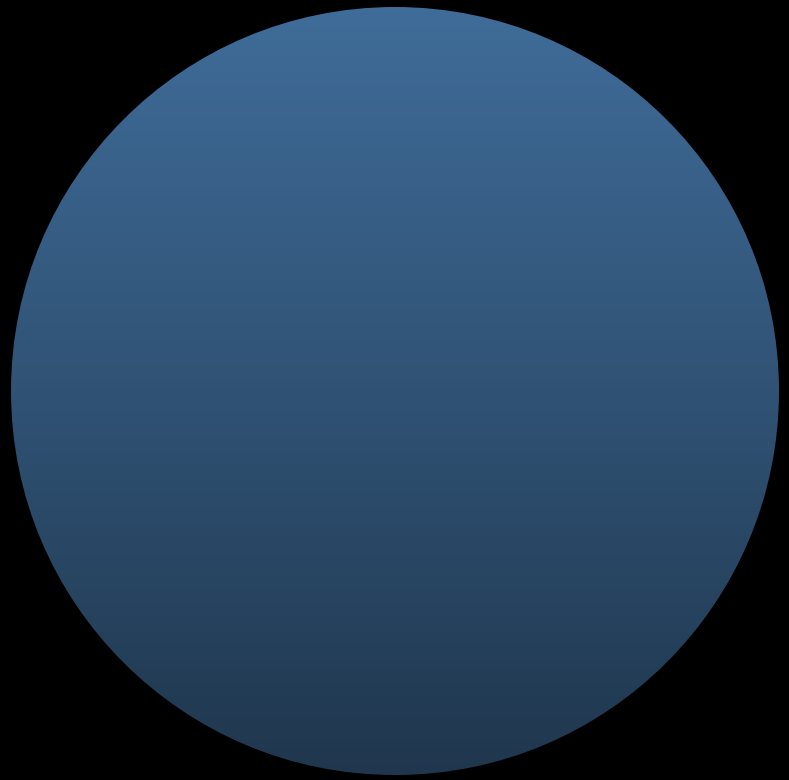
Consider NOT Assessing


WHAT IS
INTELLIGENCE?
Francis Galton
Edward L. Thorndike
David Rapaport
John Carroll
Thomas Bouchard
James Flynn
Earl Hunt
Robert Plomin
John Horn
Phillip Vernon
Robert Sternberg
Kevin McGrew
Louis Terman
Alexander Luria
Arthur Jensen
Alfred Binet
Hans Eysenck
Randall Engle
J. P. Das
Linda Gottfredson
Louis Guttman
Douglas Detterman
Alan Kaufmann
Richard Woodcock
Wendy Johnson
Leta Hollingworth
Raymond Cattell
Edith Kaplan
Psyche Cattell
Lloyd Humphries
Lazar Stankov
Howard Gardner
Phillip Ackerman
Jack Naglieri
James M. Cattell
Henry Goddard
Louis Thurstone
Donald Hebb
Cyril Burt
David Wechsler
Ian Deary
J. P. Guilford
David Lohman
Charles Spearman
Dawn Flanagan


Definition
Research
Theory


Definition
Theory
Research

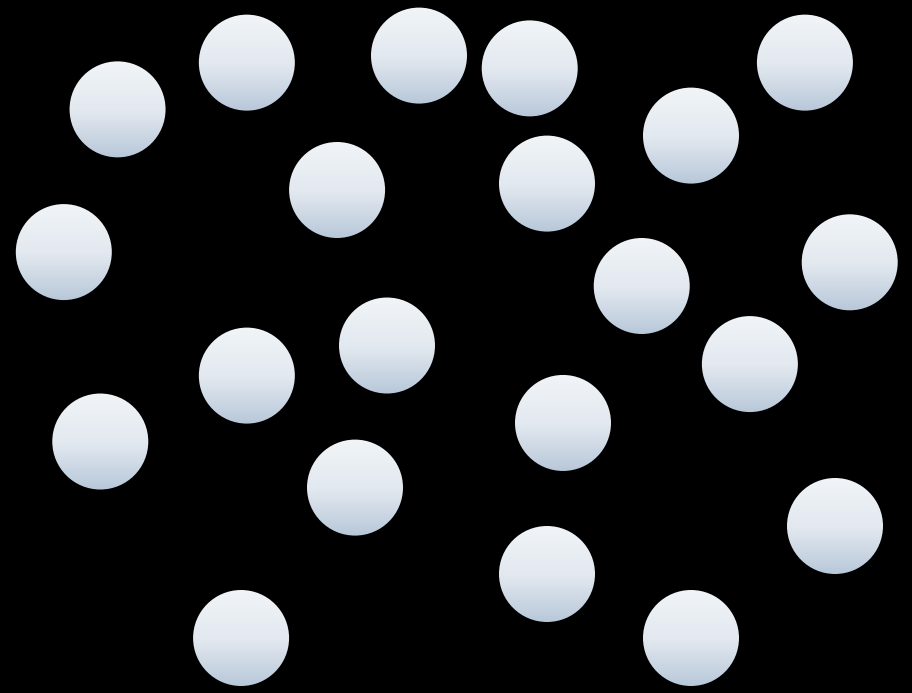
What Is Intelligence?



One Thing

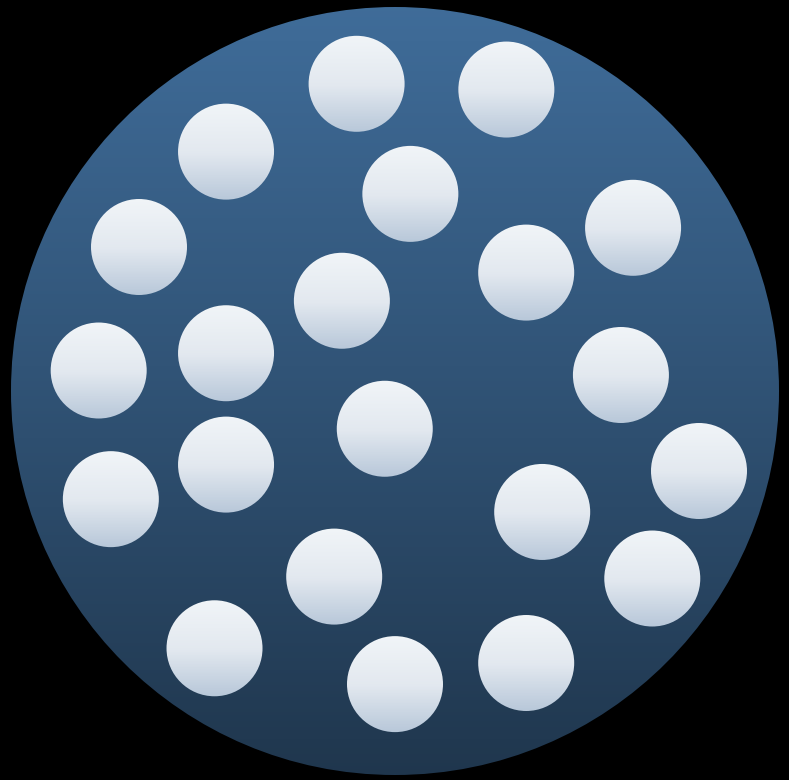
What Is Intelligence?

One Thing

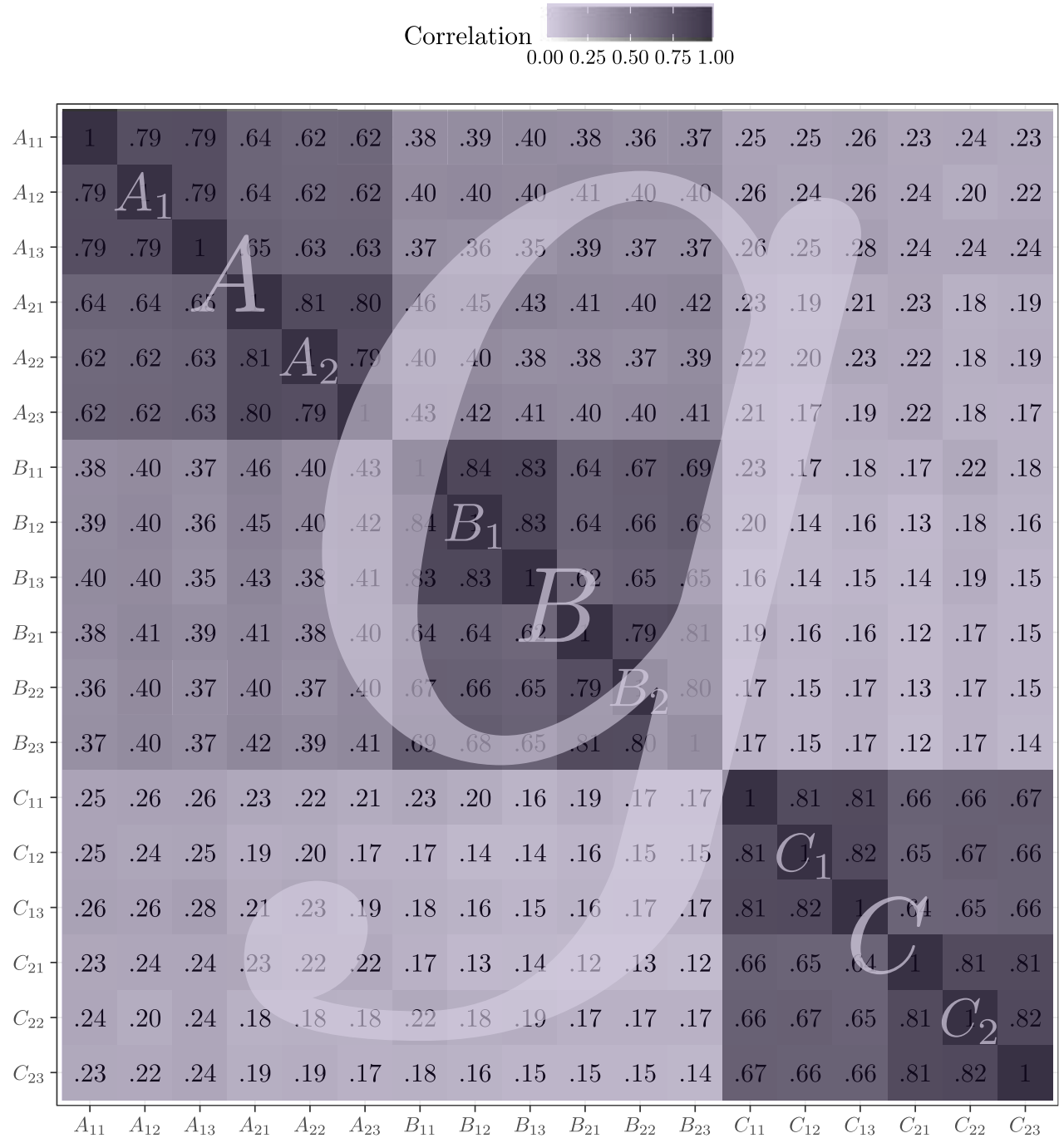


Many Things

What Is Intelligence?



One Thing and Many Things


Correlation
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A_{13} .79 .79 1 .65 .63 .63 .37 .36 .35 .39 .37 .37 .26 .25 .28 .24 .24 .24
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C_{12} .25 .24 .25 .19 .20 .17 .17 .14 .14 .16 .15 .15 .81 1 .82 .65 .67 .66
C_{13} .26 .26 .28 .21 .23 .19 .18 .16 .15 .16 .17 .17 .81 .82 1 .64 .65 .66
C_{21} .23 .24 .24 .23 .22 .22 .17 .13 .14 .12 .13 .12 .66 .65 .64 1 .81 .81
C_{22} .24 .20 .24 .18 .18 .18 .22 .18 .19 .17 .17 .17 .66 .67 .65 .81 1 .82
C_{23} .23 .22 .24 .19 .19 .17 .18 .16 .15 .15 .15 .14 .67 .66 .66 .81 .82 1
A_{11} A_{12} A_{13} A_{21} A_{22} A_{23} B_{11} B_{12} B_{13} B_{21} B_{22} B_{23} C_{11} C_{12} C_{13} C_{21} C_{22} C_{23}
A_1
A
A_2
B_1
B
B_2
C_1
C
C_2
$\mathcal{G}$

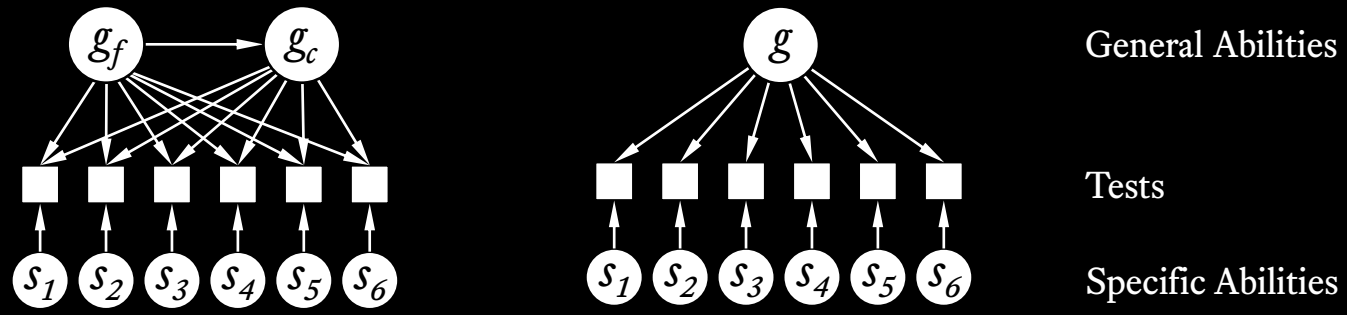
Direct Forerunners of CHC Theory

1941

Cattell
g_f-g_c Theory

1906

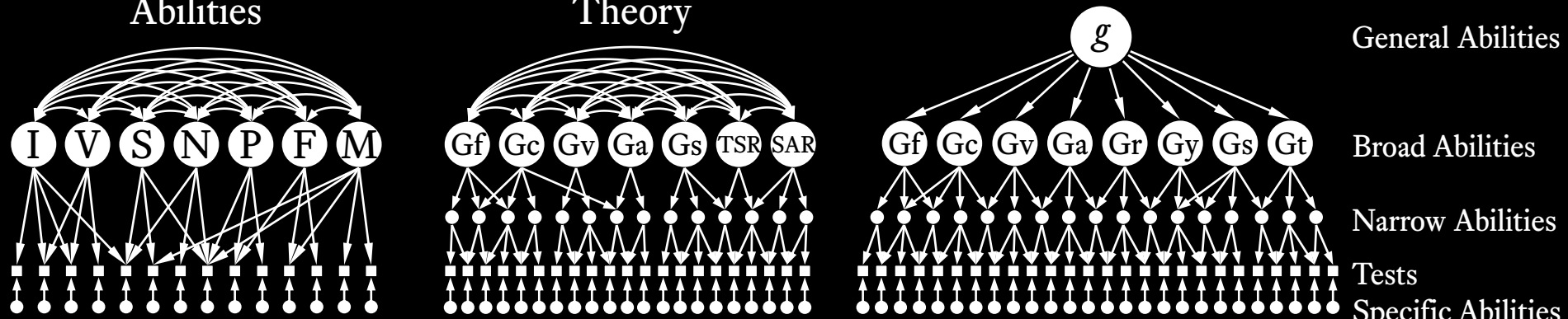
Spearman
Two-Factor Theory



Thurstone
Primary Mental Abilities

Horn
Extended Gf-Gc Theory

Carroll
Three-Stratum Theory

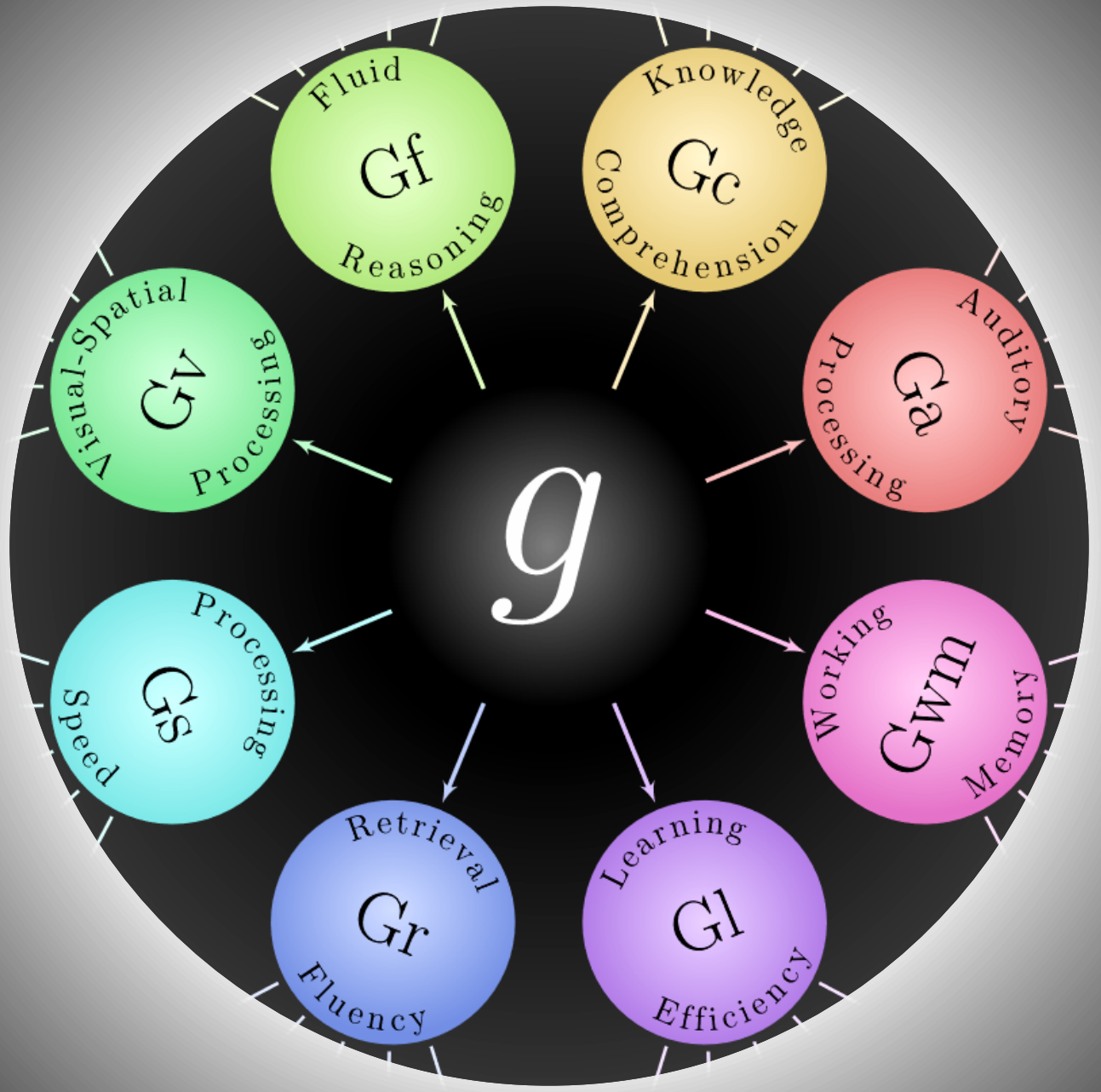


1934

1966

1993


g


g
Fluid
Gf
Reasoning
Knowledge
Gc
Comprehension
Visual-Spatial
Gv
Processing
Auditory
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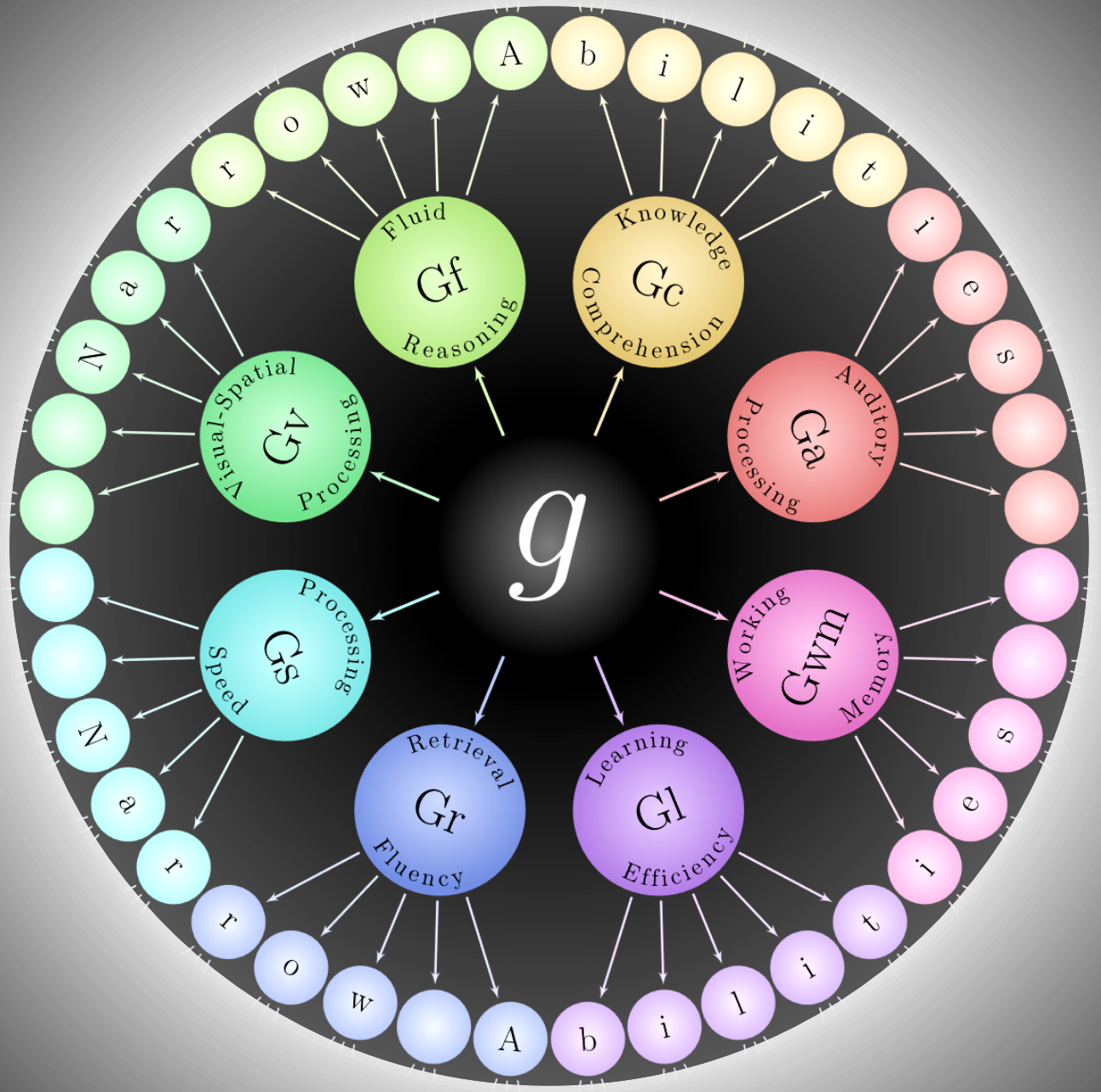
Gs
Speed
Working
Gwm
Memory
Retrieval
Gr
Fluency
Learning
Gl
Efficiency


g
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Comprehension
Visual-Spatial
Gv
Processing
Auditory
Ga
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Gs
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Working
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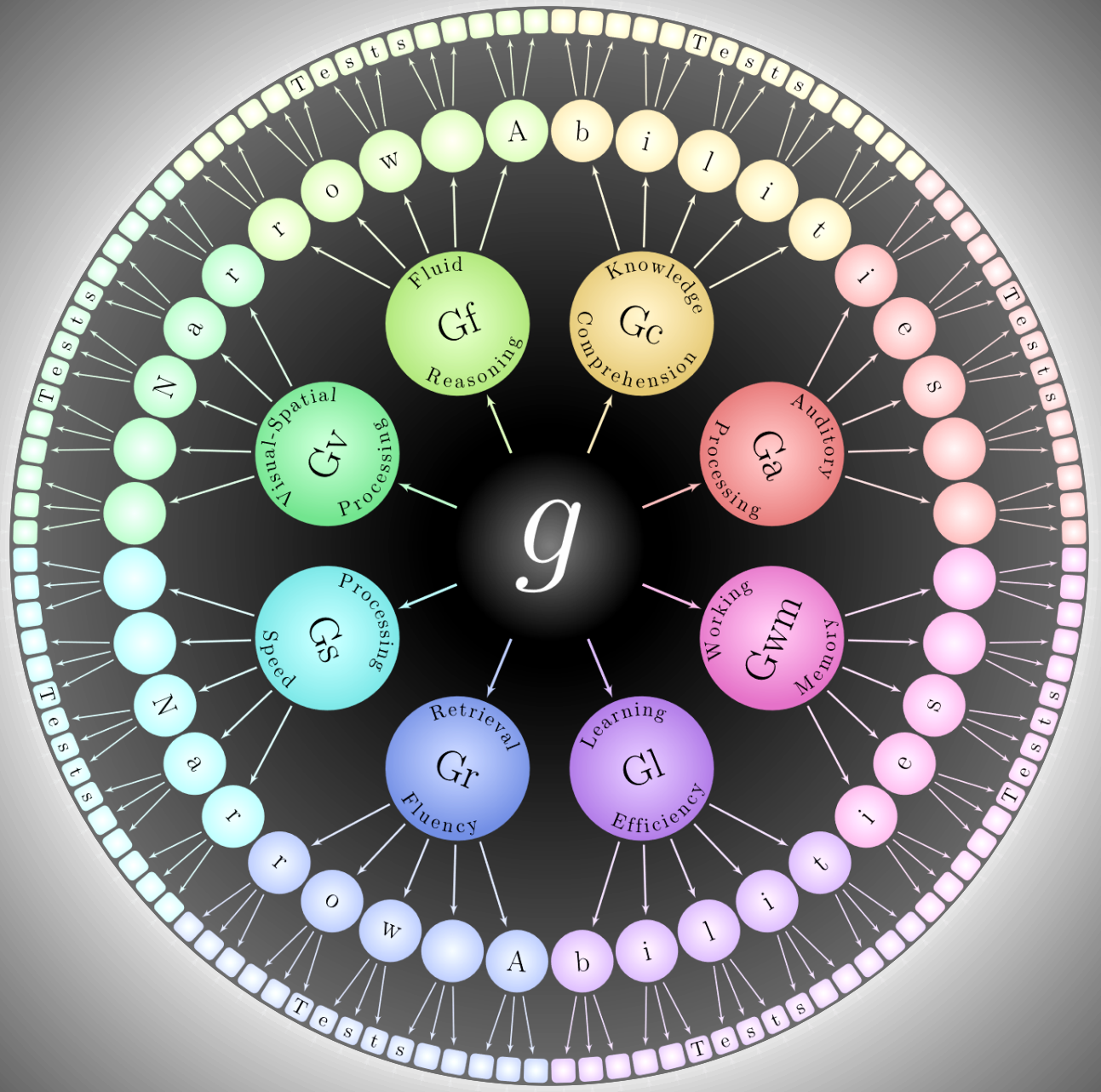
Fluency
Learning
Gl
Efficiency
Narrow Abilities
Narrow Abilities
Narrow Abilities
Narrow Abilities


g
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Reasoning
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Gv
Visual-Spatial
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Ga
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Processing
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Speed
Gwm
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Memory
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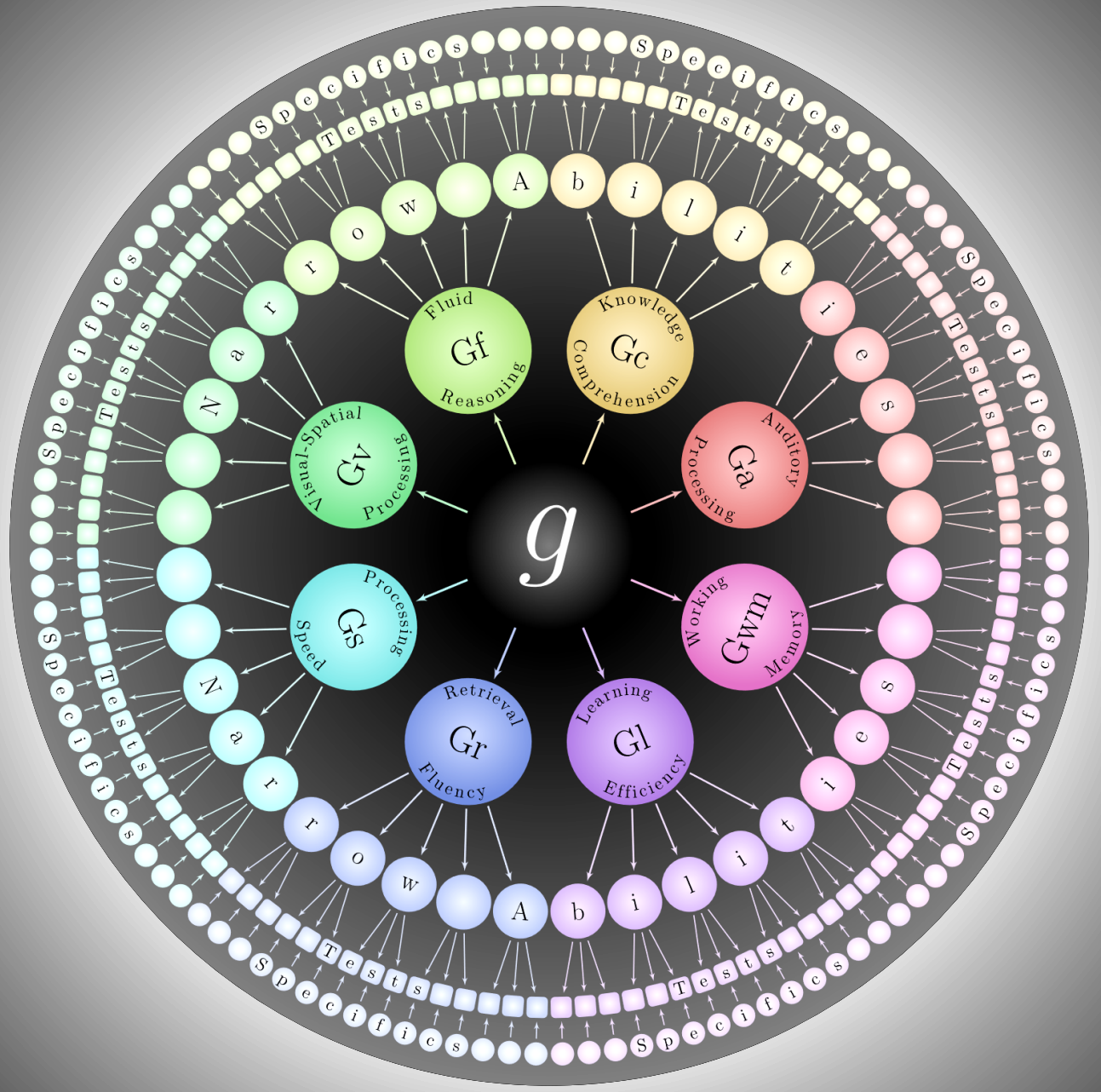
Retrieval
Fluency
Gl
Learning
Efficiency
Narrow Abilities
Tests


g
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Comprehension
Gv
Visual-Spatial
Processing
Ga
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Processing
Gs
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Speed
Gwm
Working
Memory
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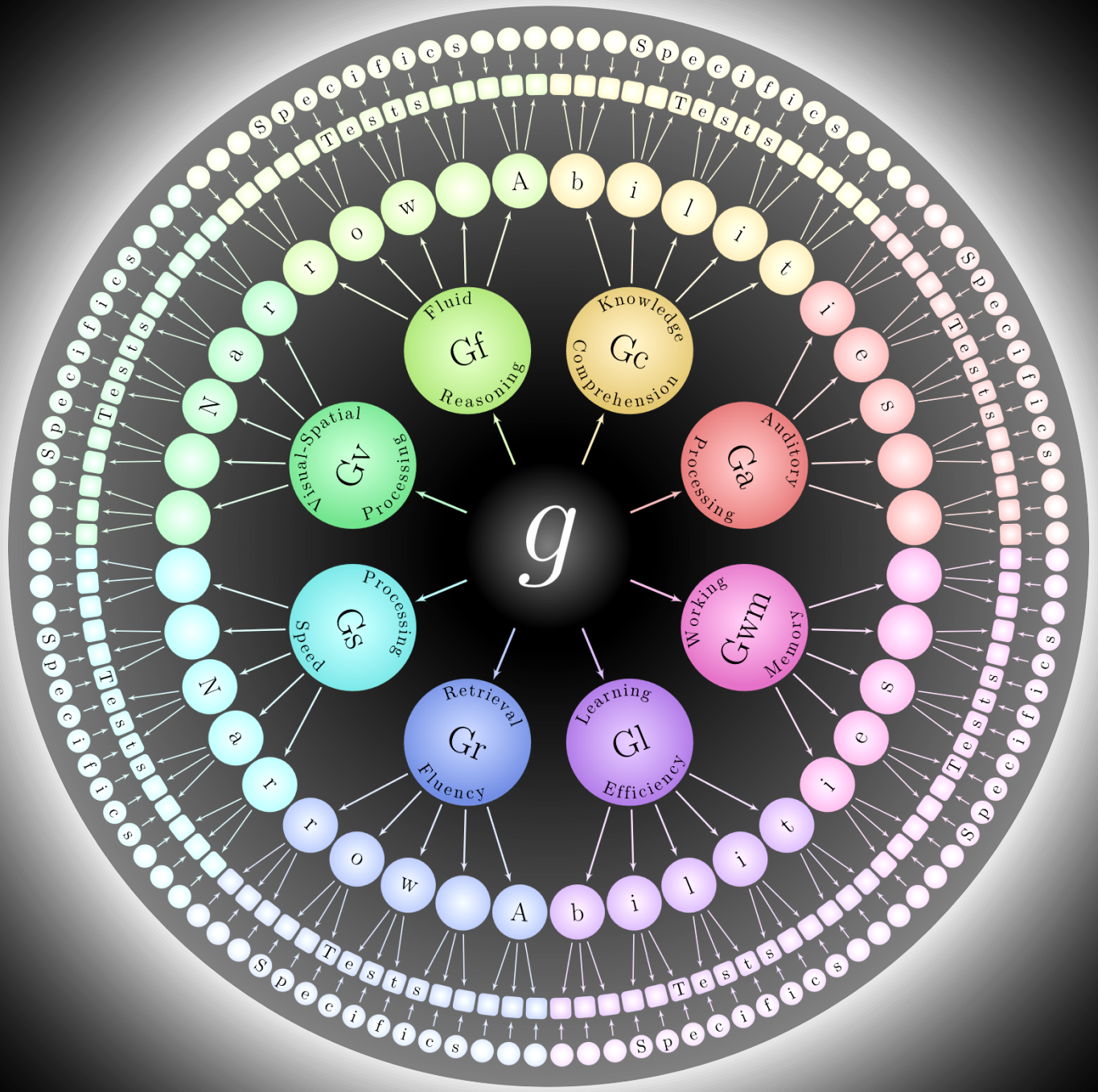
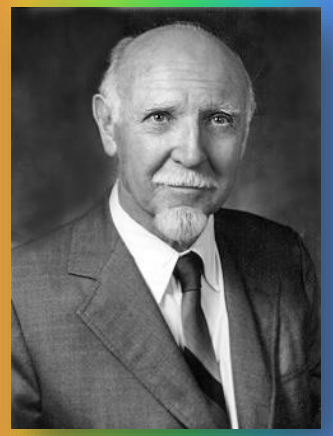
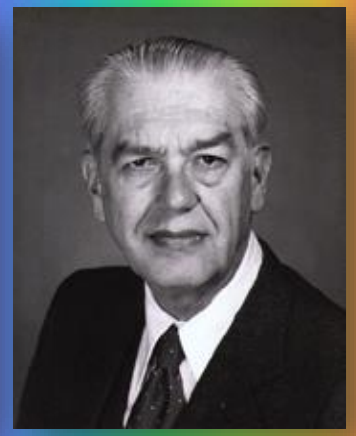
Retrieval
Fluency
Gl
Learning
Efficiency
Narrow Abilities
Specifics Tests

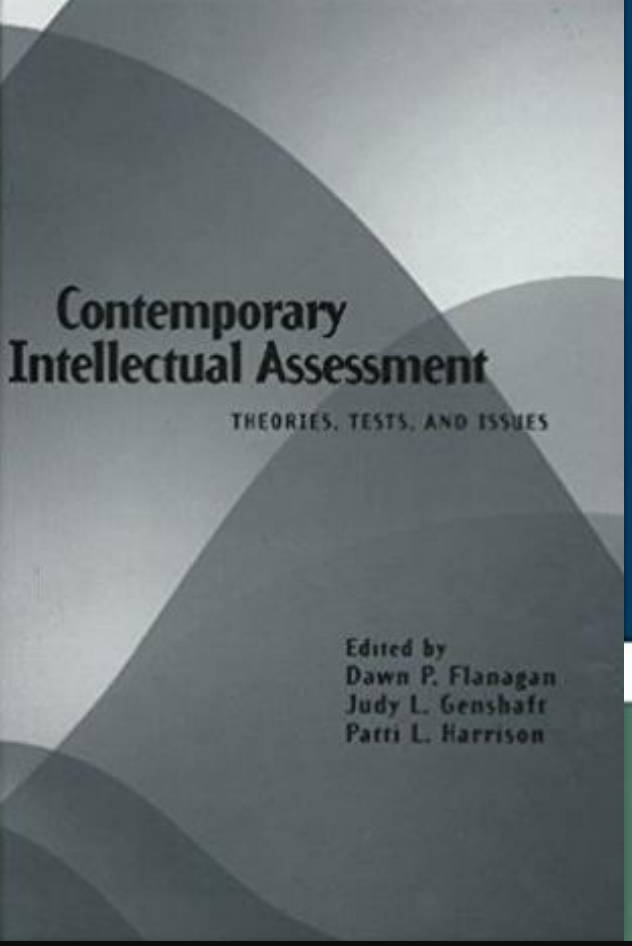






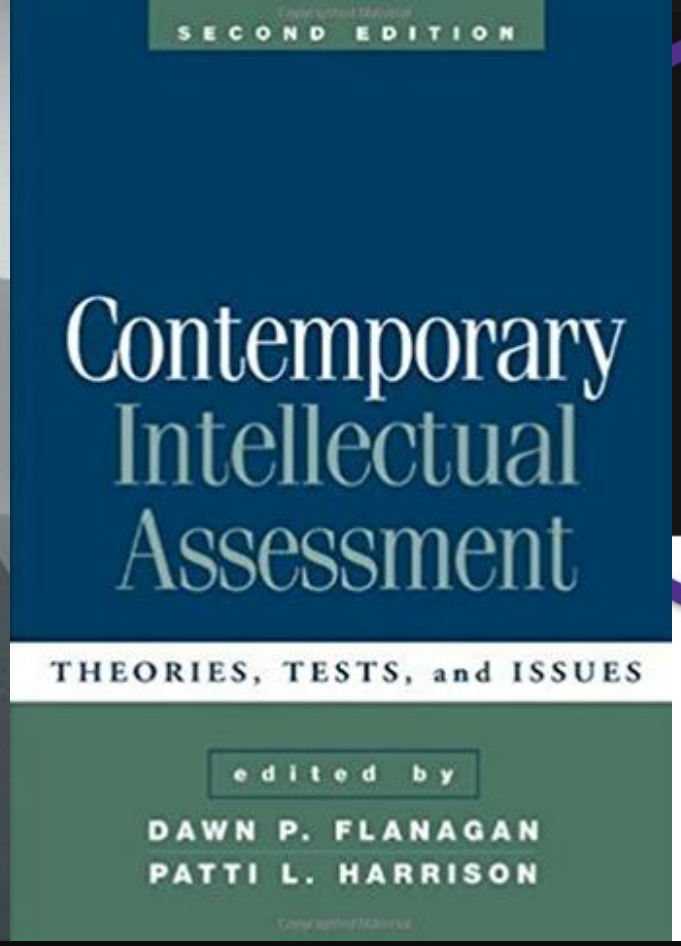
Cattell-Horn-Carroll Theory of Cognitive Abilities

An Ecumenical Space for Scholars to Suspend —Temporarily— Our Interminable, Intemperate, and Futile Feuds About the *g* Factor



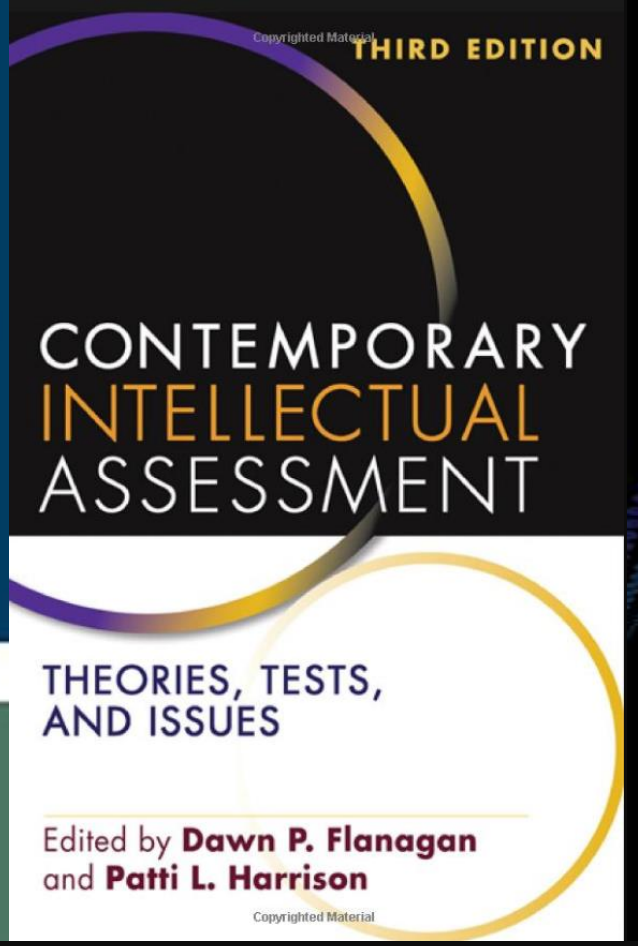
Analysis of the Major Intelligence Batteries According to a Proposed Comprehensive Gf-Gc Framework

McGrew (1997)



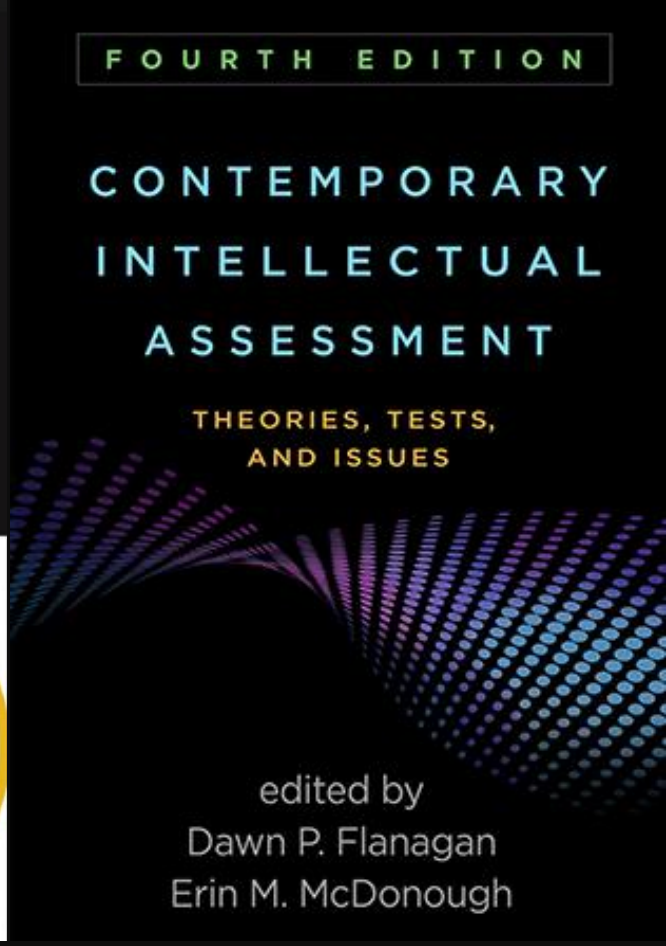
The Cattell-Horn-Carroll Theory of Cognitive Abilities

McGrew (2005)



The Cattell-Horn-Carroll Model of Intelligence

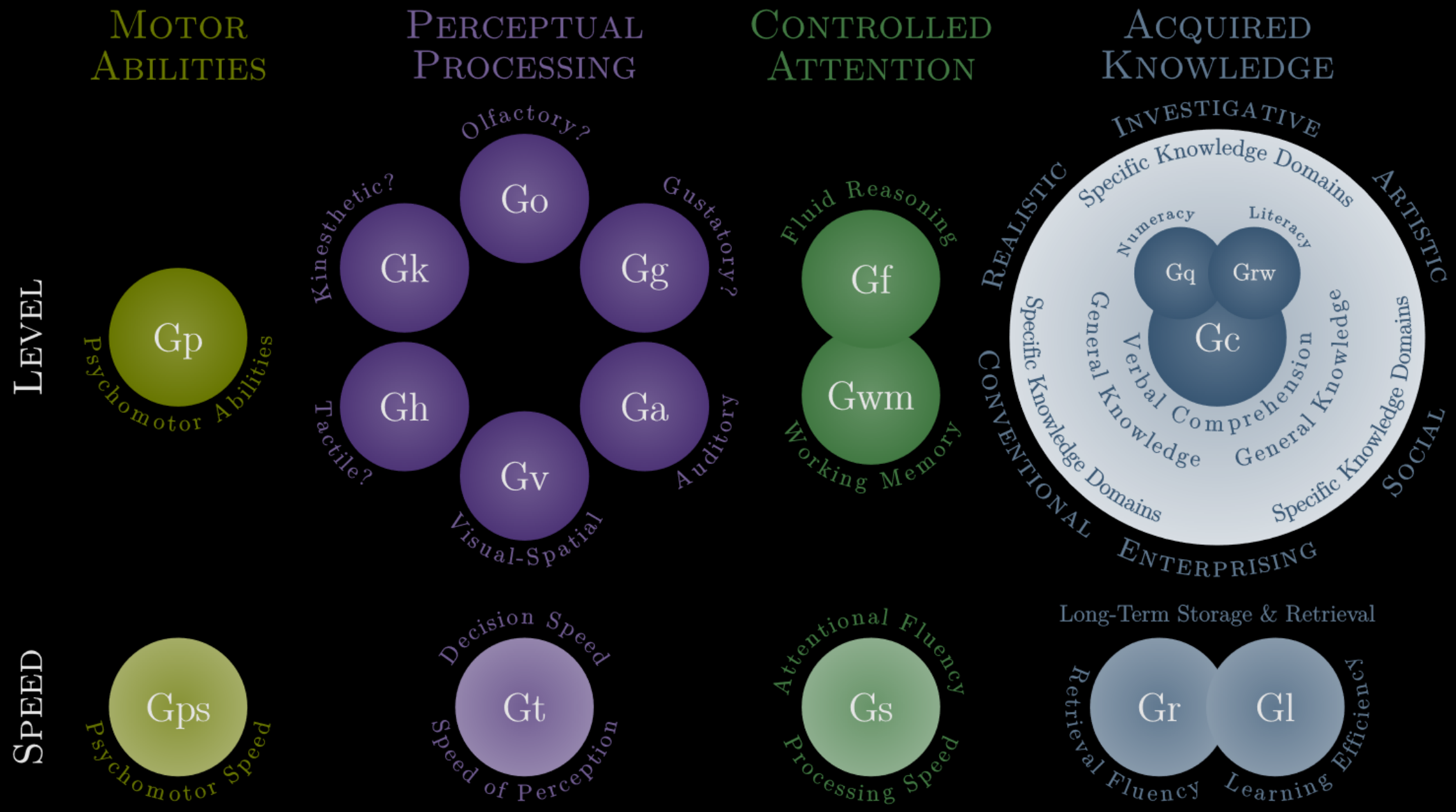
Schneider & McGrew (2012)



The Cattell–Horn–Carroll Theory of Cognitive Abilities

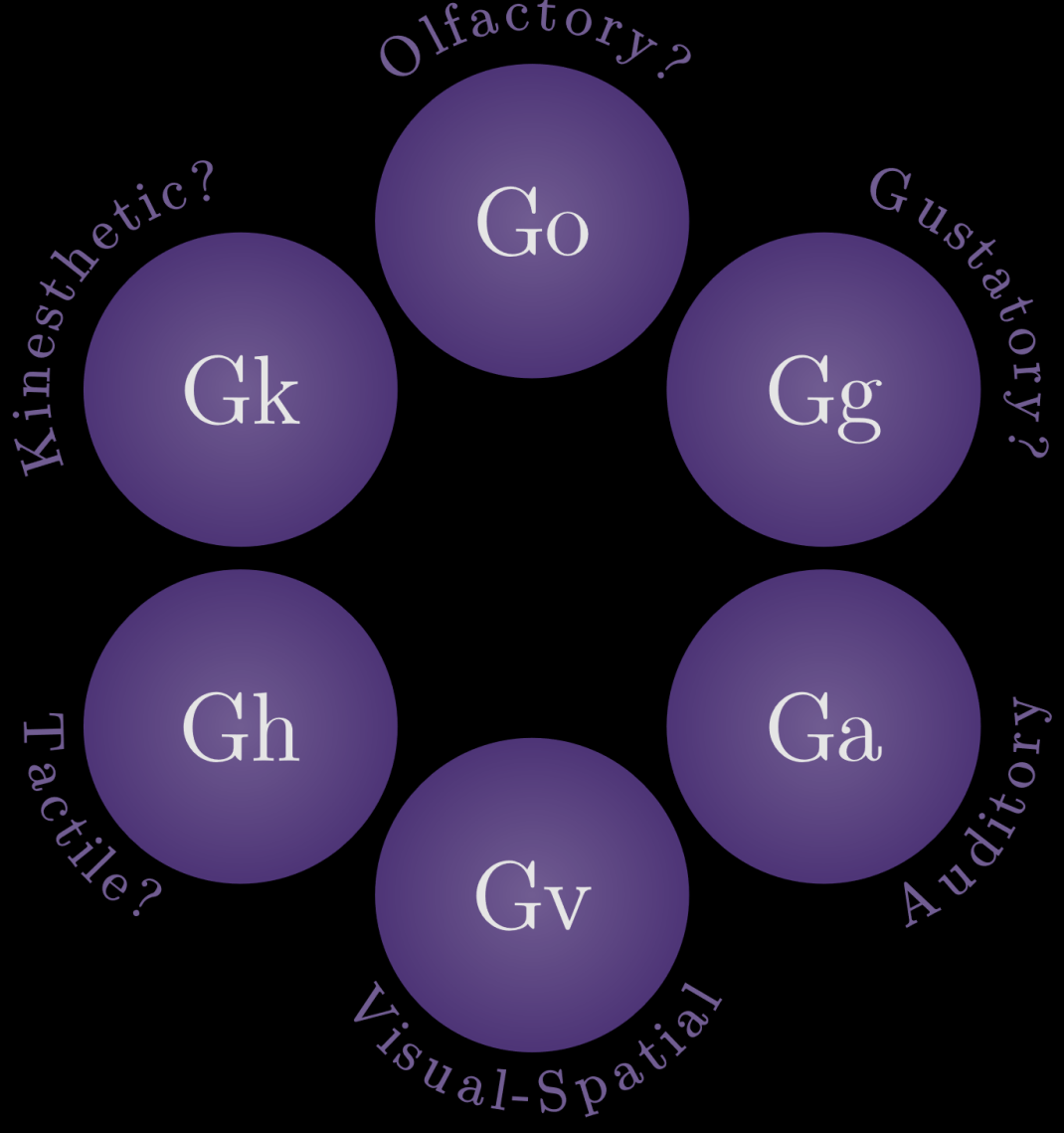
Schneider & McGrew (2018)

Cattell-Horn-Carroll Theory of Cognitive Abilities

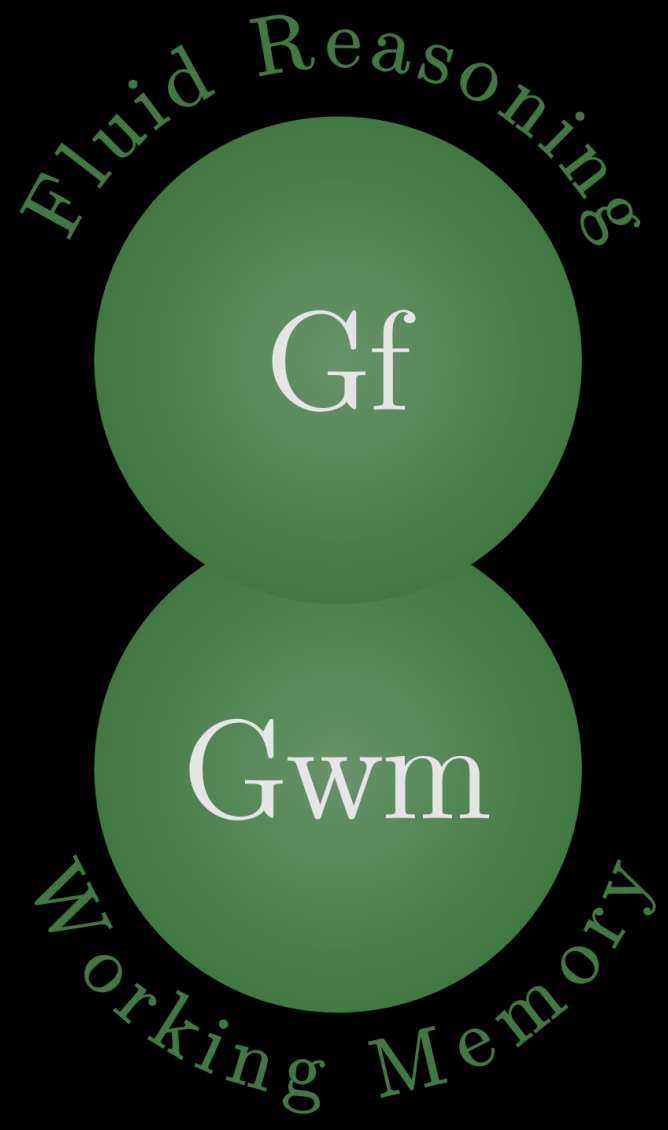


Motor Domain

Perceptual Processing

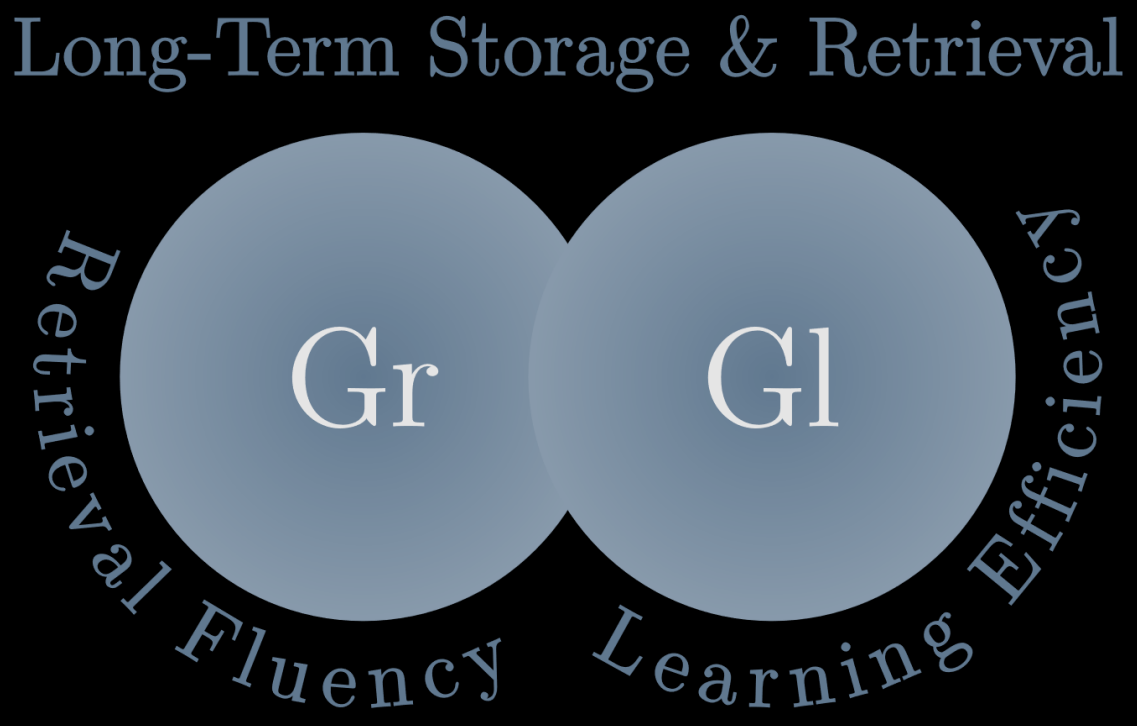


Domain-General Processing



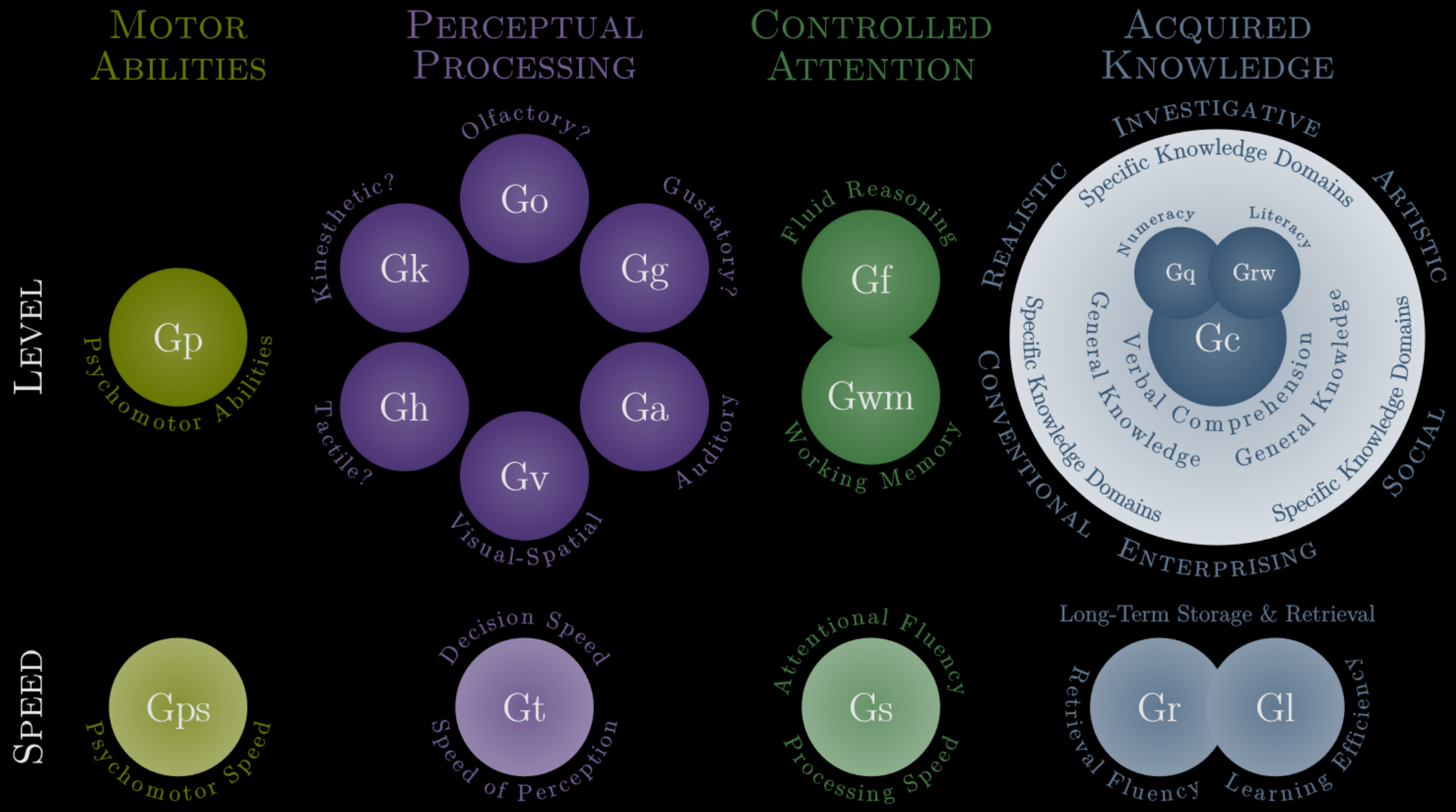
Acquired Knowledge

Long-Term Memory



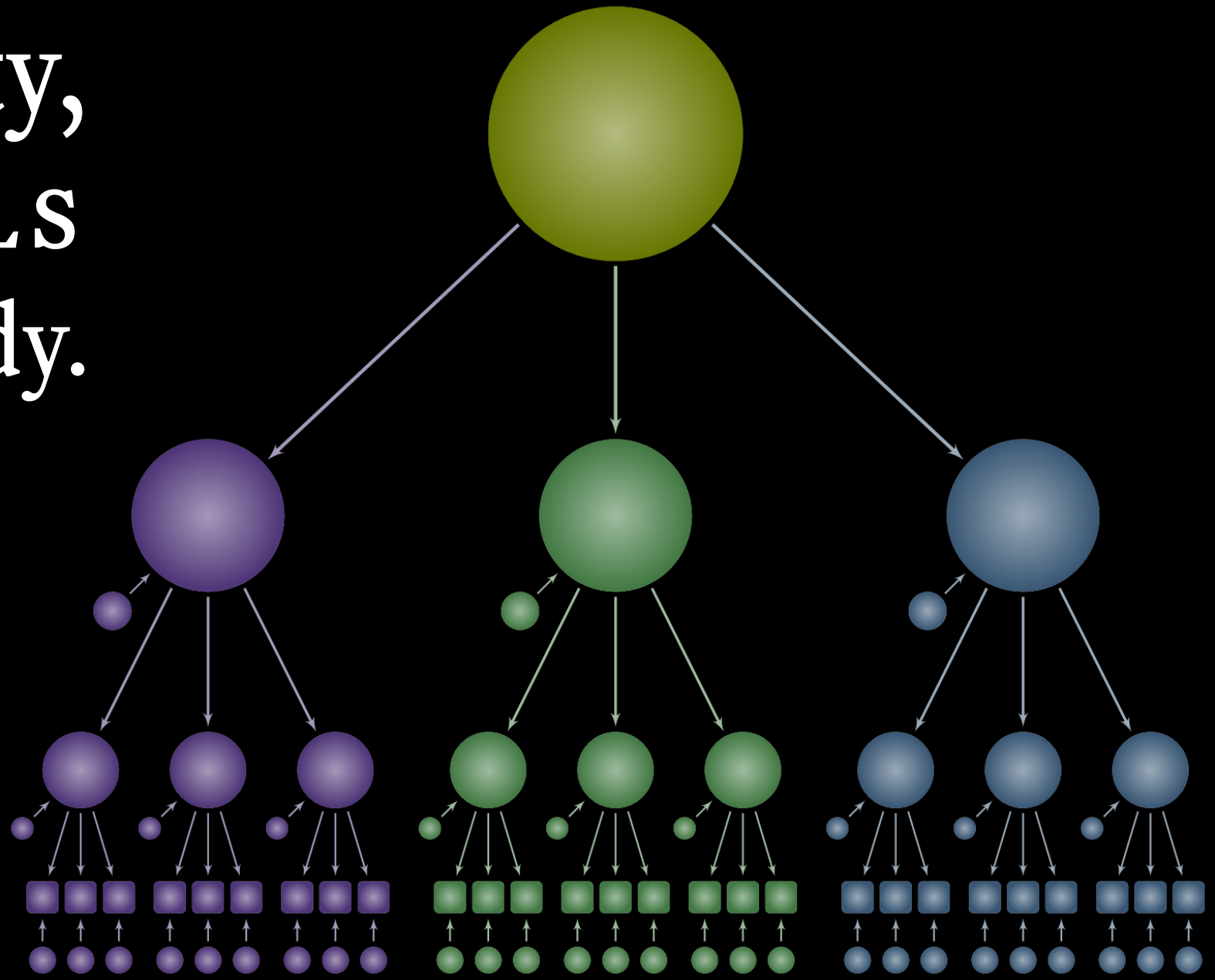
Speeded Abilities

Cattell-Horn-Carroll Theory of Cognitive Abilities

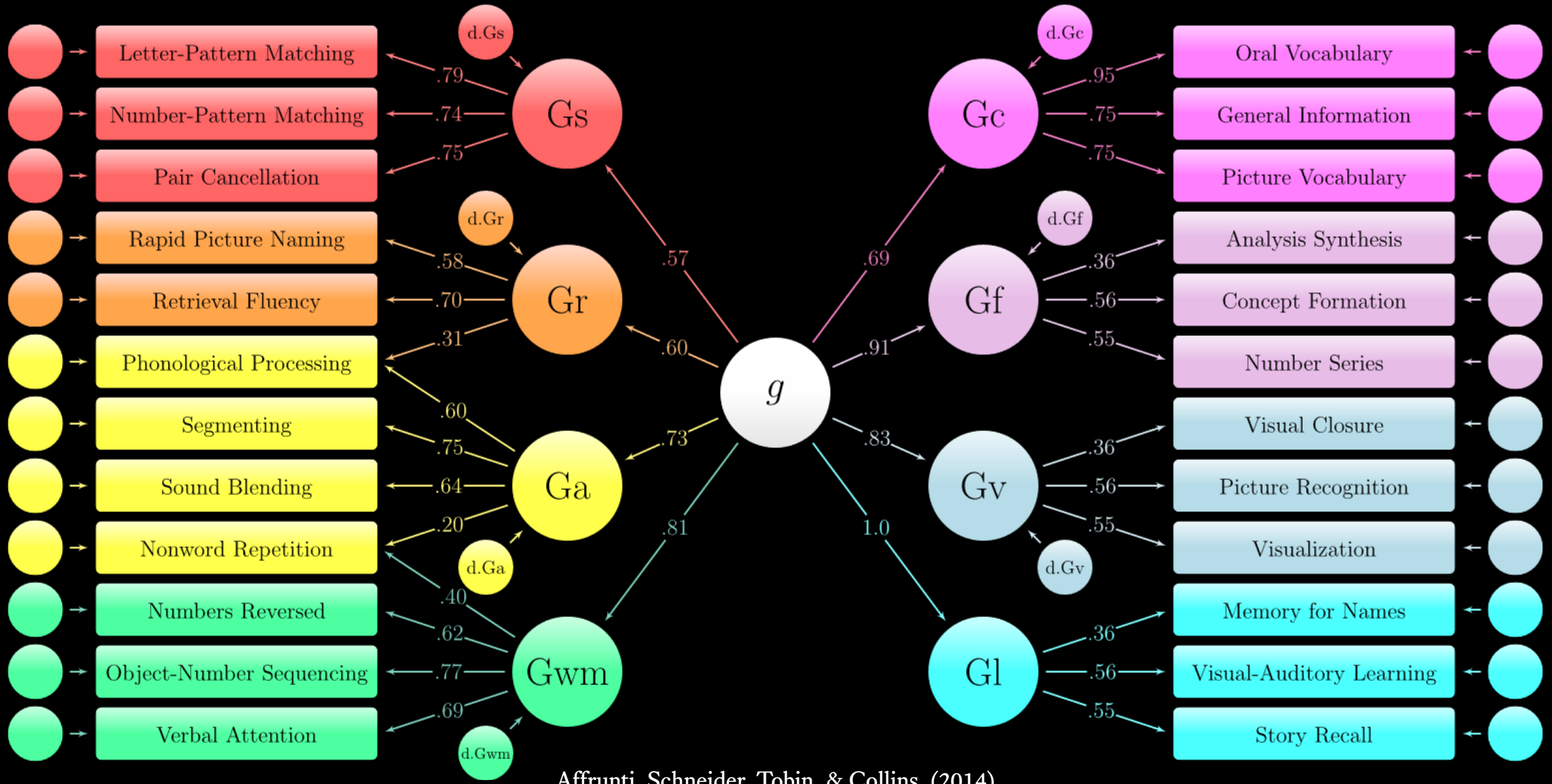


Unlike Reality, Our Models Are Neat & Tidy.

Models are to be used,
but not to be believed.
—Henry Theill



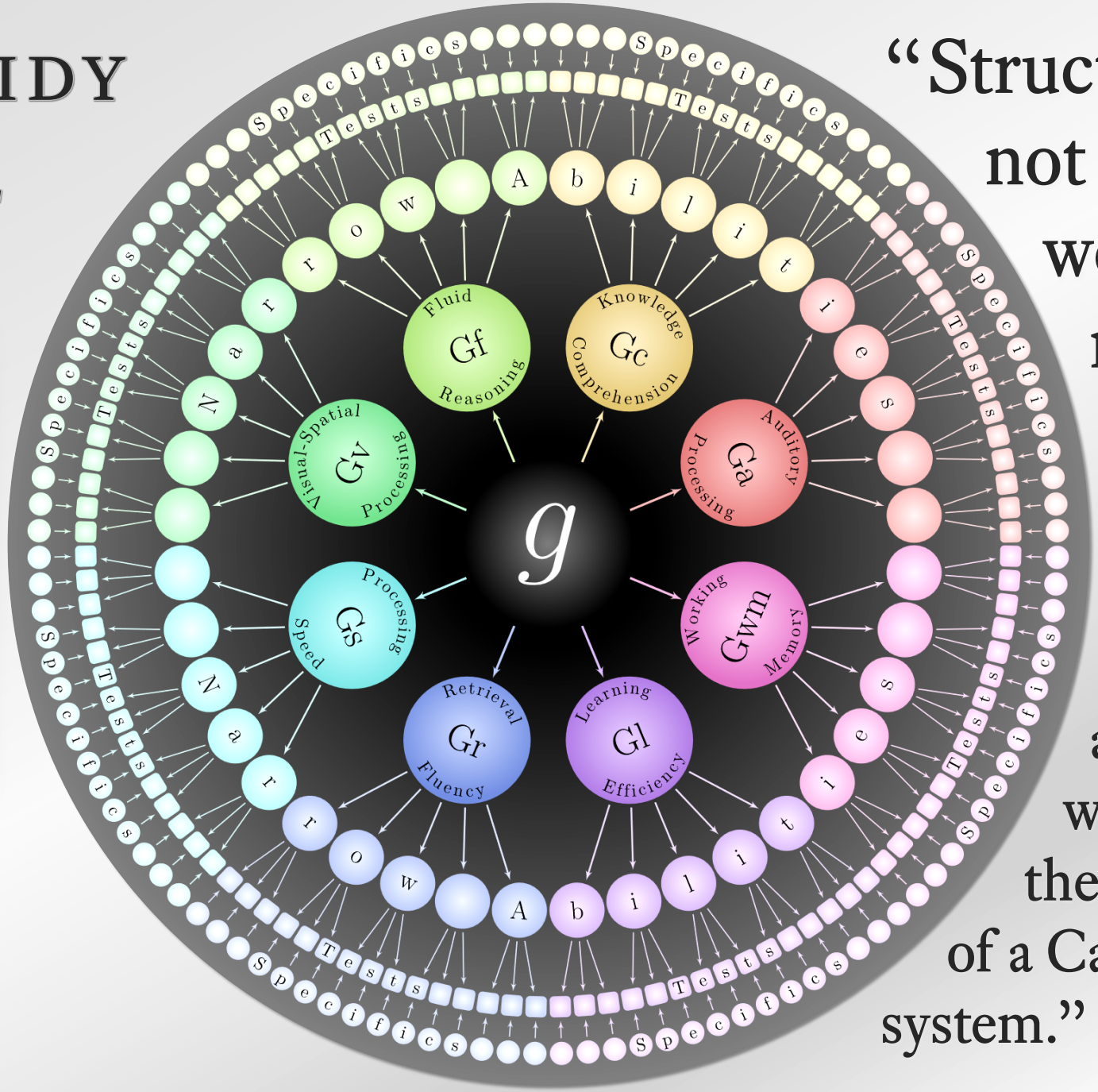
Neat, Tidy Hierarchies Are Pretty But Not Natural



Affrunti, Schneider, Tobin, & Collins. (2014)

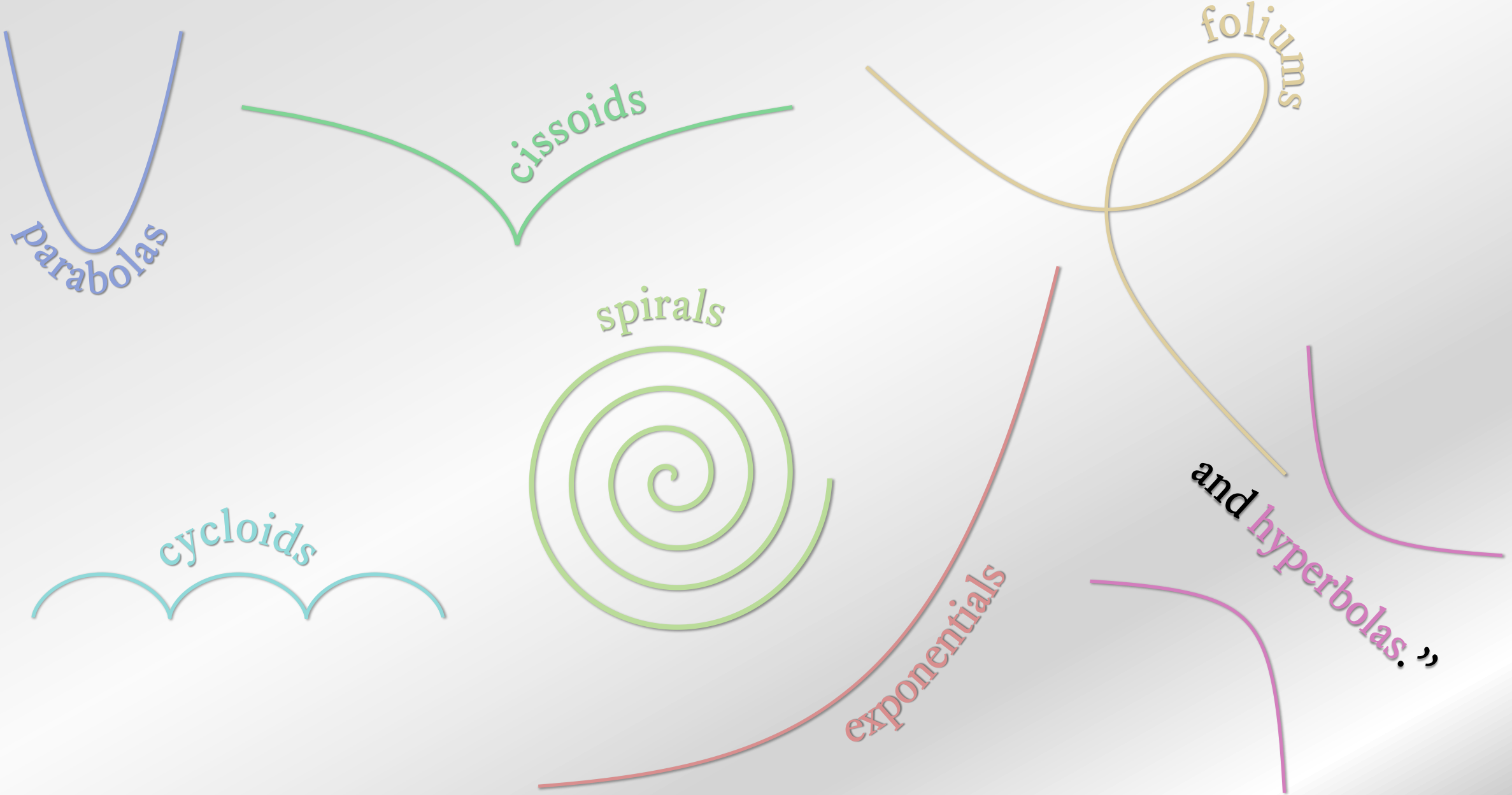
Neat & Tidy Model

John Horn
1928–2006

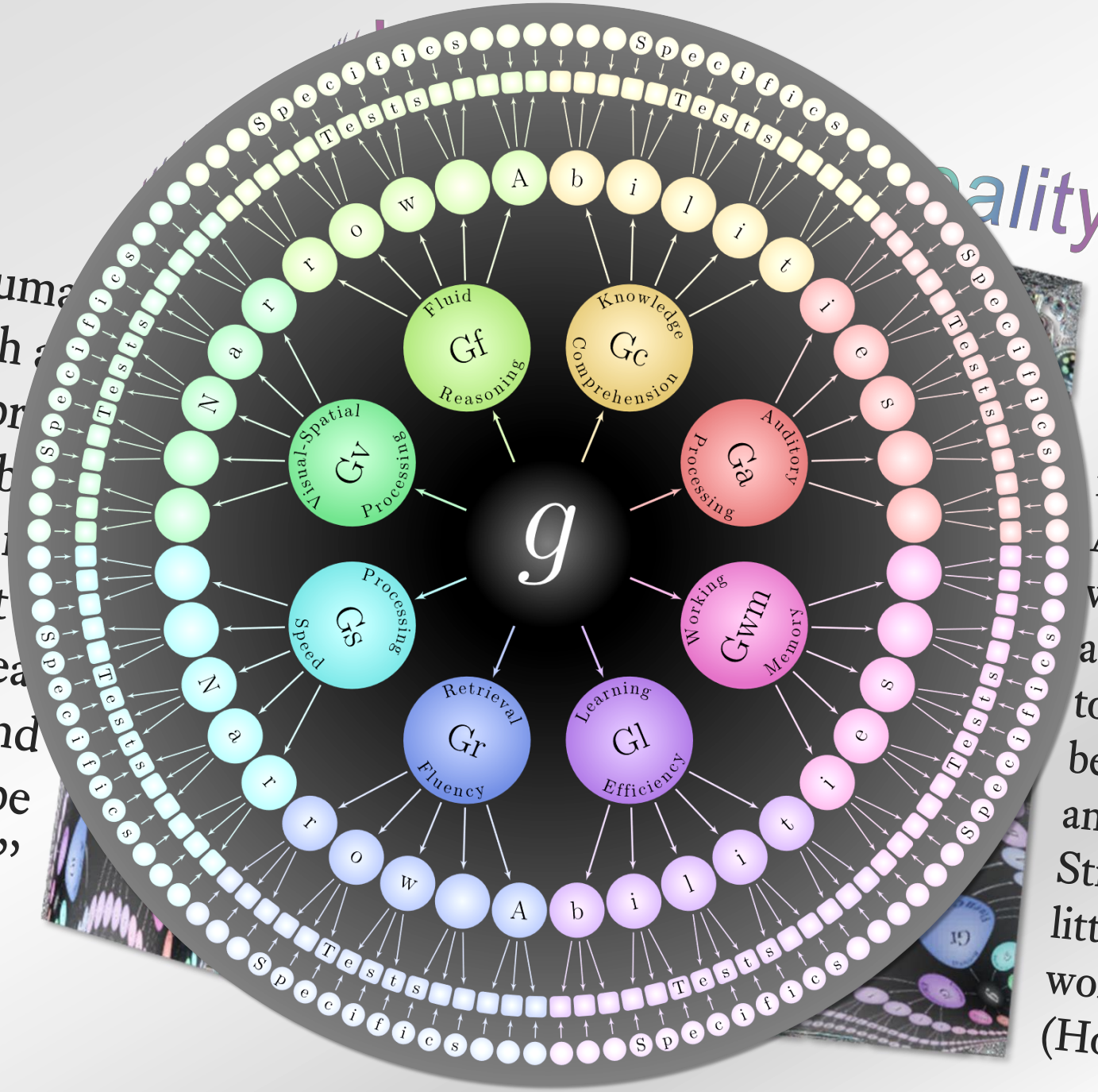


"Structural theory is not of a form that well describes natural phenomena. The phenomena of nature are usually rounded and irregular, not well described by a the linear equations of a Cartesian coordinate system."

“The equations that describe the outer structure of the brain must include

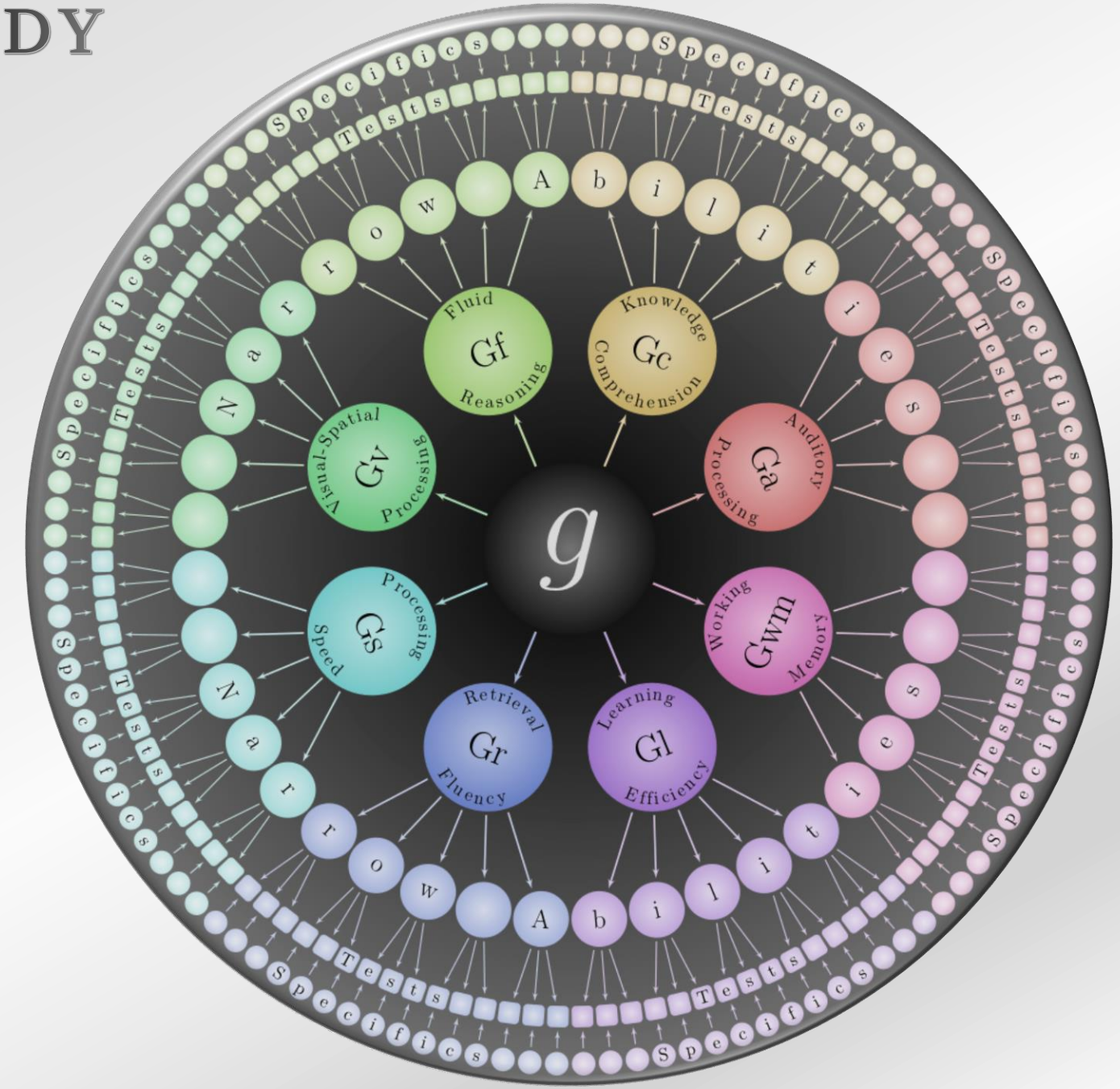


"It is likely that huma
capabilities, which a
grounded in br
structure, are b
described with simi
equations, not
terms of linea
equations of the kind
that describe
city blocks."



"The factors of structural theory do not represent biological functional relationships. A functional theory would indicate how abilities interact and work together to produce the behavior of adaptation and adjustment Structural theory does little to help indicate such workings together." (Horn, 1998, p. 64)

Neat & Tidy Model

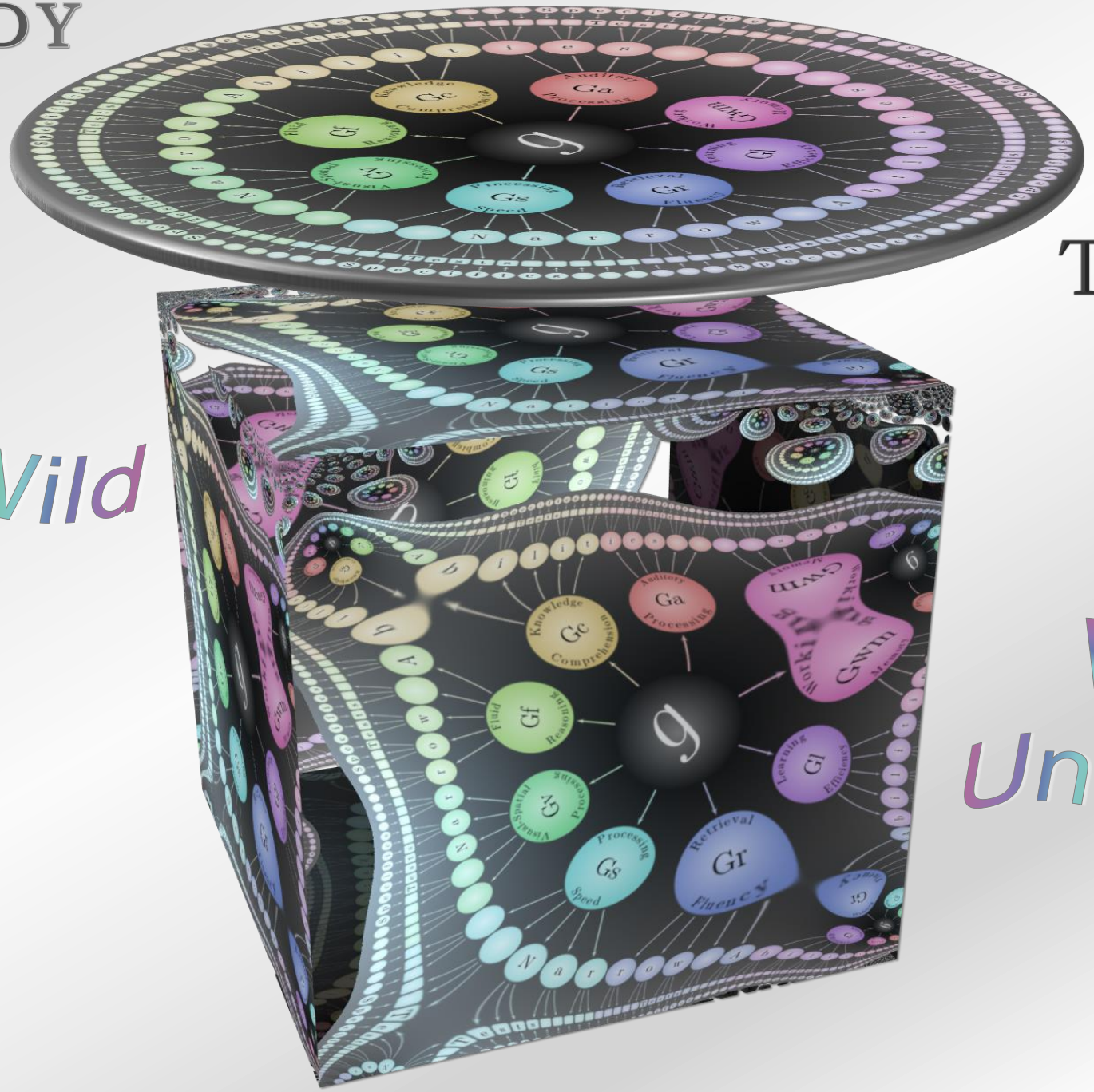


Neat & Tidy Model

What You Think You See

Weird & Wild Reality

What Is Underneath

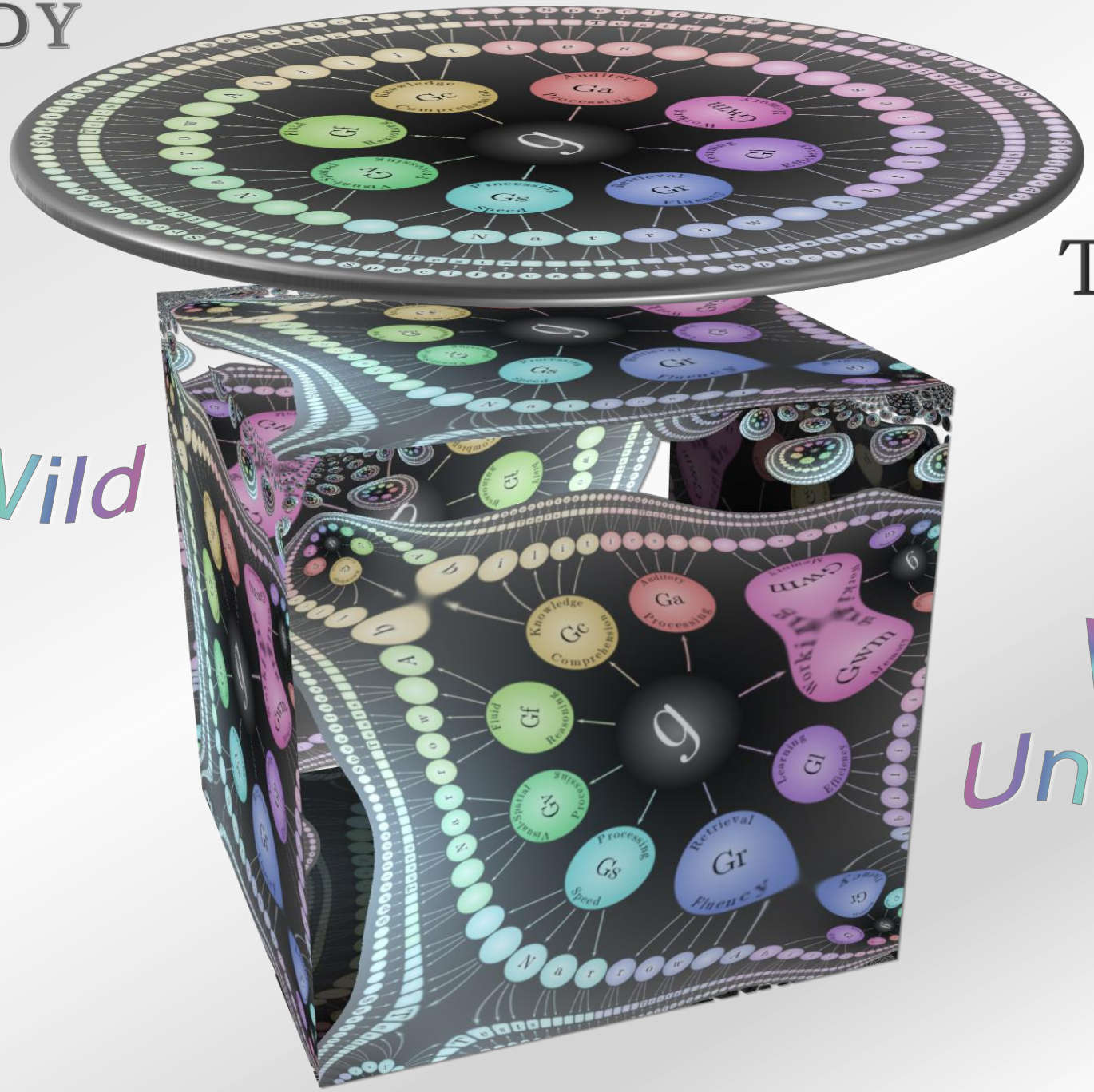


Neat & Tidy Model

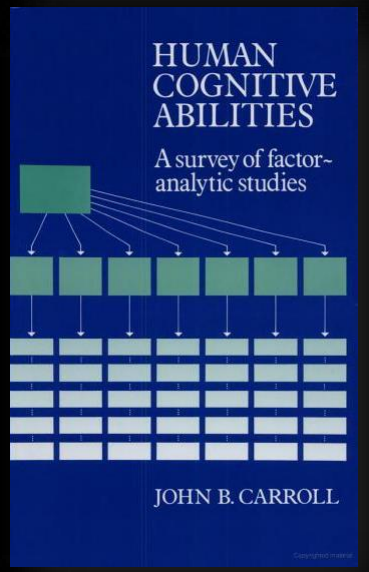
What You Think You See

Weird & Wild Reality

What Is Underneath



"To construct a theory of intelligence is to construct a theory of cognition."

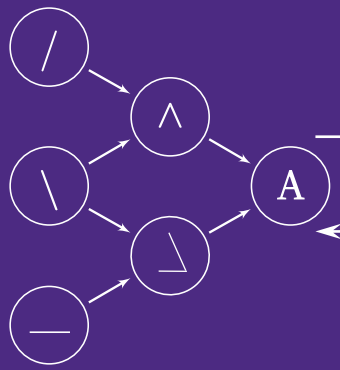


Sensation

A

Perception

Gt = Speed of Perceptual Processing



Feature Detectors

Gv/Ga/Go/Gh/Gk = Complexity of Perceptual Processing

Long-Term Memory

Gc/Gkn/Gq/Grw = Breadth, Depth, and Complexity of Knowledge

Gl = Learning Efficiency

Gr = Retrieval Fluency

Storage

Retrieval

Activation

Priming

Recently Activated Concepts

A

Focus of Attention

Memory Span = Size of Activated Area

Gf = Complexity of Reasoning within Working Memory

Working Memory

Central Executive

Working Memory Capacity = Efficiency of Attentional Control

Gs = Attentional Fluency

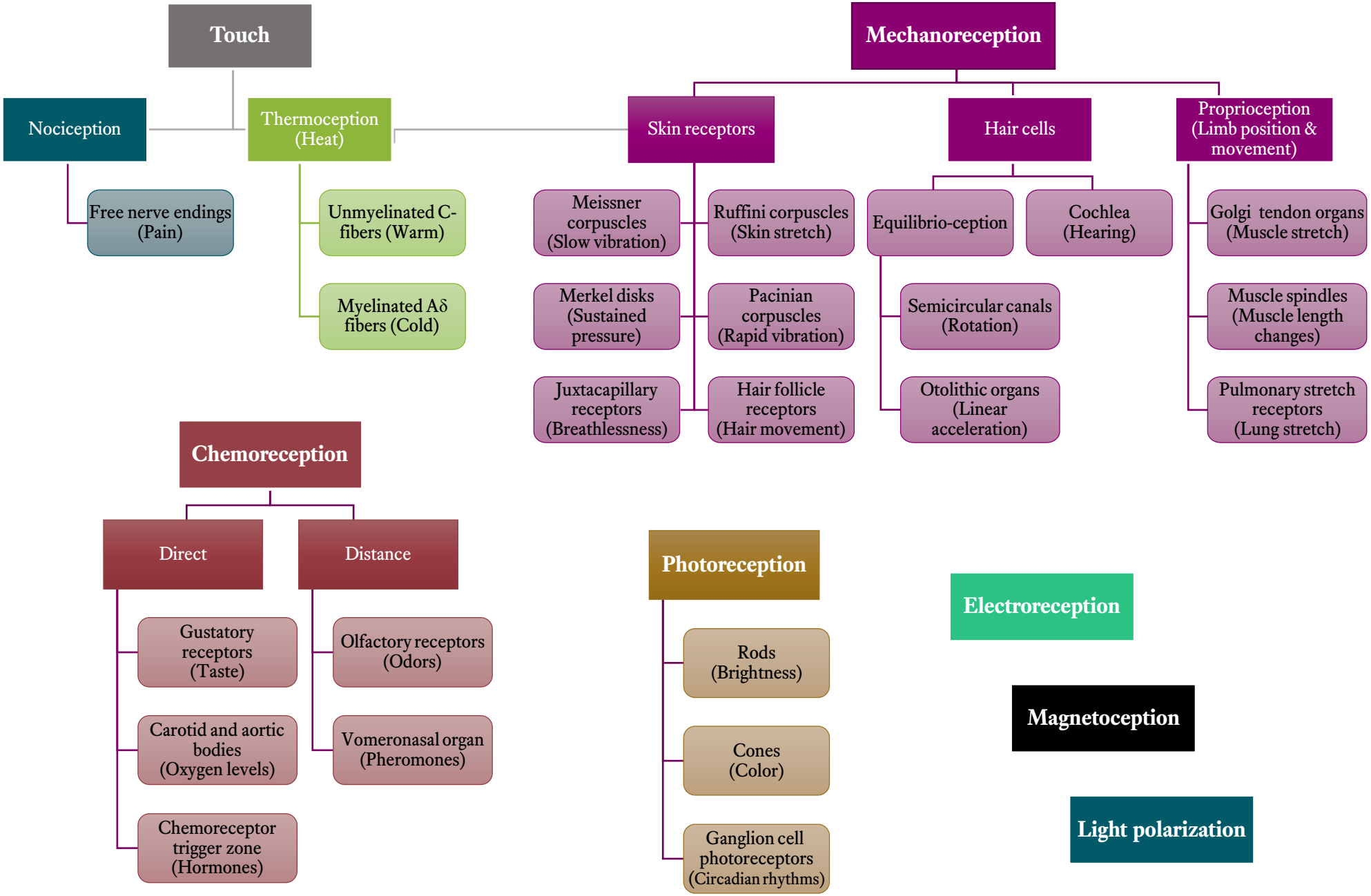
Gp = Psychomotor Ability

Decisions

CHC Broad Abilities

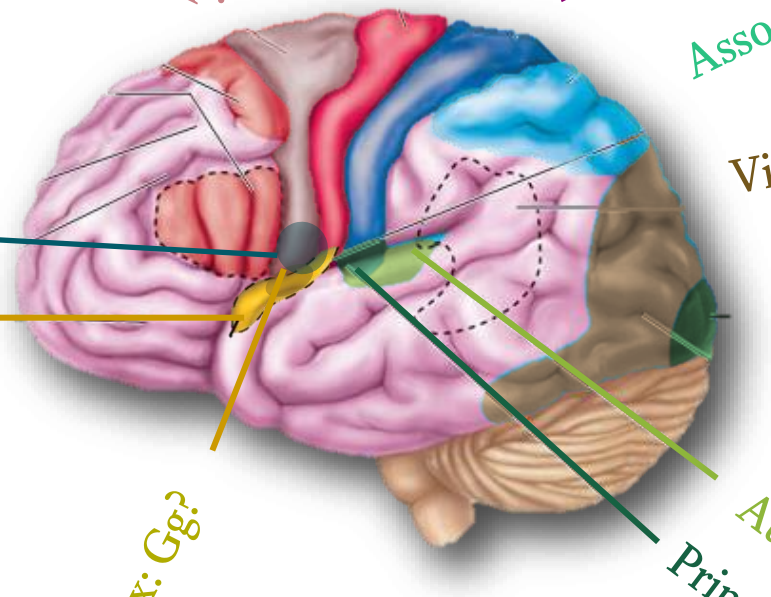
as parameters of information processing

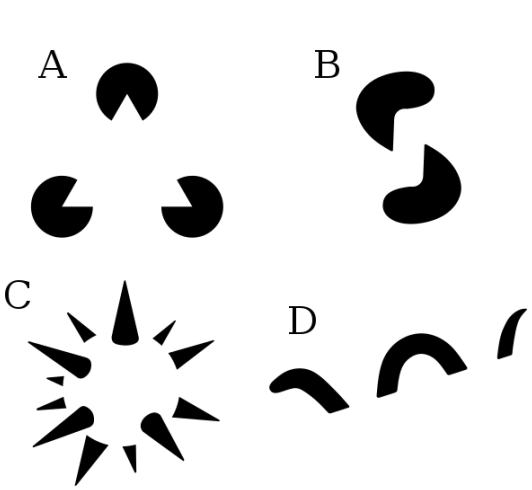
SENSATION

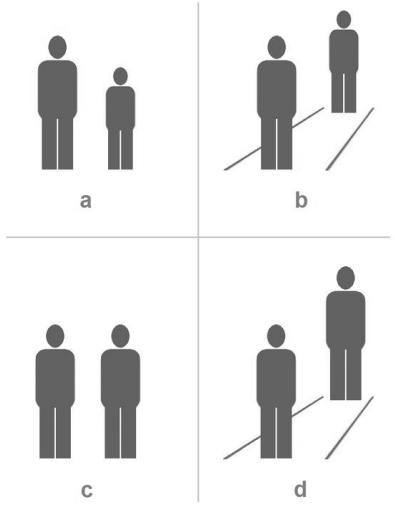

Touch
Nociception
Free nerve endings (Pain)
Thermoception (Heat)
Unmyelinated C-fibers (Warm)
Myelinated Aδ fibers (Cold)
Mechanoreception
Skin receptors
Meissner corpuscles (Slow vibration)
Ruffini corpuscles (Skin stretch)
Merkel disks (Sustained pressure)
Pacinian corpuscles (Rapid vibration)
Juxtacapillary receptors (Breathlessness)
Hair follicle receptors (Hair movement)
Hair cells
Equilibrio-ception
Cochlea (Hearing)
Semicircular canals (Rotation)
Otolithic organs (Linear acceleration)
Proprioception (Limb position & movement)
Golgi tendon organs (Muscle stretch)
Muscle spindles (Muscle length changes)
Pulmonary stretch receptors (Lung stretch)
Chemoreception
Direct
Distance
Gustatory receptors (Taste)
Carotid and aortic bodies (Oxygen levels)
Chemoreceptor trigger zone (Hormones)
Olfactory receptors (Odors)
Vomeronasal organ (Pheromones)
Photoreception
Rods (Brightness)
Cones (Color)
Ganglion cell photoreceptors (Circadian rhythms)
Electroreception
Magnetoception
Light polarization

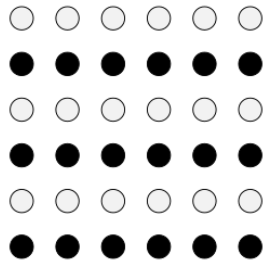
I did not approve of this joke.

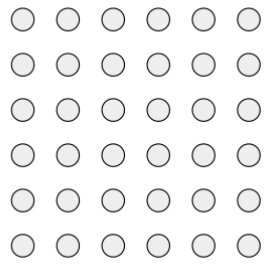
Sense and Sense Ability

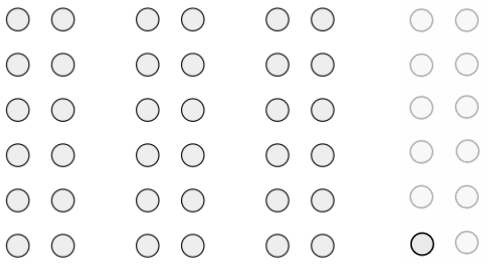








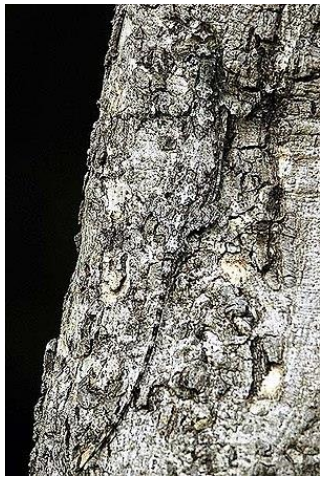


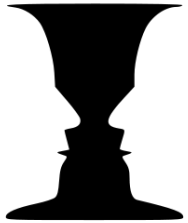


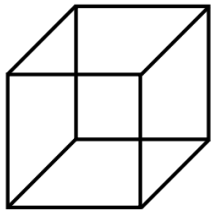
Gv

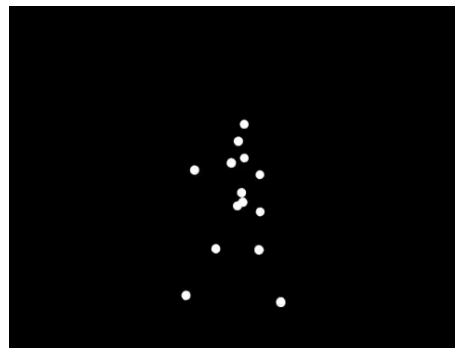
Visual-Spatial Processing

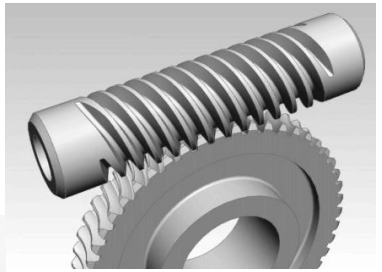
The ability to perceive, analyze, transform, generate, and reason with visual patterns and stimuli.

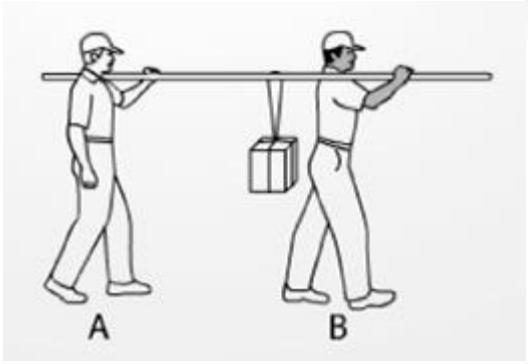


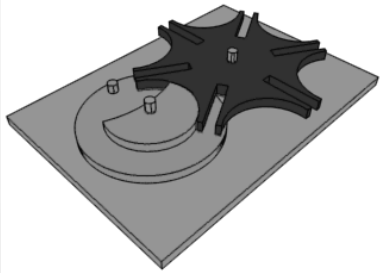


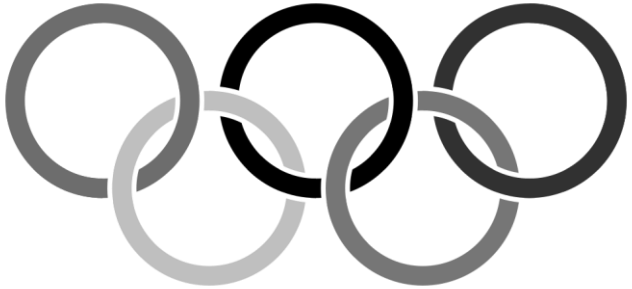


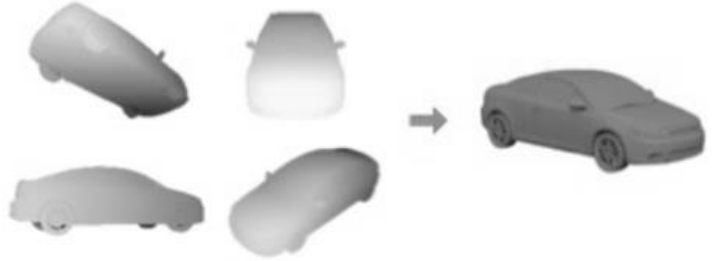






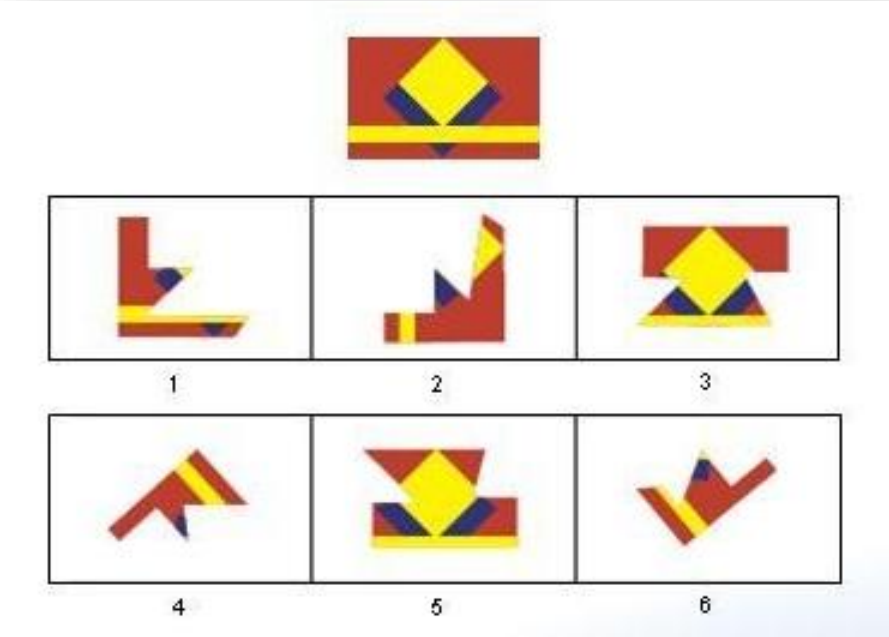


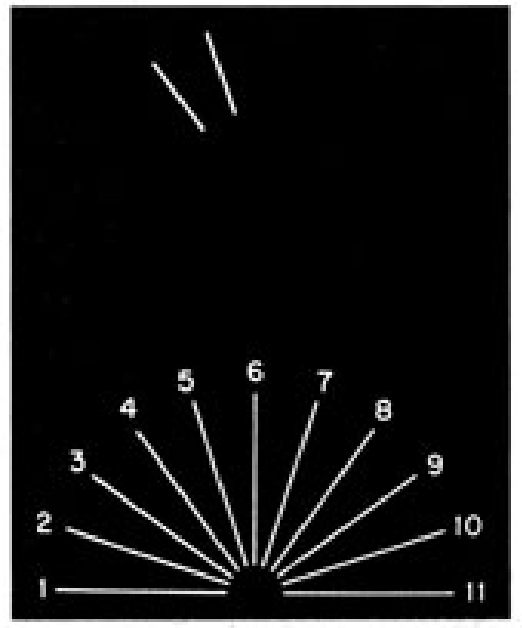


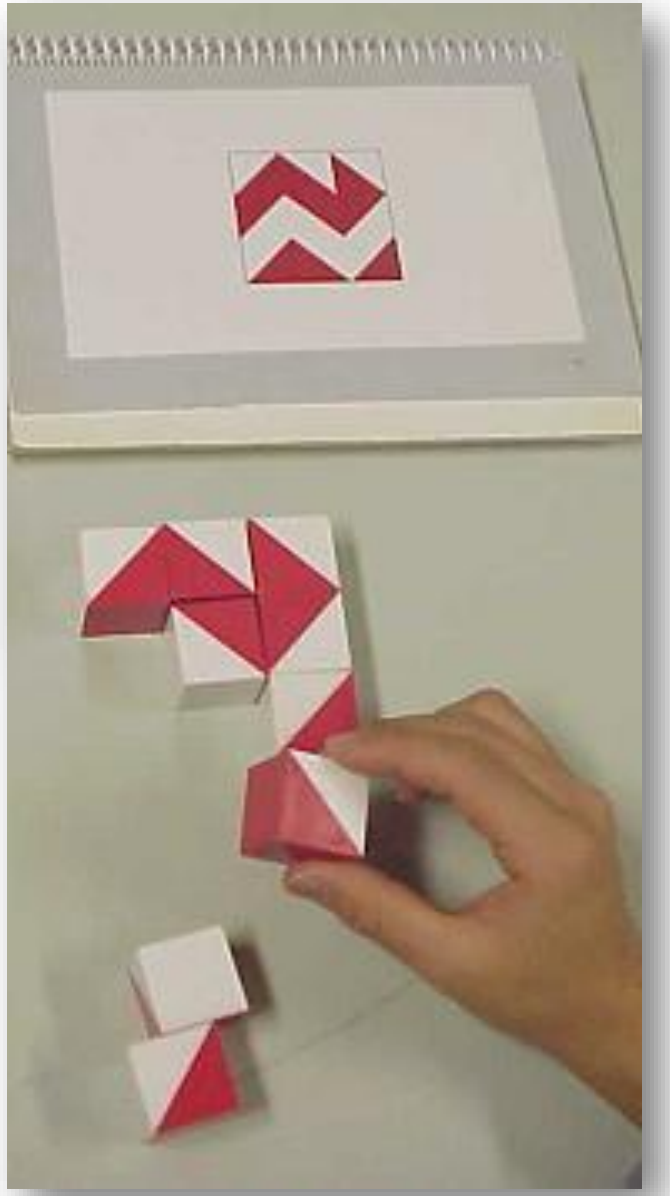


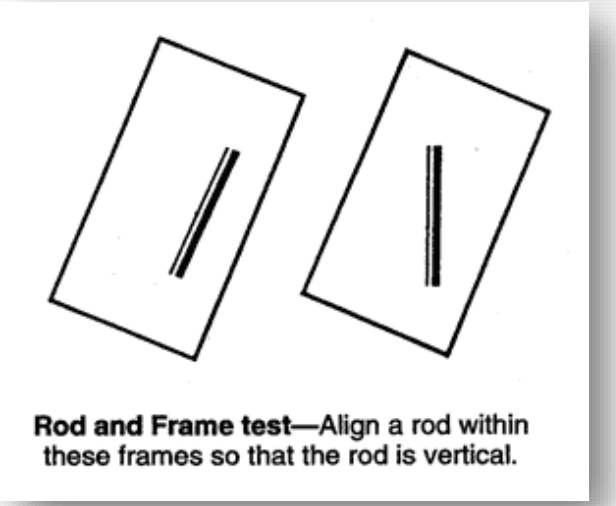
Visualization

The ability to perceive complex patterns and mentally simulate how they might look when transformed.









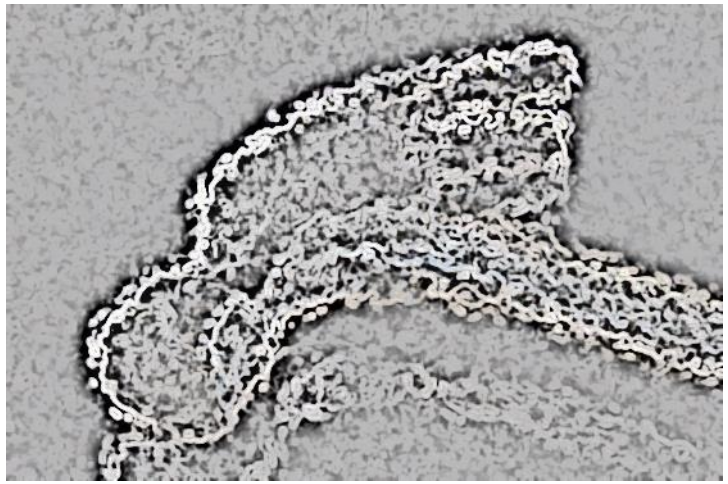
Rod and Frame test—Align a rod within these frames so that the rod is vertical.

Serial Perceptual Integration

Ability to recognize an object after only parts of it are shown in rapid succession.

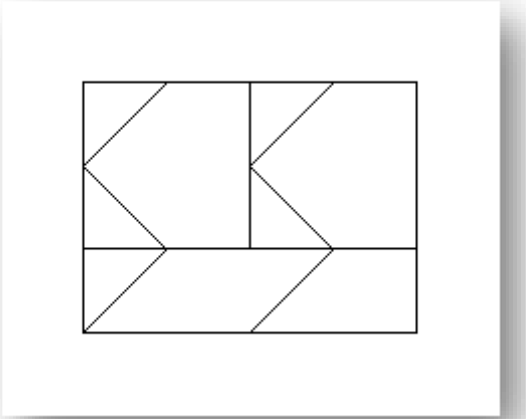
Gestalt Closure

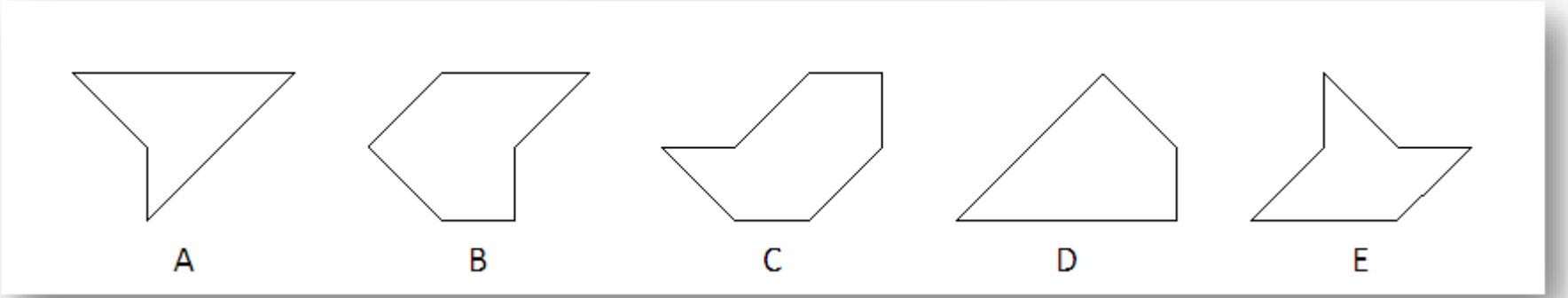
Ability to quickly identify an object from incomplete visual stimuli.



Flexibility of Closure

Ability to identify a known visual figure embedded in a complex visual pattern

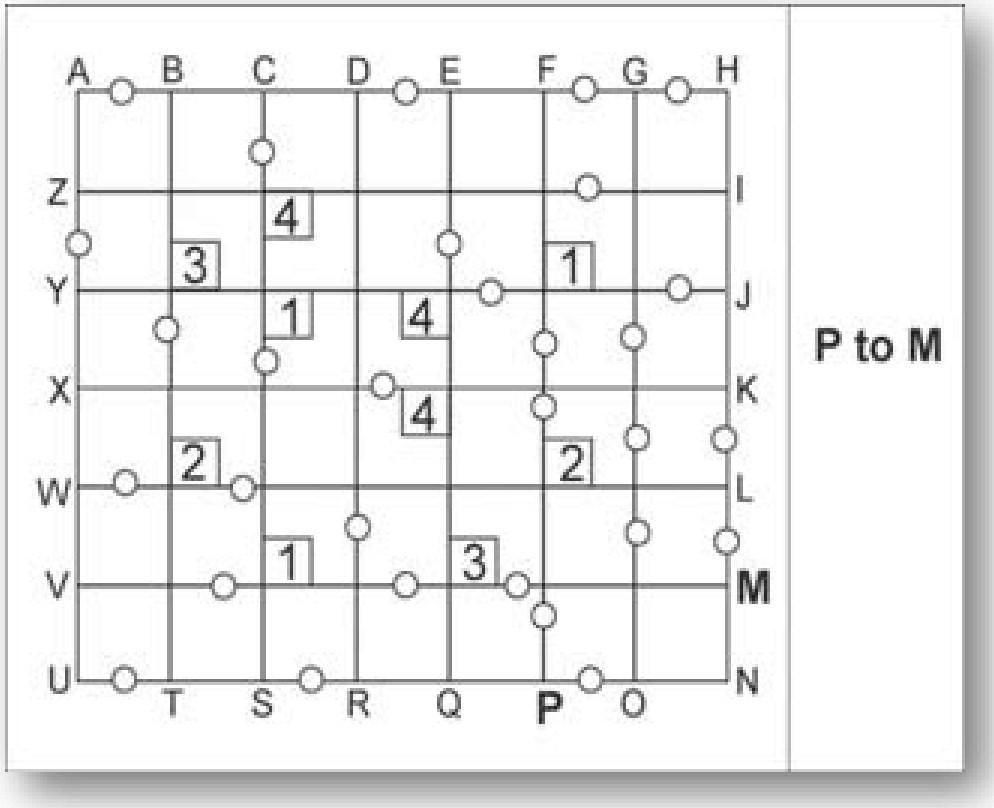




Which of these figures can be found in the figure above?

Spatial Scanning

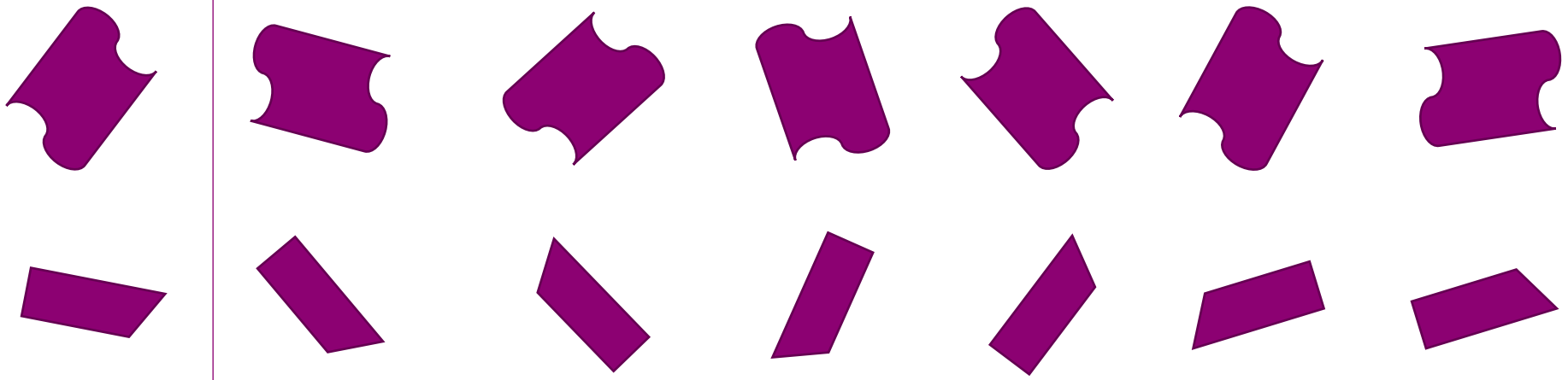
Ability to visualize a path out of a maze.



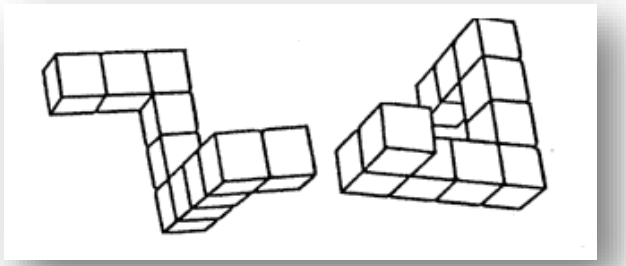
Which number(s) will you pass if you trace the shortest route from P to M (circles are roadblocks)?

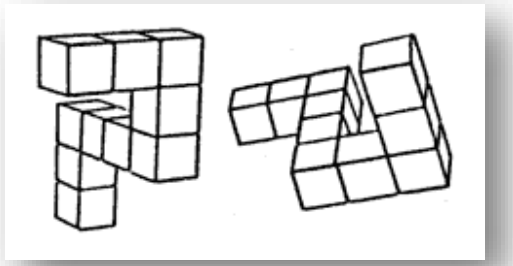
Speeded Rotation

The ability to mentally rotate images quickly.



Which figures are the same as the first figure in each row (i.e., rotated, not flipped)?





Are these figures the same, except for their orientation?

Tests of Visual Processing

Block Design

Visual Puzzles

Wechsler Tests

Object Assembly

Copying

Pattern Construction

DAS-II

Recall of Designs

Visualization

Visual Memory

Gestalt Closure

Block Counting

Triangles

KABC-II

Gestalt Closure

Face Recognition

Recognition of Pictures

Visualization

Woodcock-Johnson IV

Visual Closure

Picture Recognition

Tests of Visual Processing

Visual Puzzles

Copying

Pattern Construction

Block Design

Visualization

Visualization

Block Counting

Triangles

Object Assembly

Picture Recognition

Visual Memory

Gestalt Closure

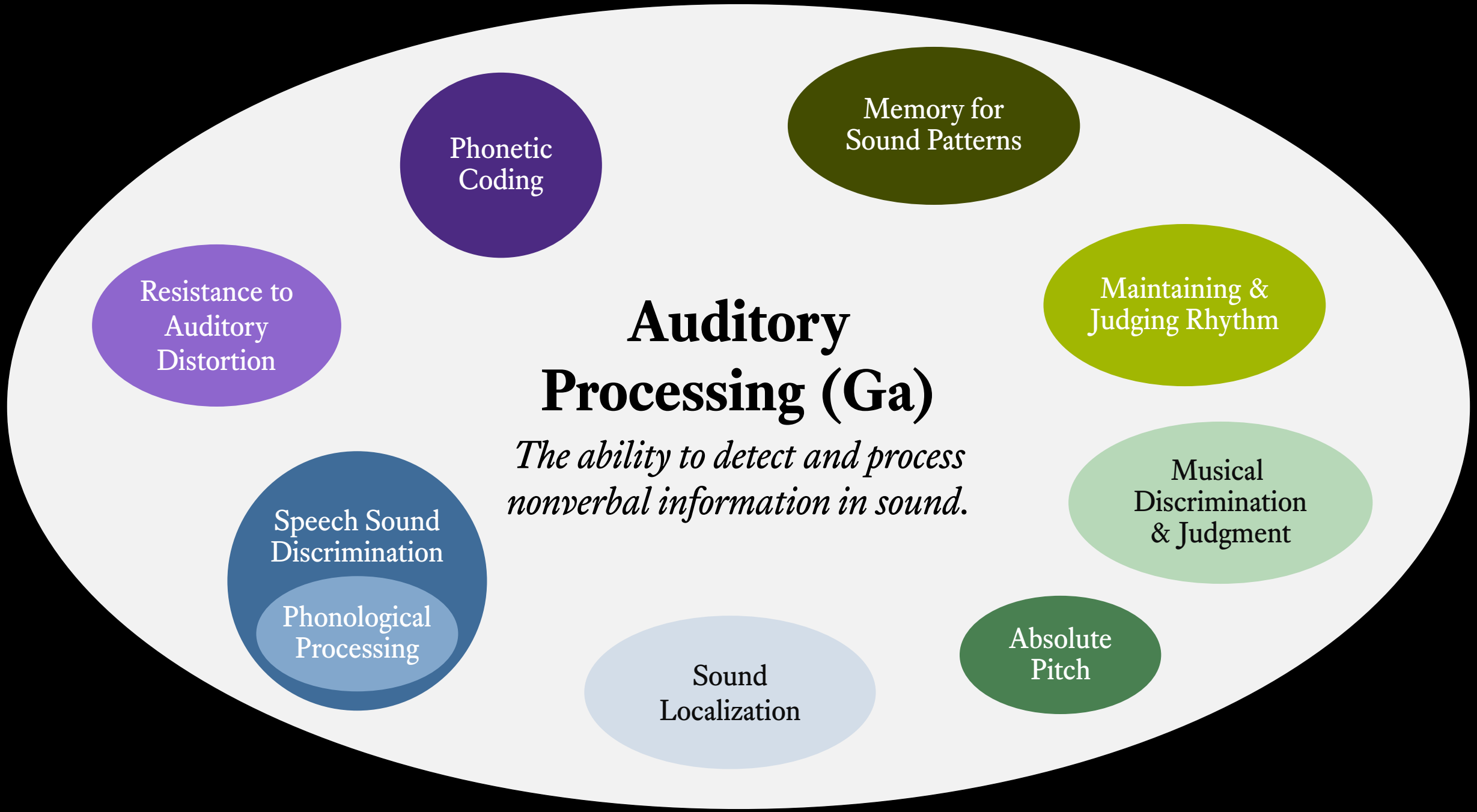
Face Recognition

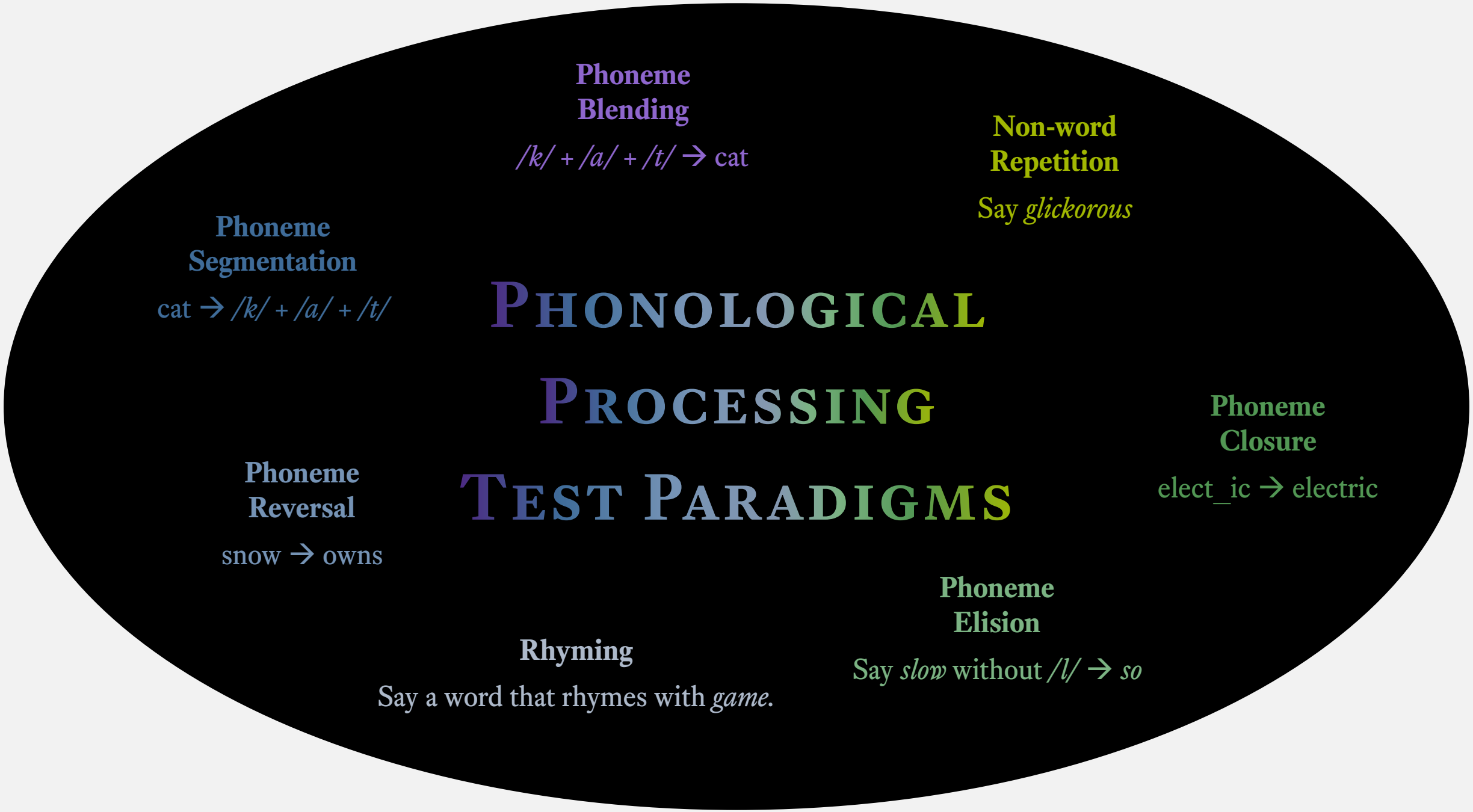
Recognition of Pictures

Recall of Designs

Visual Closure

Gestalt Closure


Phonetic Coding
Memory for Sound Patterns
Resistance to Auditory Distortion
Maintaining & Judging Rhythm
Auditory Processing (Ga)
The ability to detect and process nonverbal information in sound.
Speech Sound Discrimination
Phonological Processing
Musical Discrimination & Judgment
Absolute Pitch
Sound Localization


Phoneme Blending
/k/ + /a/ + /t/ → cat
Non-word Repetition
Say glickorous
Phoneme Segmentation
cat → /k/ + /a/ + /t/
PHONOLOGICAL PROCESSING TEST PARADIGMS
Phoneme Reversal
snow → owns
Phoneme Closure
elect_ic → electric
Phoneme Elision
Say slow without /l/ → so
Rhyming
Say a word that rhymes with game.

Tests of Auditory Processing

Speech Discrimination in Noise

Blending

ASA

Rhyming

Tonal Discrimination

Phonological Processing

Resistance to Auditory Distortion

Pitch Discrimination

Blending Nonwords

Blending Words

CTOPP-2

Elision

Segmenting Nonwords

Phoneme Isolation

DAS-II

Phonological Processing

KTEA-III

Phonological Processing

WIAT-IV

Phonological Proficiency

SCAN-3

Auditory Figure-Ground

Time Compressed Sentences

Phonological Processing

Woodcock-Johnson IV

Sound Blending

Segmentation

Tests of Auditory Processing

Blending

Phonological Proficiency

Phonological Processing

Phonological Processing

Rhyming

Phonological Processing

Phonological Processing

Blending Words

Segmentation

Blending Nonwords

Phoneme Isolation

Elision

Segmenting Nonwords

Sound Blending

Resistance to Auditory Distortion

Auditory Figure-Ground

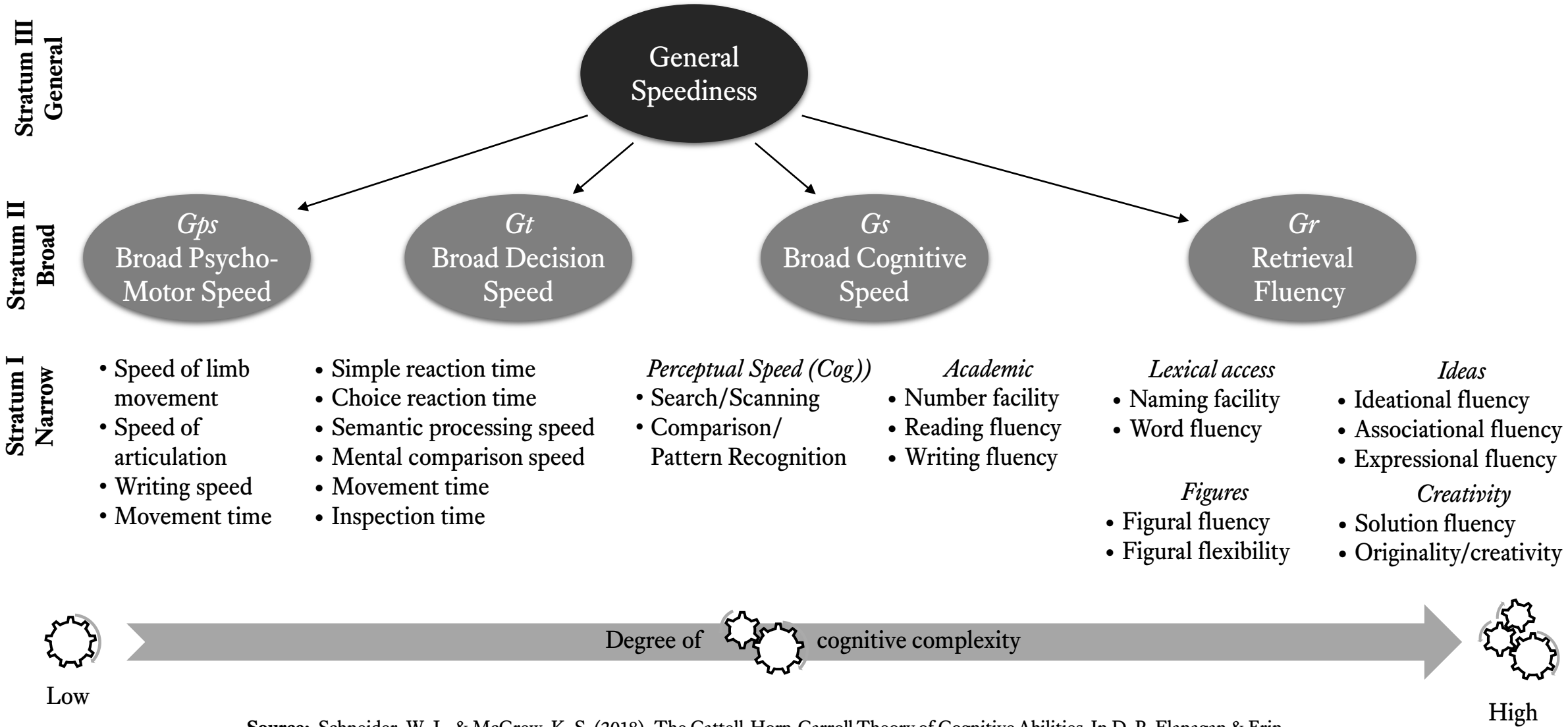
Time Compressed Sentences

Speech Discrimination in Noise

Pitch Discrimination

Tonal Discrimination

A PROPOSED HIERARCHY OF SPEED ABILITIES



Source: Schneider, W. J., & McGrew, K. S. (2018). The Cattell-Horn-Carroll Theory of Cognitive Abilities. In D. P. Flanagan & Erin M. McDonough (Eds.), *Contemporary intellectual assessment: Theories, tests and issues* (4th ed.,) New York: Guilford Press.

Perceptual Speed (Scanning)

leg	damage	food	leather
or	all	eye	division
join	pin	account	hope
plough	force	iron	fiction
hammer	rat	mist	building
sex	dark	impulse	brake
bell	knife	chain	question
form	hook	material	part
probable	glass	seem	harmony
answer	experience	necessary	pot
sail	sea	great	fall
sharp	same	sheep	cry
insect	cover	advertisement	ready
arch	order	right	journey
fixed	run	place	shelf
feeble	guide	face	far
air	liquid	news	frequent
make	farm	quality	front
bit	cruel	fish	meat
act	last	card	fat

As quickly as you can, cross out every word with an “a.”

Perceptual Speed (Scanning)

leg	~~damage~~	food	~~leather~~
or	~~all~~	eye	division
join	pin	~~account~~	hope
plough	force	iron	fiction
~~hammer~~	~~rat~~	mist	building
sex	~~dark~~	impulse	~~brake~~
bell	knife	~~chain~~	question
form	hook	~~material~~	~~part~~
~~probable~~	~~glass~~	seem	~~harmony~~
~~answer~~	experience	~~necessary~~	pot
~~sail~~	~~sea~~	~~great~~	~~fall~~
~~sharp~~	~~same~~	sheep	cry
insect	cover	~~advertisement~~	~~ready~~
~~arch~~	order	right	journey
fixed	run	~~place~~	shelf
feeble	guide	~~face~~	~~far~~
~~air~~	liquid	news	frequent
~~make~~	~~farm~~	~~quality~~	front
bit	cruel	fish	~~meat~~
~~act~~	~~last~~	~~card~~	~~fat~~

As quickly as you can, cross out every word with an “a.”

Perceptual Speed (Comparison)

51	_____	15
89	_____	89
16	_____	16
624	_____	634
708	_____	708
101	_____	110
4741	_____	4741
6503	_____	6508
2743	_____	2743
84285	_____	84285
78788	_____	78787
59544	_____	59444
412297	_____	412297
396518	_____	396528
291769	_____	291769
1178997	_____	1187997
6536999	_____	6536999
9708239	_____	9788239

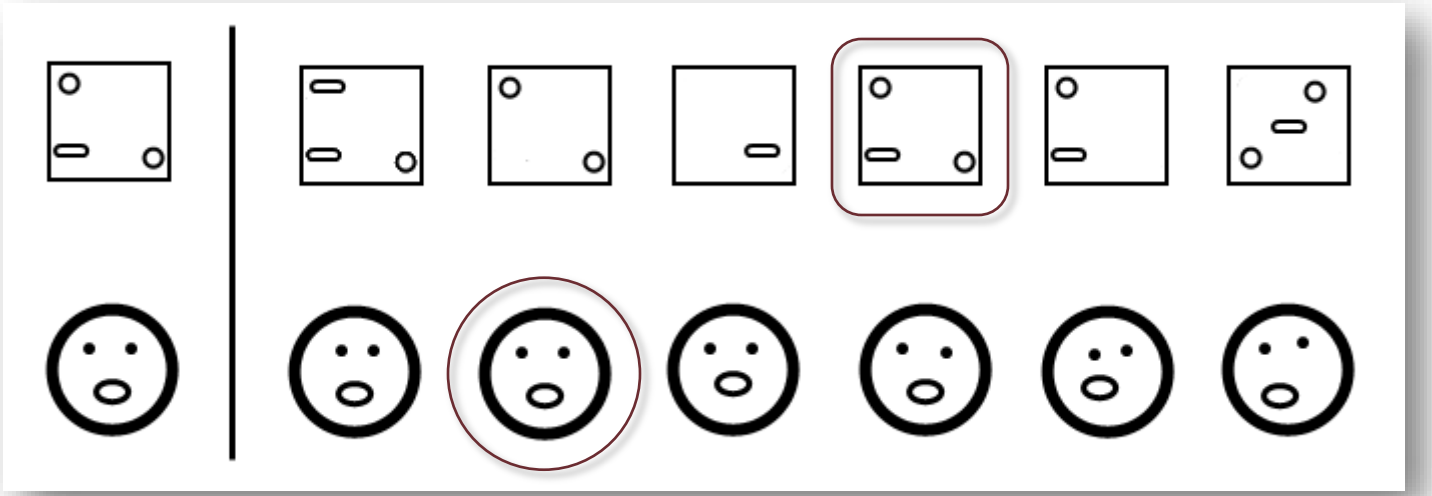
Put an “X” between each pair of numbers that matches.

Perceptual Speed (Comparison)

51		15
89	X	89
16	X	16
624		634
708	X	708
101		110
4741	X	4741
6503		6508
2743	X	2743
84285	X	84285
78788		78787
59544		59444
412297	X	412297
396518		396528
291769	X	291769
1178997		1187997
6536999	X	6536999
9708239		9788239

Put an “X” between each pair of numbers that matches.

Perceptual Speed (Comparison)



In each row, find the picture than looks the same as the first picture.

Tests of Processing Speed

Comparison Speed
Scanning Speed

Symbol Search

Coding

Wechsler Tests

Cancellation

DAS-II

Speed of Information Processing

Letter-Pattern Matching

Woodcock-Johnson IV

Pair Cancelation

Number-Pattern Matching

Tests of Processing Speed

Symbol Search

Speed of Information Processing

Comparison Speed

Coding

Cancellation

Scanning Speed

Number-Pattern Matching

Letter-Pattern Matching

Pair Cancelation

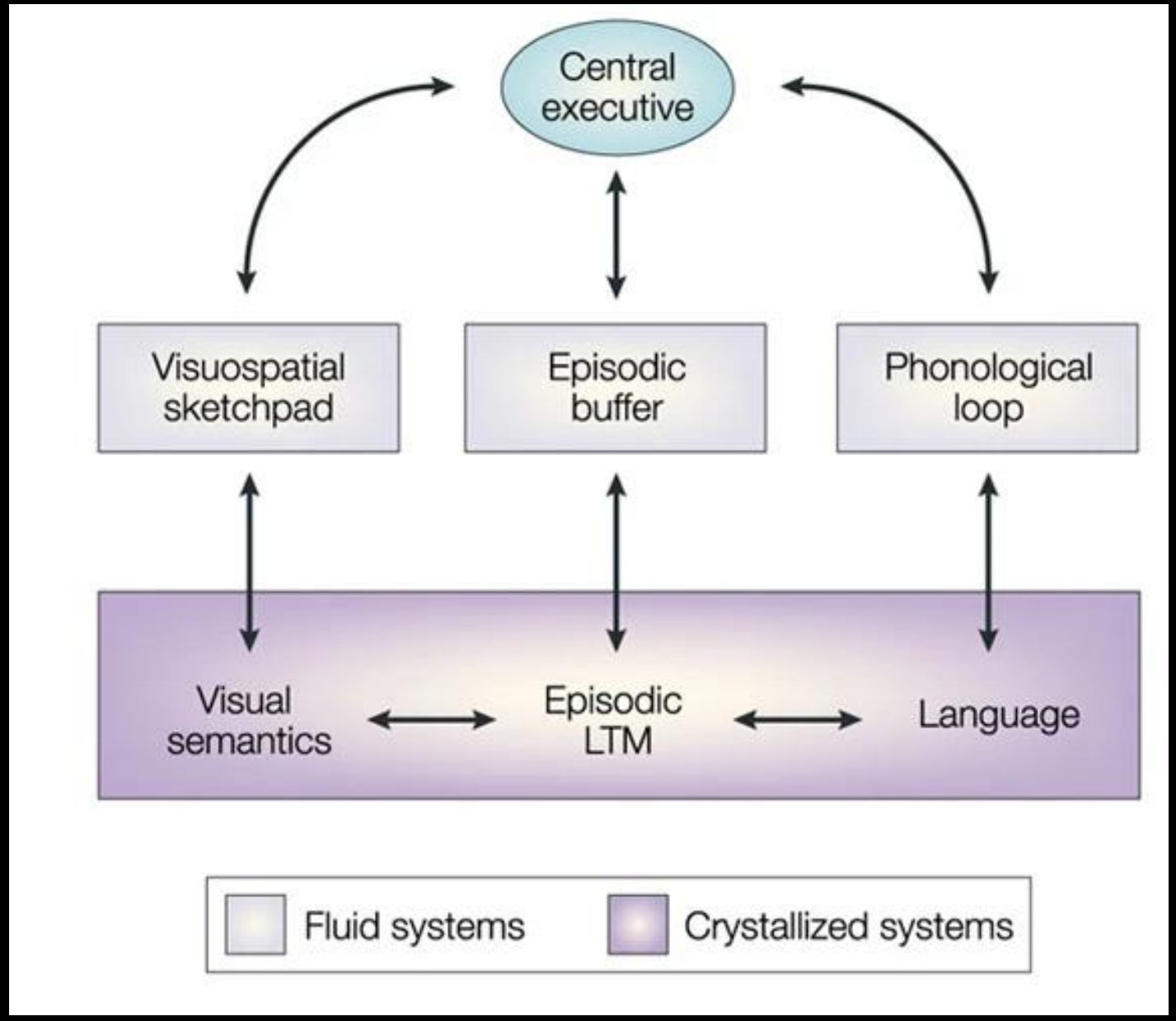
You can buy two types of memory:

Option A

- Lavishly expensive
- Ridiculously fragile
- Achingly slow
- Laughably error prone
- Holds only three or four items at a time,
- Continuously overwritten every time your attention wanders

Option B

- Quick
- Cheap
- Reliable
- Robust
- Lasts forever
- Offers unlimited storage space.



Working Memory

"A limited capacity system, which temporarily maintains and stores information, supports human thought processes by providing an interface between perception, long-term memory and action."

Image and Definition from
Baddeley, A. (2003). Working memory: looking back and looking forward. *Nature Reviews Neuroscience 4*, 829–839. https://doi.org/10.1038/nrn1201

Working Memory Capacity (GWM)

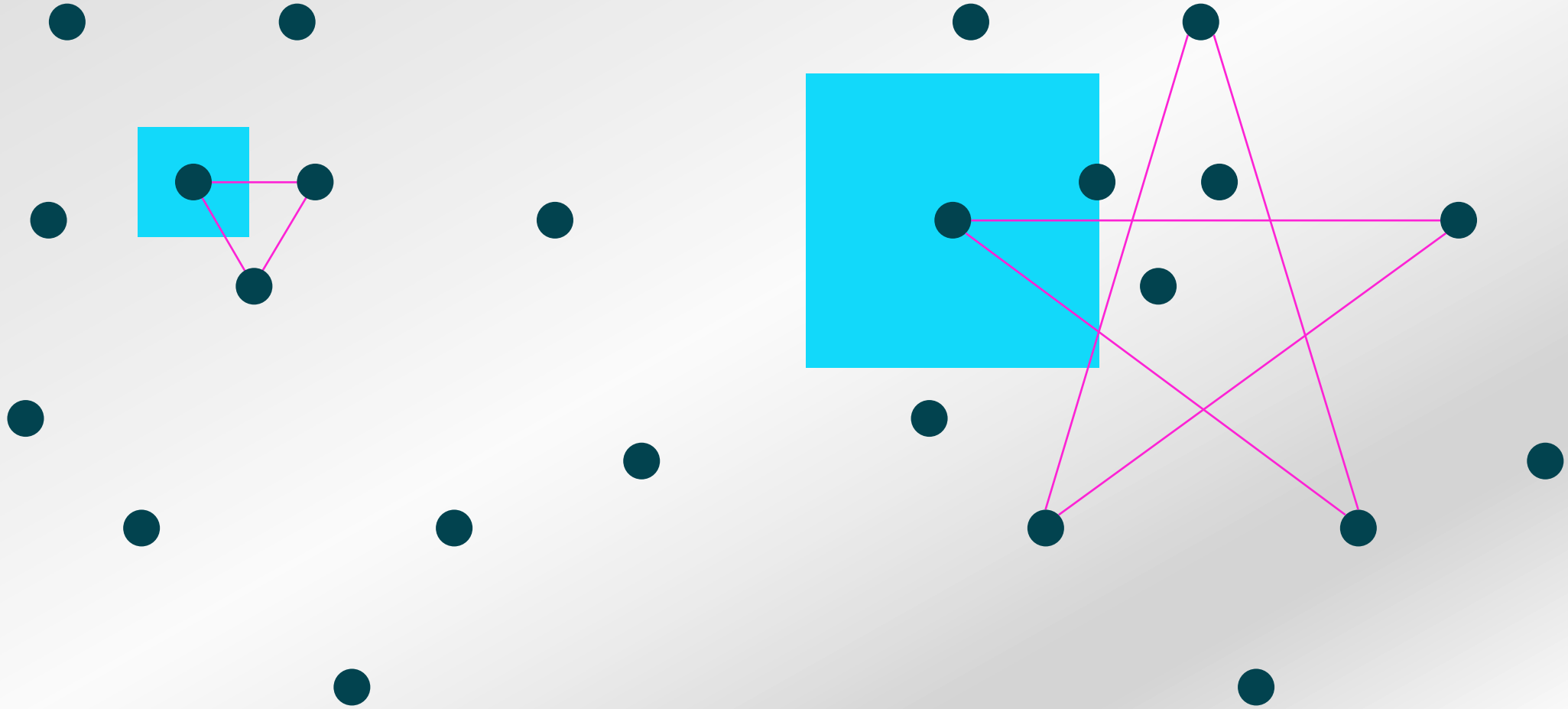
The ability to maintain and manipulate information in active attention.

Visual-Spatial Short-Term Storage
The ability to encode and maintain visual information in primary memory

Attentional Control
The ability to manipulate the spotlight of attention flexibly to focus on relevant stimuli

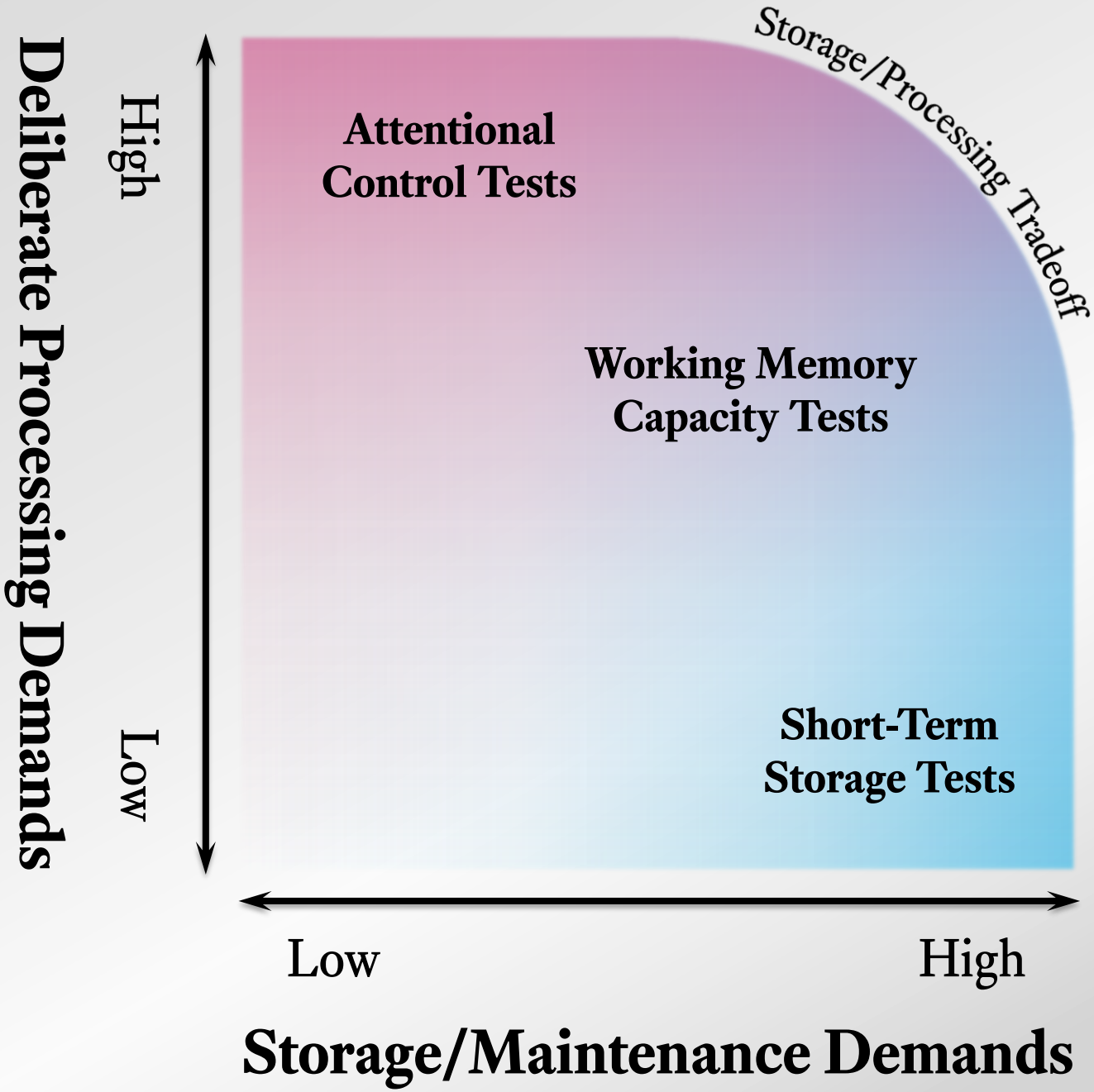
Auditory Short-Term Storage
The ability to encode and maintain verbal information in primary memory

The Size of Your Work Surface Limits the Range of Tasks You Can Do



Hurdling

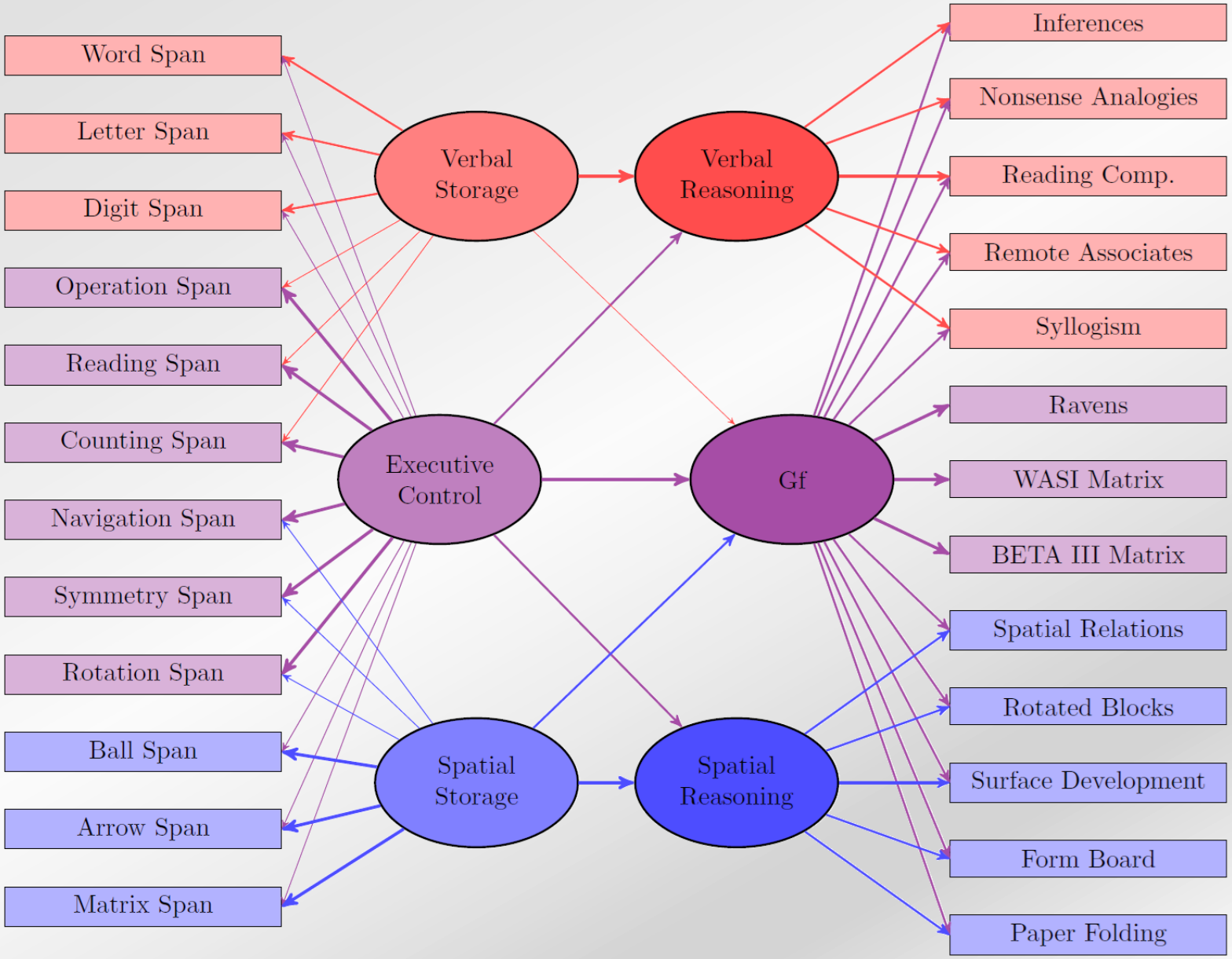
Alternating Between Running & Jumping



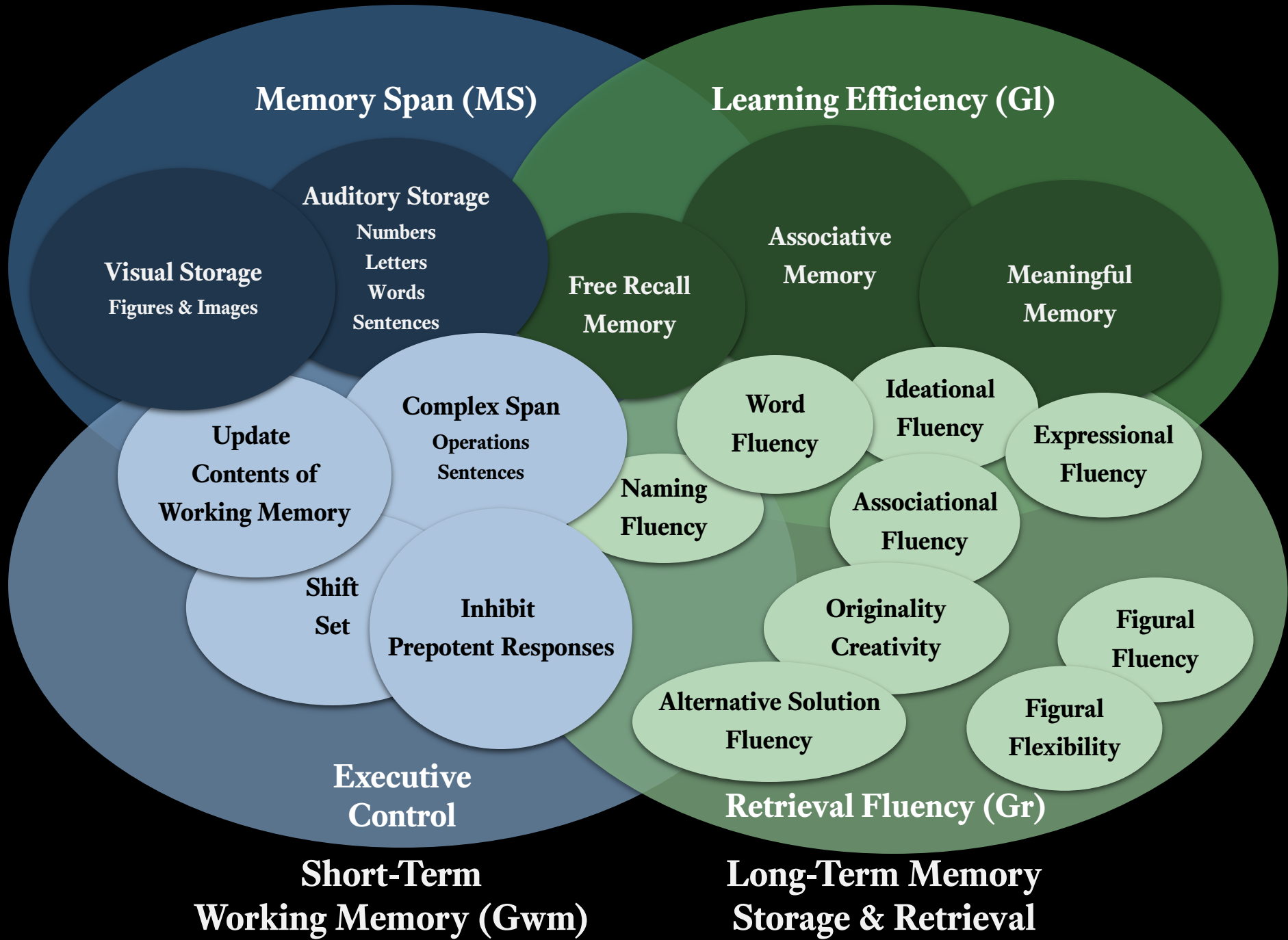
Working Memory Is a Strange Construct.

In the same way that *hurdling* is the controlled alternation of running and jumping, *working memory capacity* is the controlled alternation of storage and deliberate processing.

Differential Effects of Broad & Narrow Abilities



Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology-General*, *133*(2), 189-217.


Memory Span (MS)
Learning Efficiency (Gl)
Visual Storage
Figures & Images
Auditory Storage
Numbers
Letters
Words
Sentences
Free Recall Memory
Associative Memory
Meaningful Memory
Word Fluency
Ideational Fluency
Expressional Fluency
Naming Fluency
Associational Fluency
Originality Creativity
Figural Fluency
Alternative Solution Fluency
Figural Flexibility
Update Contents of Working Memory
Complex Span
Operations
Sentences
Shift Set
Inhibit Prepotent Responses
Executive Control
Retrieval Fluency (Gr)
Short-Term Working Memory (Gwm)
Long-Term Memory Storage & Retrieval

Tests of Learning Efficiency

Logical Memory

Verbal Paired Associates

Wechsler Tests

Immediate Symbol Translation

Paired Recall

Visual Selective Reminding

Word Selective Reminding

TOMAL-2

Object Recall

Memory for Stories

Meaningful Memory

Associative Learning

List Learning

Sound Symbol

WRAML2

Story Memory

Verbal Learning

Memory for Names

Visual-Auditory Learning

Woodcock-Johnson IV

Kaufman

Atlantis

Rebus

DAS-II

Recall of Objects

Story Recall

Tests of Learning Efficiency

Visual Selective Reminding

Word Selective Reminding

Object Recall

List Learning

Recall of Objects

Verbal Learning

Immediate Symbol Translation

Verbal Paired Associates

Visual-Auditory Learning

Memory for Names

Memory for Stories

Story Memory

Associative Learning

Meaningful Memory

Sound Symbol

Paired Recall

Logical Memory

Story Recall

Atlantis

Rebus

Tests of Retrieval Fluency

Naming Speed Literacy

Oral Word Fluency

Wechsler Tests

Naming Speed Quantity

Rapid Color Naming

Rapid Digit Naming

CTOPP-II

Rapid Object Naming

Rapid Letter Naming

Naming Speed

Ideational Fluency

Word Fluency

Retrieval Fluency

Woodcock-Johnson IV

Object Naming Facility

Kaufman

Associational Fluency

DAS-II

Rapid Naming

Rapid Picture Naming

Tests of Retrieval Fluency

Rapid Digit Naming

Rapid Color Naming

Rapid Letter Naming

Rapid Picture Naming

Naming Speed

Naming Speed Quantity

Rapid Object Naming

Naming Speed Literacy

Object Naming Facility

Rapid Naming

Ideational Fluency

Retrieval Fluency

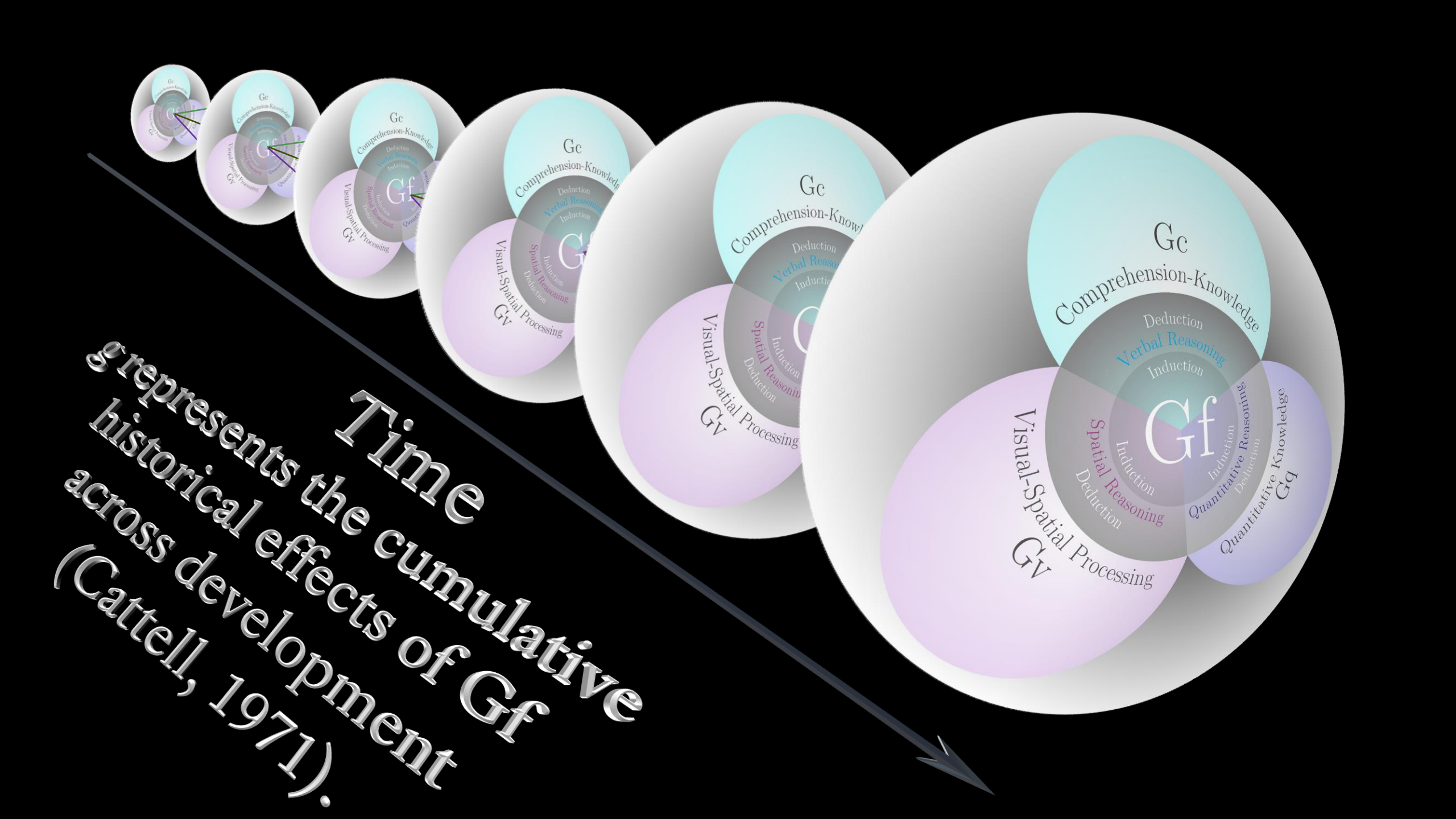
Oral Word Fluency

Word Fluency

Associational Fluency

Time

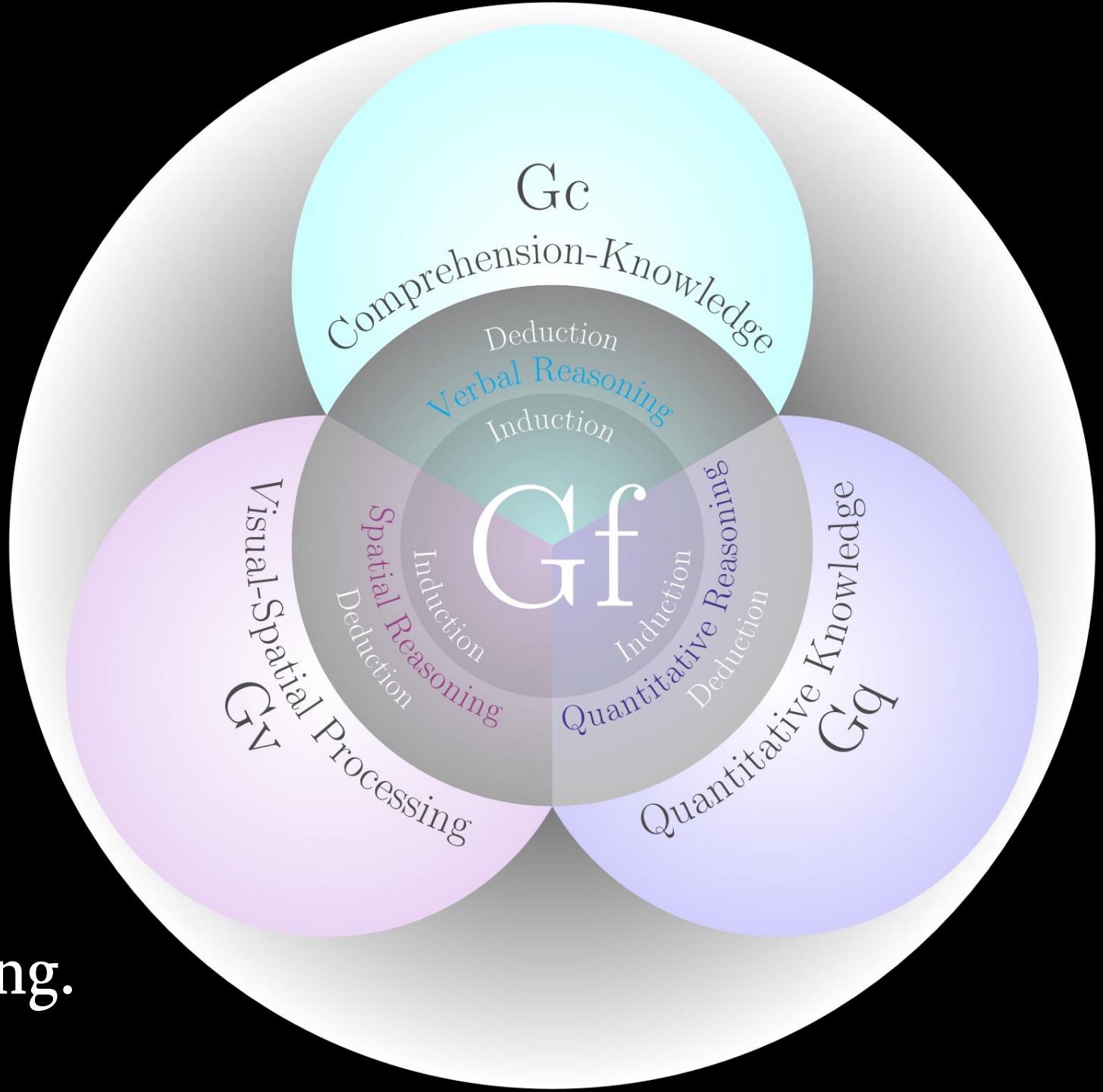
Time


Gc
Comprehension-Knowledge
Deduction
Verbal Reasoning
Induction
Gf
Induction
Spatial Reasoning
Deduction
Induction
Quantitative Reasoning
Deduction
Visual-Spatial Processing
Gv
Quantitative Knowledge
Gq
Time
g represents the cumulative
historical effects of Gf
across development
(Cattell, 1971).

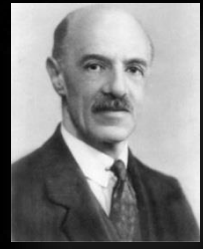
Fluid Reasoning

The use of deliberate and controlled procedures (often requiring focused attention) to solve novel "on the spot" problems that cannot be solved by using previously learned habits, schemas, and scripts.

Gf has its fingers in everything.



Principles of Cognition



Charles Spearman

1. Apprehension of Experience: Encoding of stimuli
2. Eduction of relations: Inductive reasoning
3. Eduction of correlates: Deductive reasoning

Educe: To draw out (something hidden or latent); Deduce

A and B have a relationship.
With which letter does Y
have the same relationship?

A : B :: Y : _____

Relation? Same

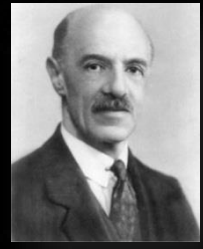
Morningstar : Venus :: Eveningstar : _____

Hope : Disappointed :: Dread : _____

USA : George Washington :: Turkey : _____

Cowardly : Prudent :: Hotheaded : _____

Principles of Cognition



Charles Spearman

1. Apprehension of the Fundaments of Experience
2. Eduction of relations: Inductive reasoning
3. Eduction of correlates: Deductive reasoning

Educe: To draw out something hidden or latent

Eduction of Relations

Relations: ?

Fundaments: Day — Night

What is the relationship?

Eduction of Correlations

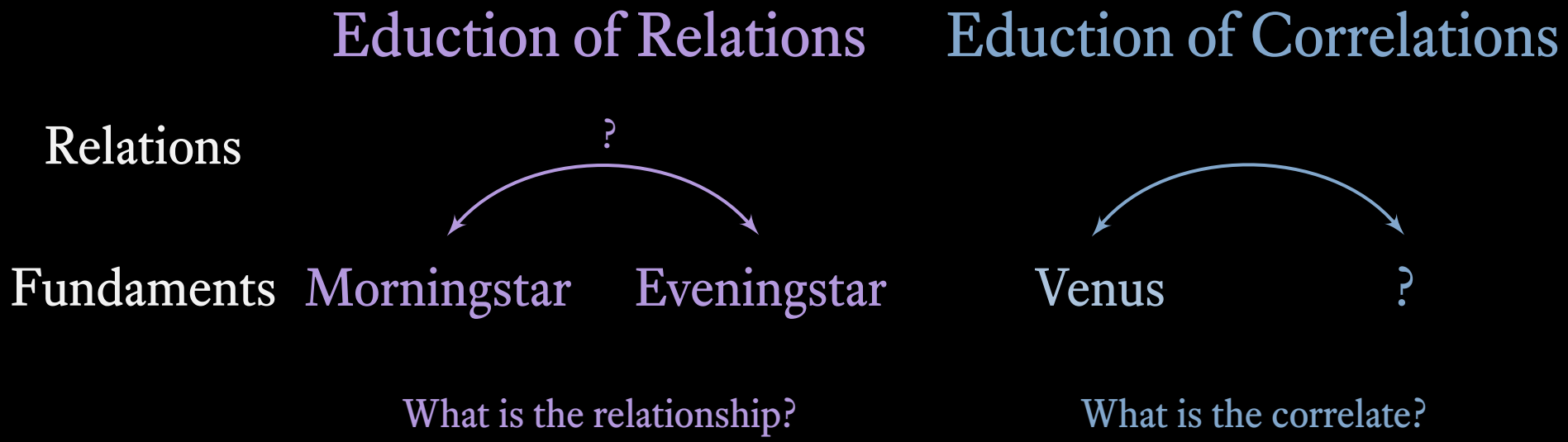
Opposite

Friend — ?

What is the correlate?

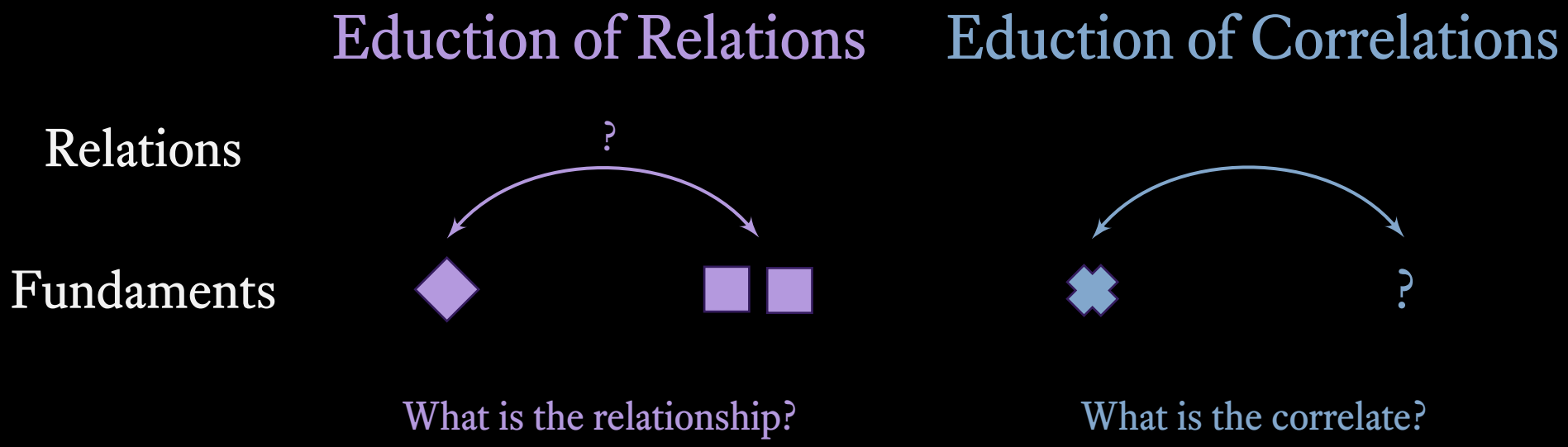
Culture-Reduced tests

Fundaments must be equally familiar to all examinees



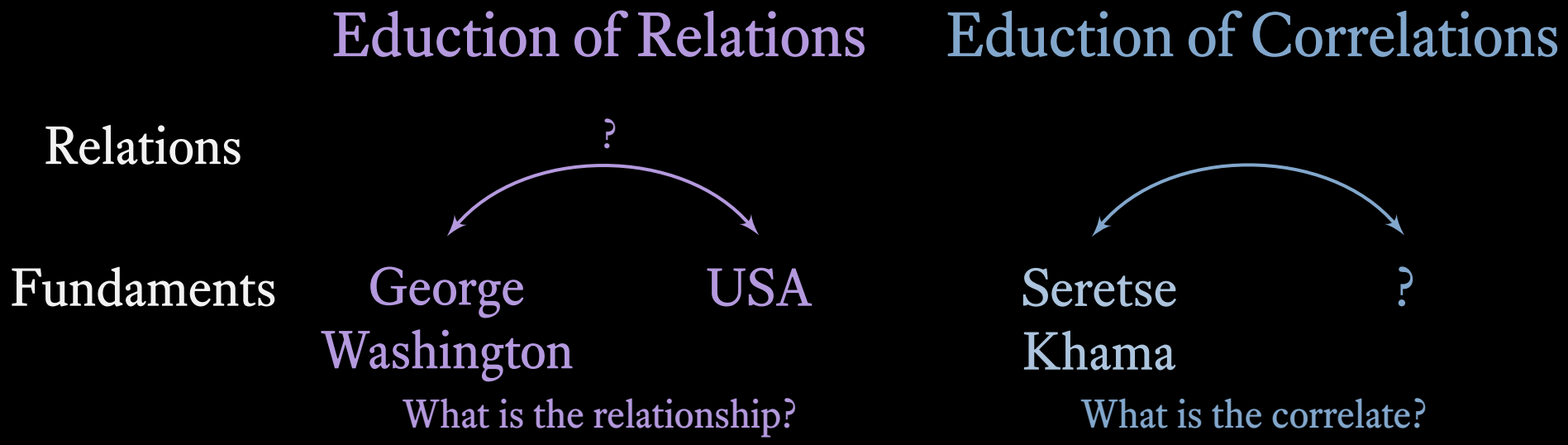
Culture-Reduced tests

Fundaments must be equally familiar to all examinees



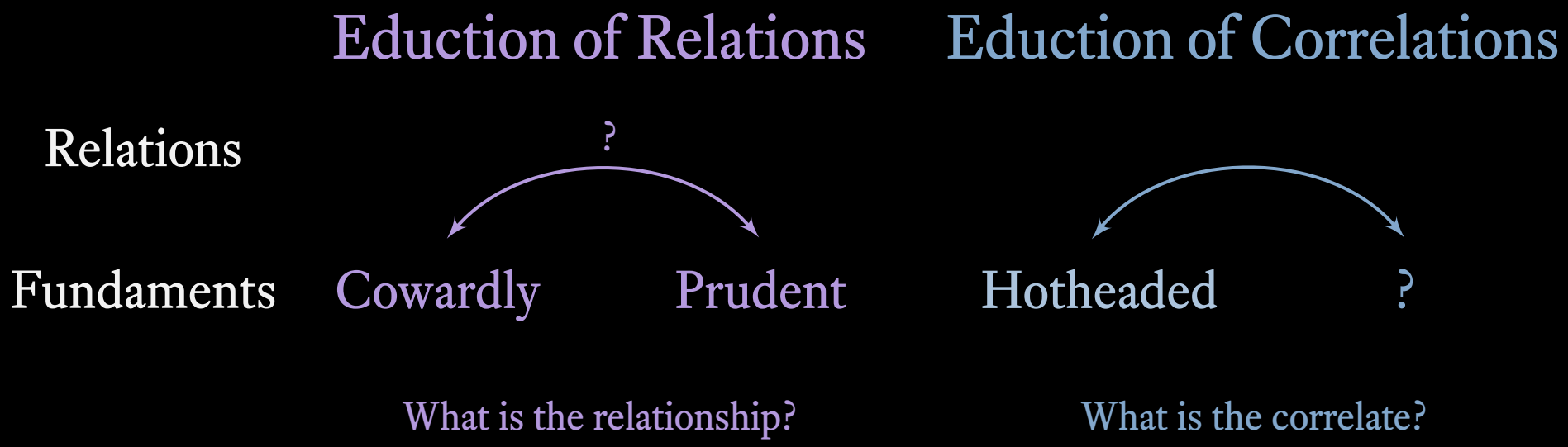
Culture-Reduced tests

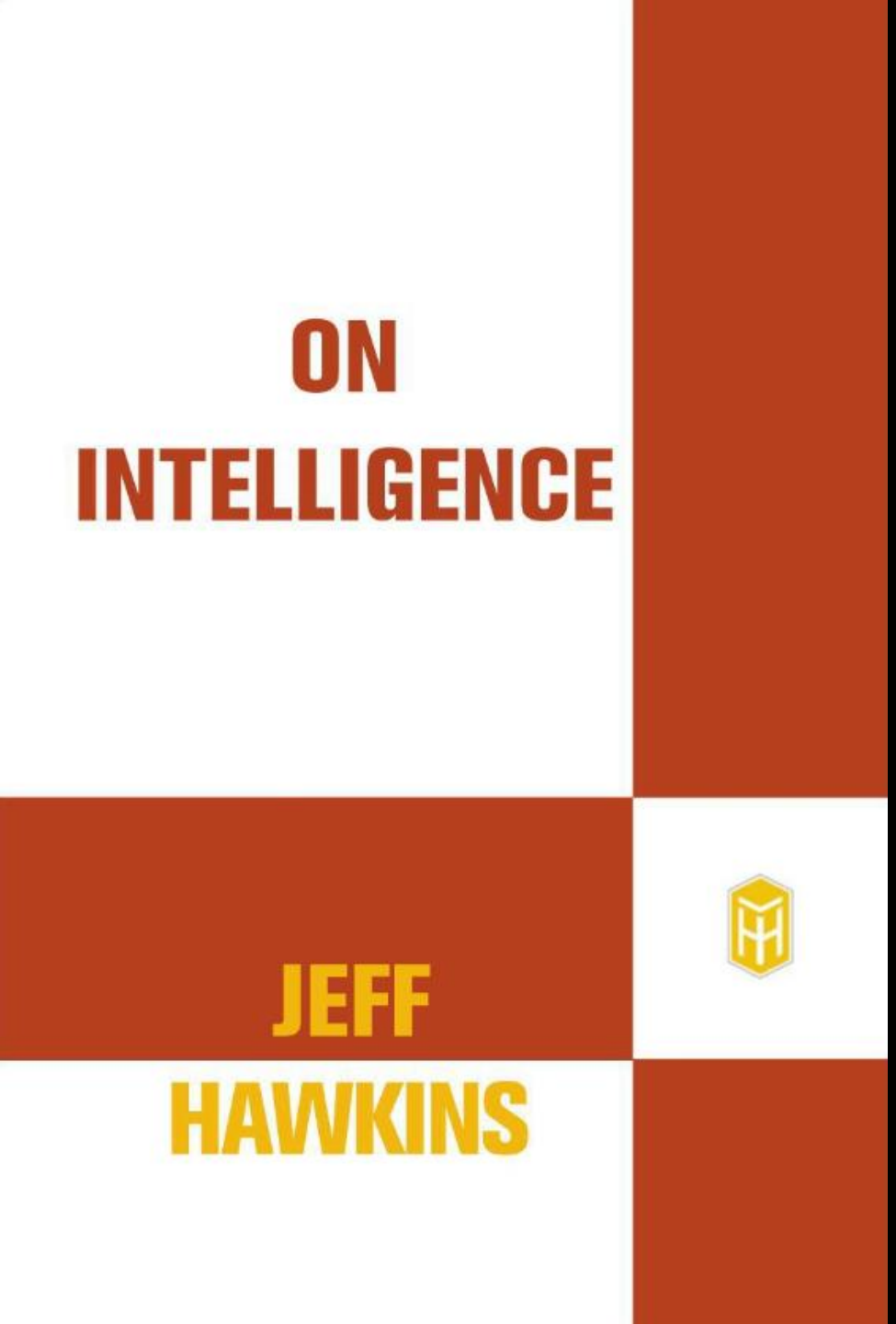
Educing correlates must not require specialized knowledge



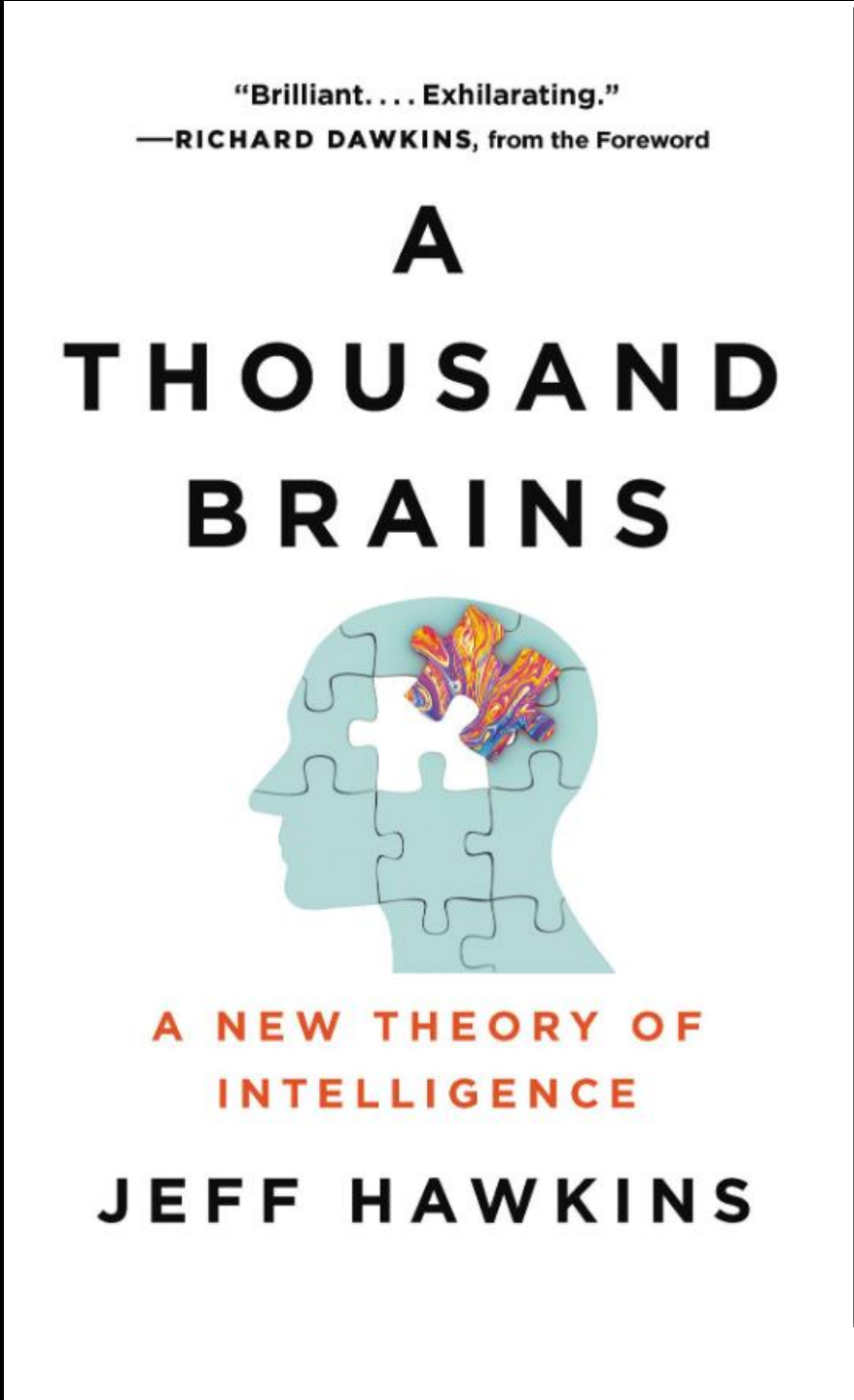
Culture-Reduced tests

The correlates must exist in the examinee's language

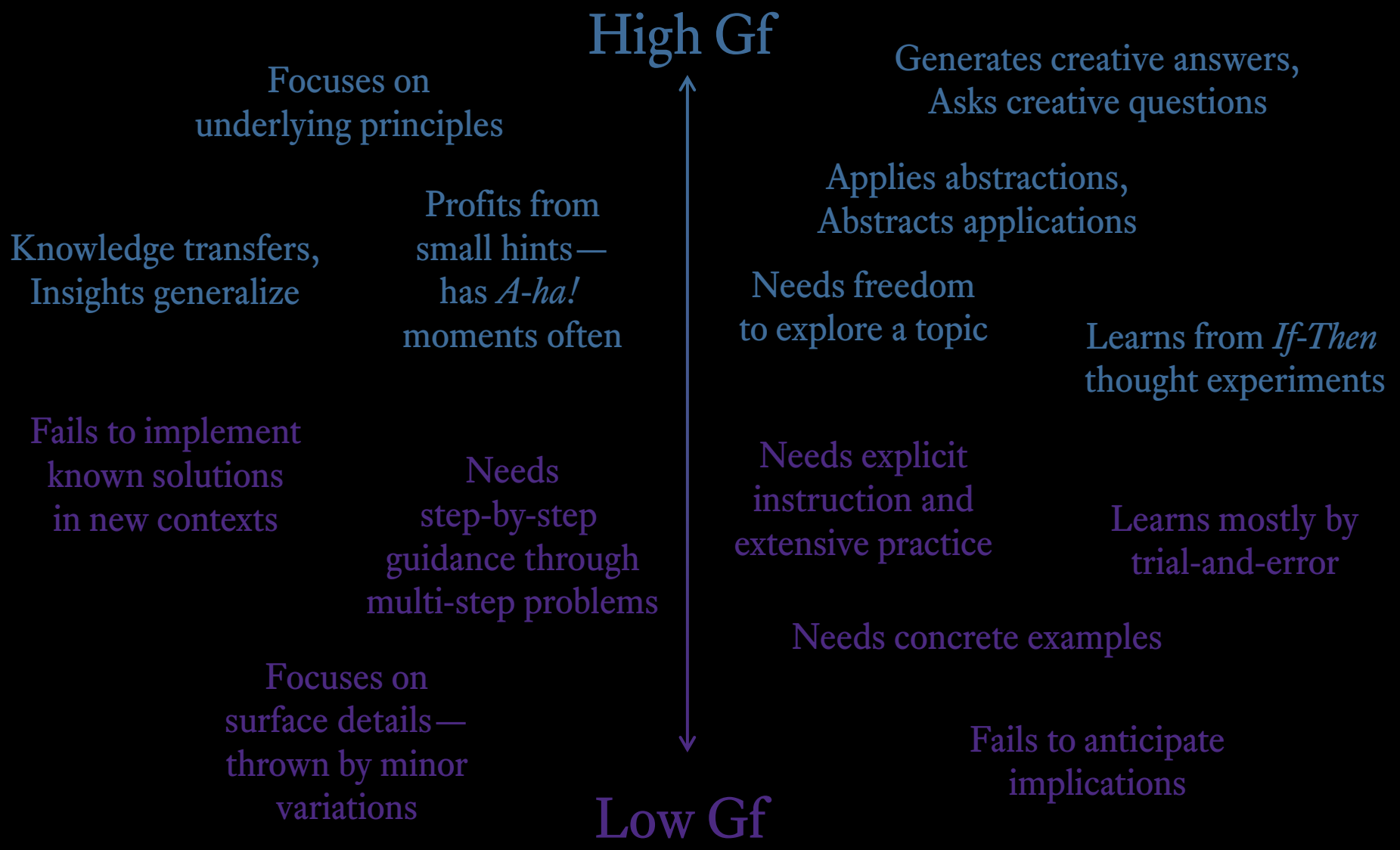




"The brain creates a predictive model. This just means that the brain continuously predicts what its inputs will be. Prediction isn't something that the brain does every now and then; it is an intrinsic property that never stops, and it serves an essential role in learning. When the brain's predictions are verified, that means the brain's model of the world is accurate. A mis-prediction causes you to attend to the error and update the model."
— Jeff Hawkins (2021)



Fluid Reasoning
in the Classroom & on the Job



Tests of Fluid Reasoning

Inductive Reasoning
Deductive/Sequential Reasoning
Quantitative Reasoning

Matrix Reasoning
Picture Concepts
Wechsler Tests
Figure Weights
Arithmetic

Matrices
Picture Similarities
DAS-II
Sequential & Quantitative Reasoning

Pattern Reasoning
KABC-II
Story Completion

Concept Formation
Analysis-Synthesis
Woodcock-Johnson IV
Number Matrices
Number Series

Tests of Fluid Reasoning

Quantitative Reasoning

Number Matrices

Arithmetic

Number Series

Sequential & Quantitative Reasoning

Deductive/Sequential Reasoning

Story Completion

Figure Weights

Analysis-Synthesis

Inductive Reasoning

Matrix Reasoning

Matrices

Pattern Reasoning

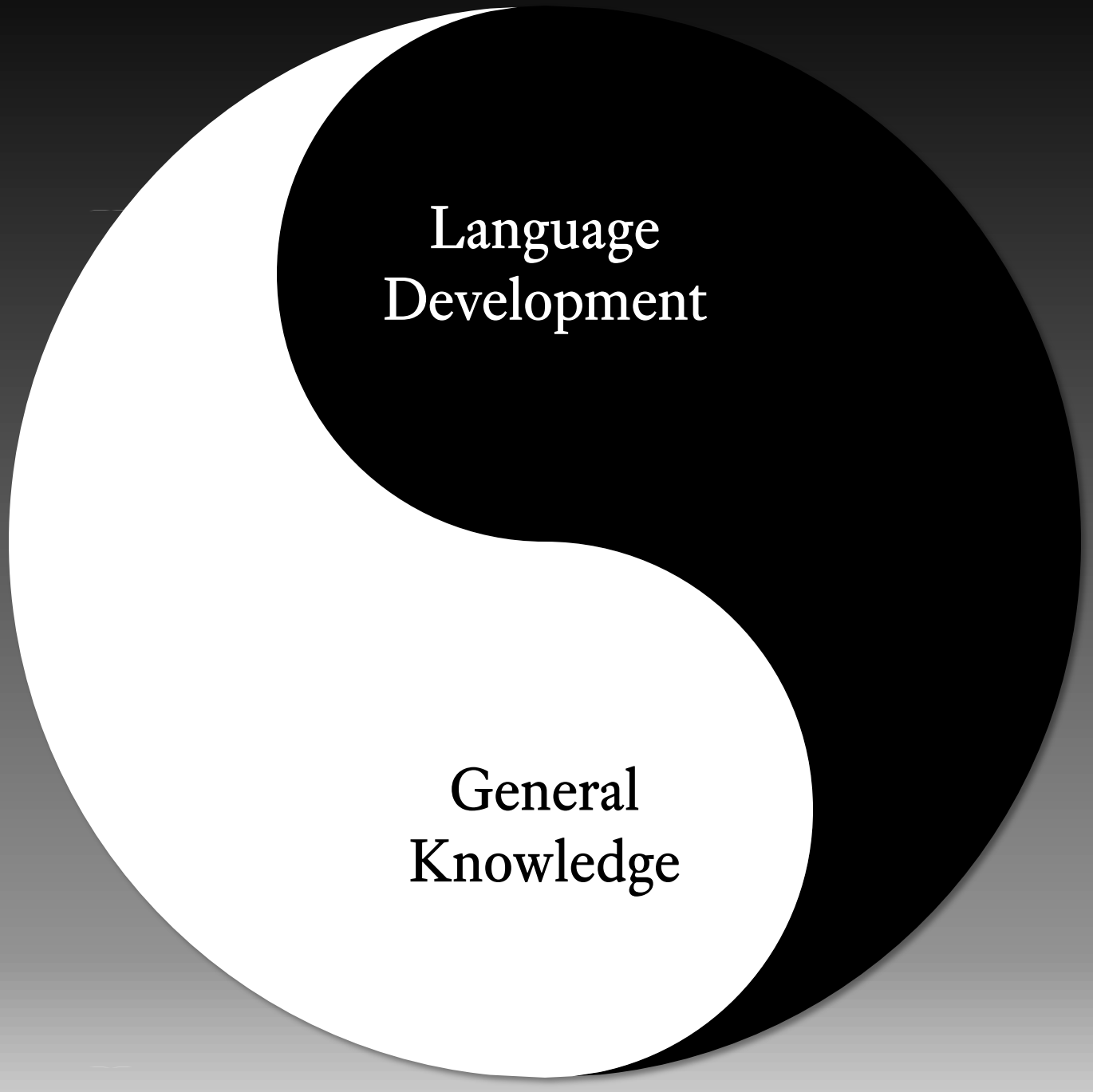
Picture Similarities

Concept Formation

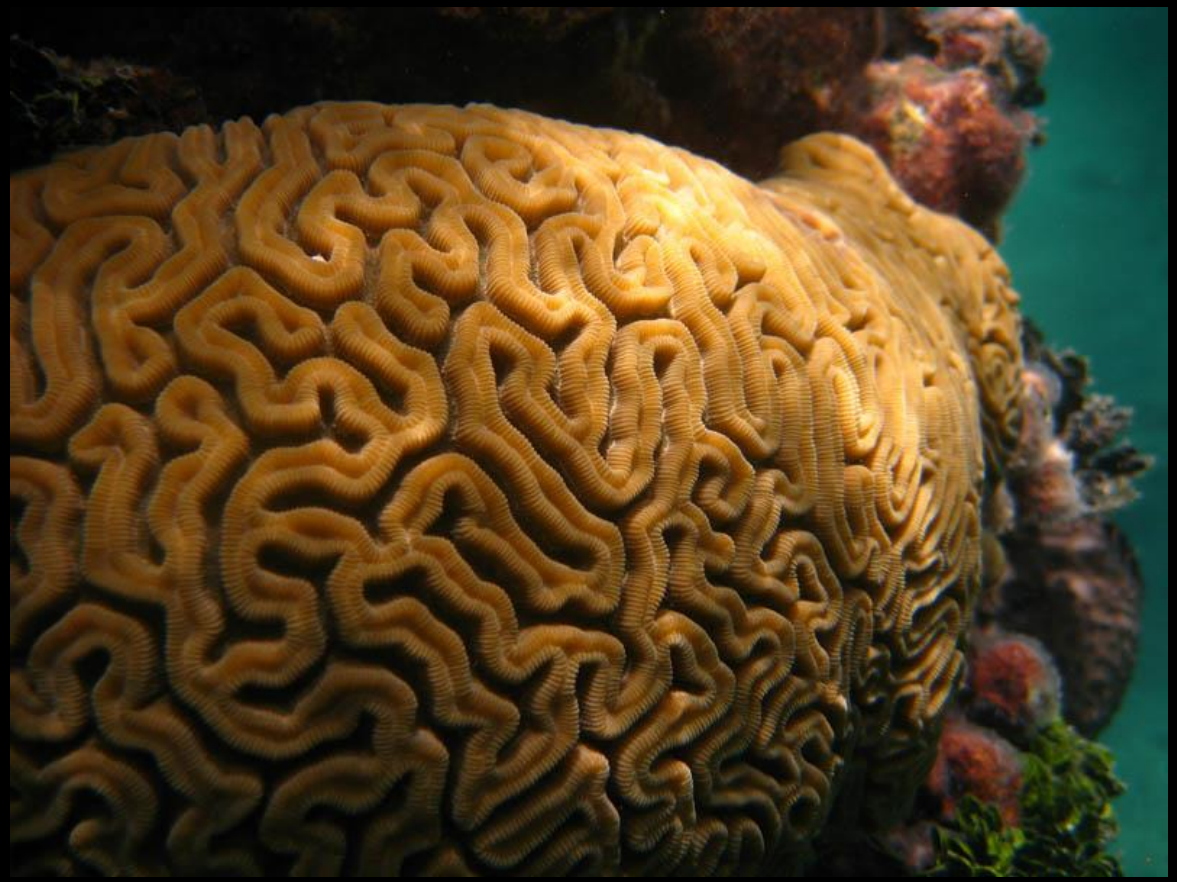
Picture Concepts

Crystallized Intelligence

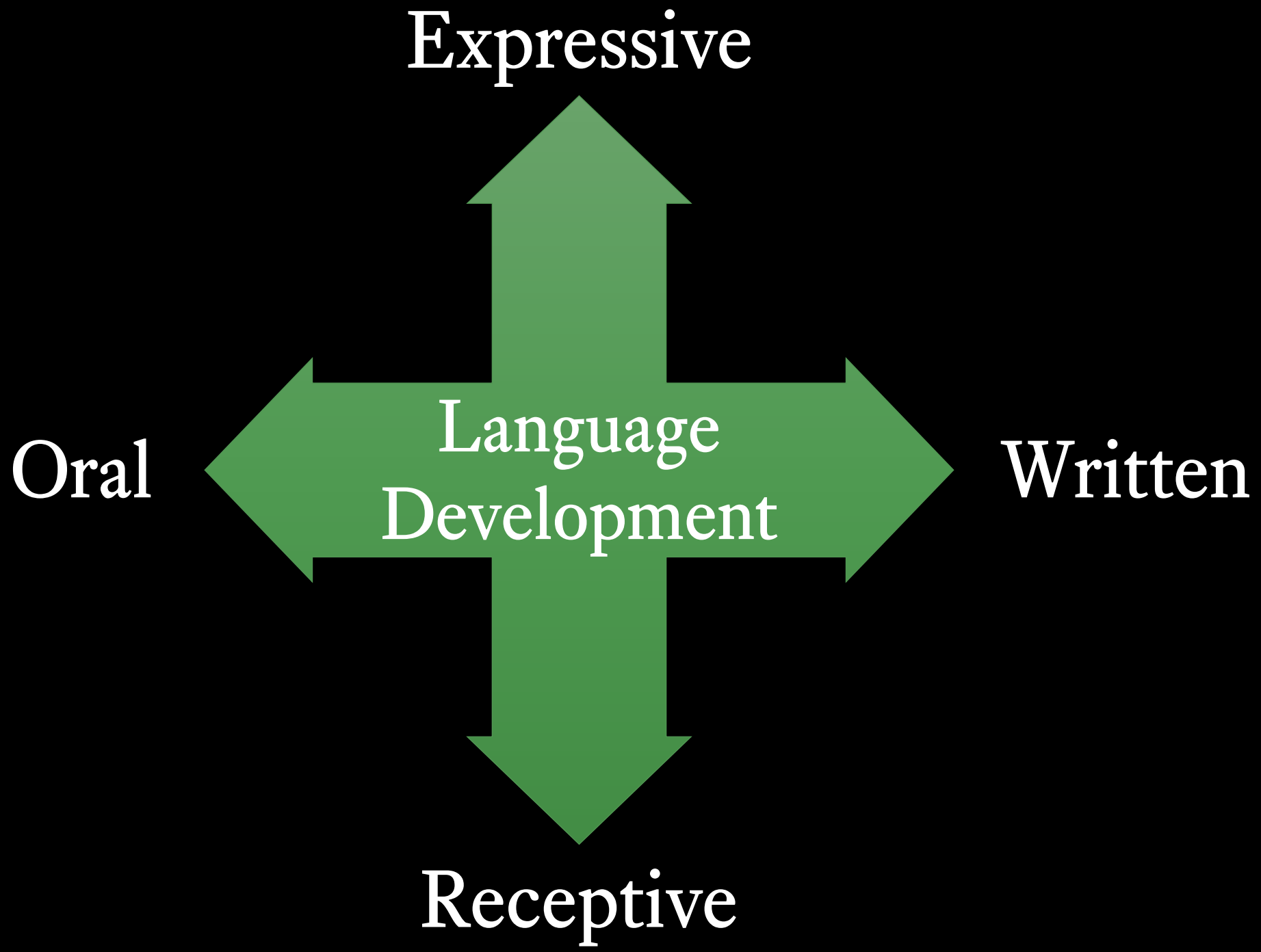
Use of language to acquire and use culturally-valued knowledge



Gf = Outer living layer



Gc = Accumulated skeletal remains


Expressive
Oral
Language Development
Written
Receptive

Language Development

Comprehension and Communication Skills Via Language

Crystallized Intelligence in the Classroom & on the Job

Tests of Crystallized Intelligence

Vocabulary

Comprehension

Wechsler Tests

Information

Similarities

Lexical Knowledge

General Knowledge

General Gc/Mixed Measure

Word Definitions

Verbal Comprehension

Verbal Knowledge

DAS-II

Verbal Similarities

Oral Vocabulary

Humanities, Social Science, Science

KABC-II

Riddles

Woodcock-Johnson IV

Picture Vocabulary

General Information

Tests of Crystallized Intelligence

General Gc/Mixed Measure

Similarities

Riddles

Verbal Comprehension

Verbal Similarities

Lexical Knowledge

General Information

General Knowledge

Word Definitions

Verbal Knowledge

Comprehension

Humanities, Social Science, Science

Picture Vocabulary

Vocabulary

Information

Oral Vocabulary

Holland's Structure of Career Interests: RIASEC

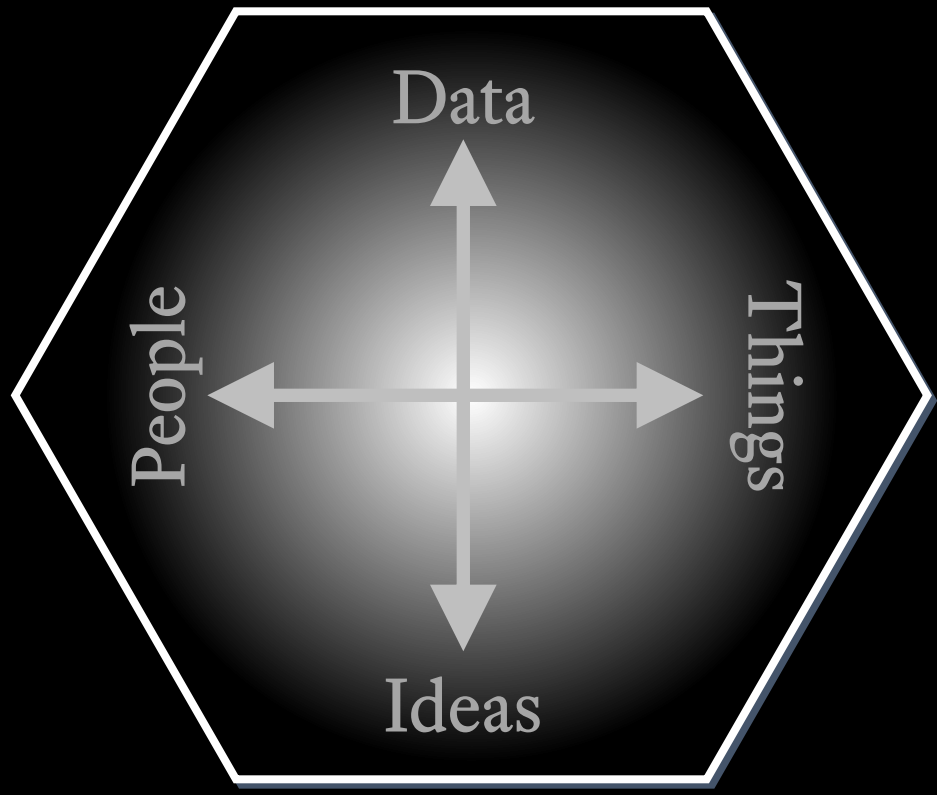
Definitions from https://www.hollandcodes.com

Personality: Persuasive, Energetic, Sociable, Adventurous, Ambitious, and Risk-taking.
Likes: leading, managing, and organizing.

Enterprising

Personality: Careful, Conforming, Conservative, Conscientious, Self-controlled, and Structured.
Likes: ordering activities paying attention to details.

Conventional



Social

Personality: helping, informing, teaching, inspiring, counseling, and serving.
Likes: interacting with people and concerned with the welfare of people.

Realistic

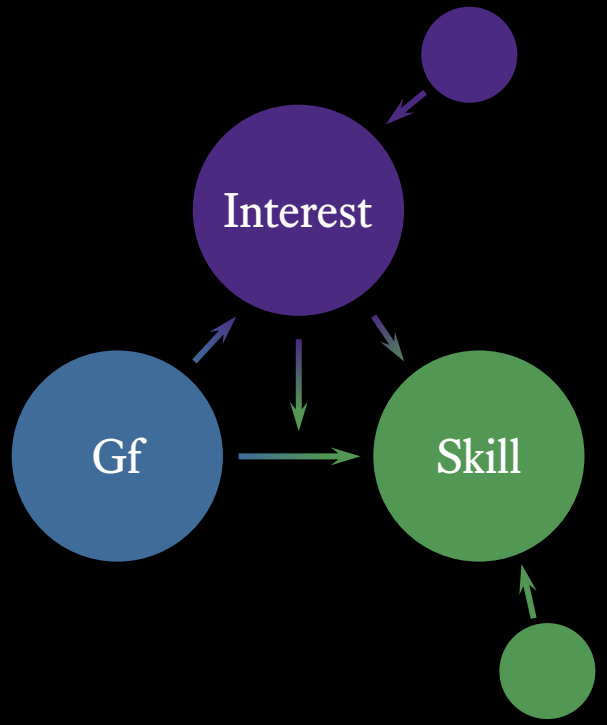
Personality: frank, practical, focused, mechanical, determined, or rugged
Likes: manipulating tools, doing mechanical or manual tasks, or doing athletic activities

Artistic

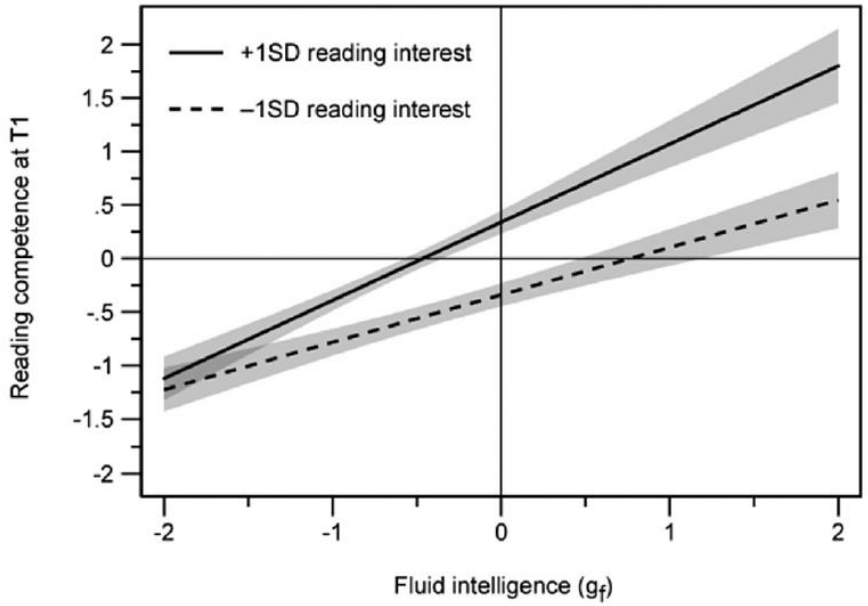
Personality: complicated, original, impulsive, independent, expressive, and creative
Likes: using imagination and feelings in creative expression

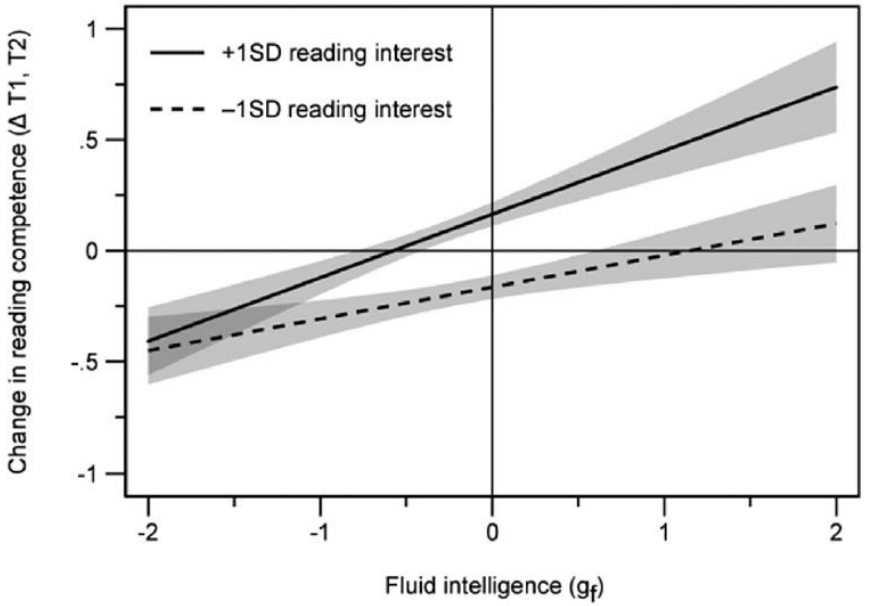
Investigative

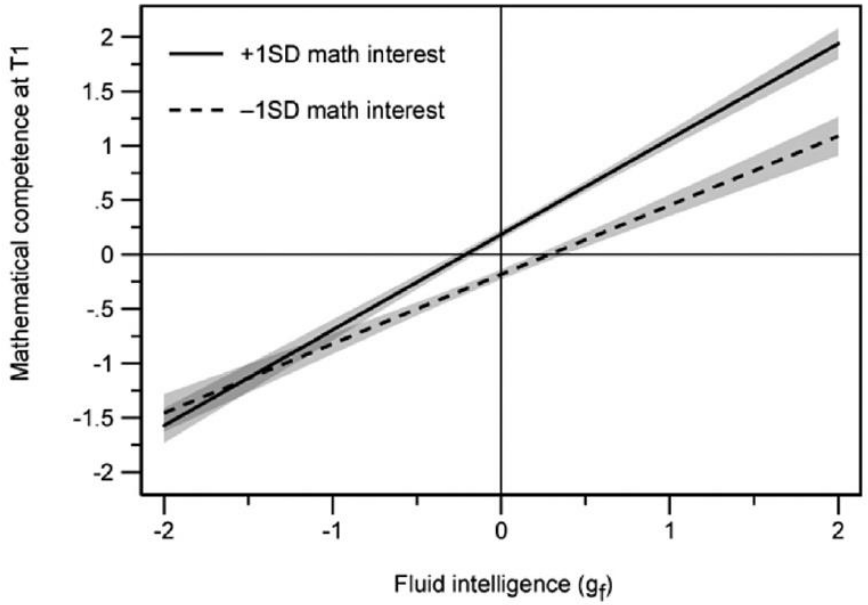
Personality: analytical, intellectual, reserved, independent, and scholarly.
Likes: working with abstract ideas and intellectual problems.

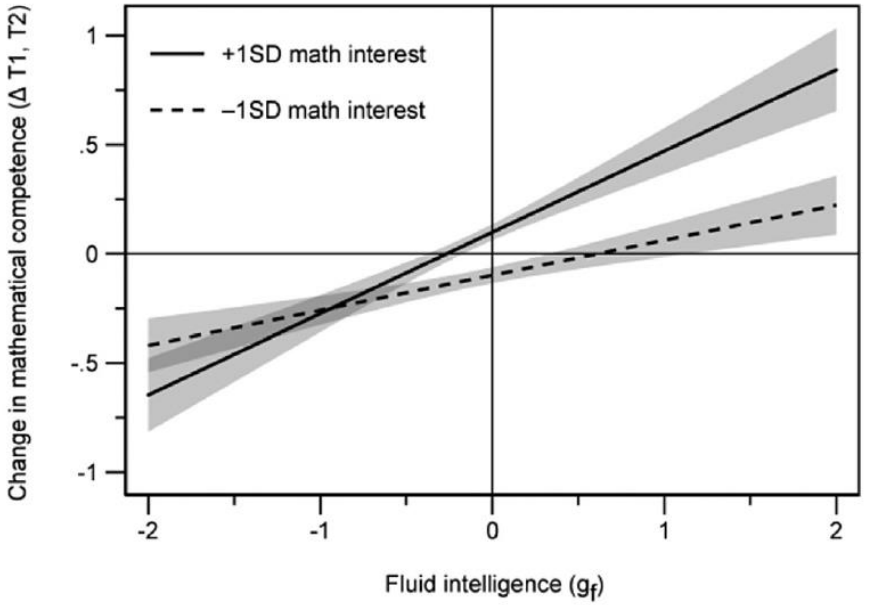


Lechner, C. M., Miyamoto, A., & Knopf, T. (2019). Should students be smart, curious, or both? Fluid intelligence, openness, and interest co-shape the acquisition of reading and math competence. *Intelligence*, *76*, 101378. https://doi.org/10.1016/j.intell.2019.101378



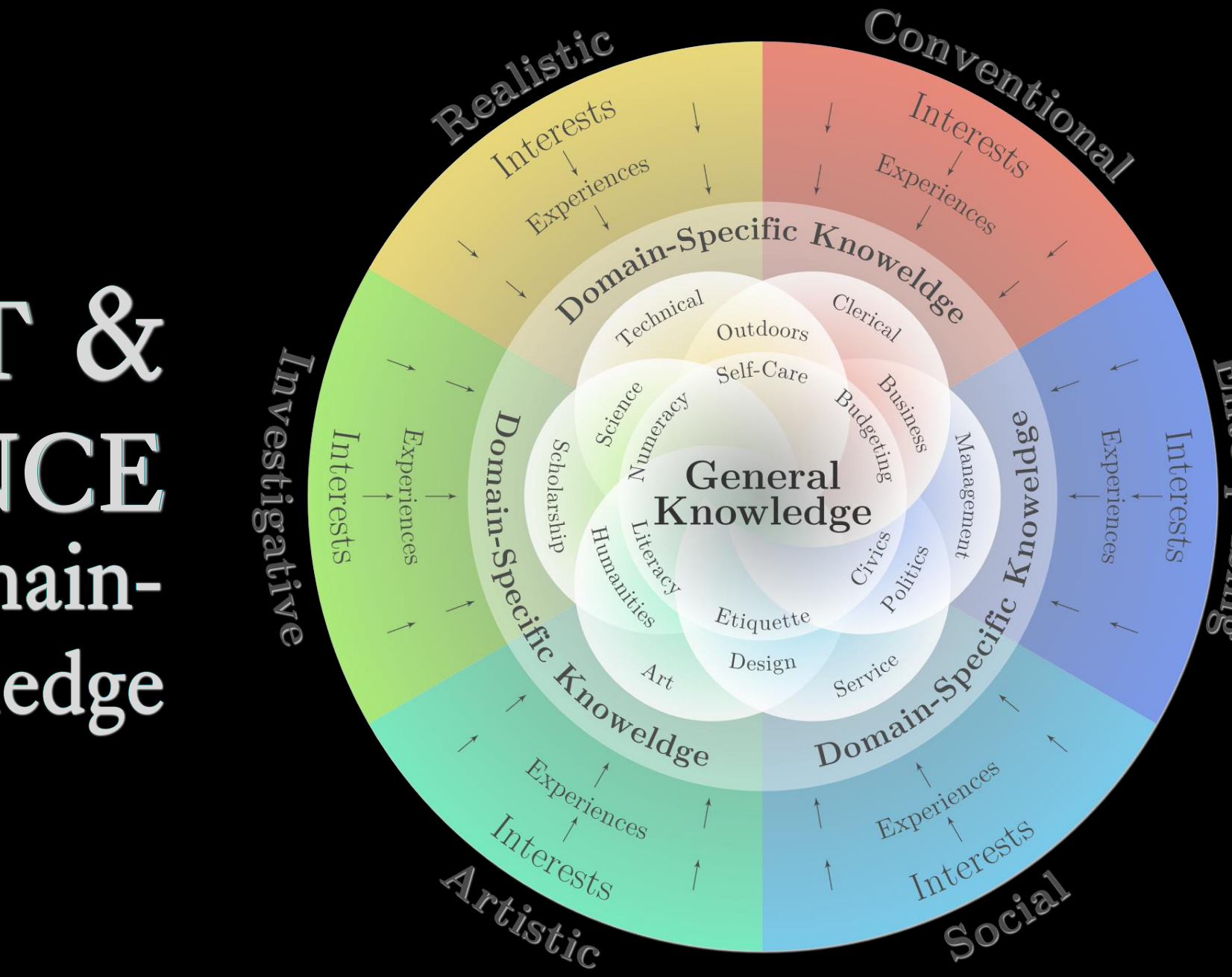


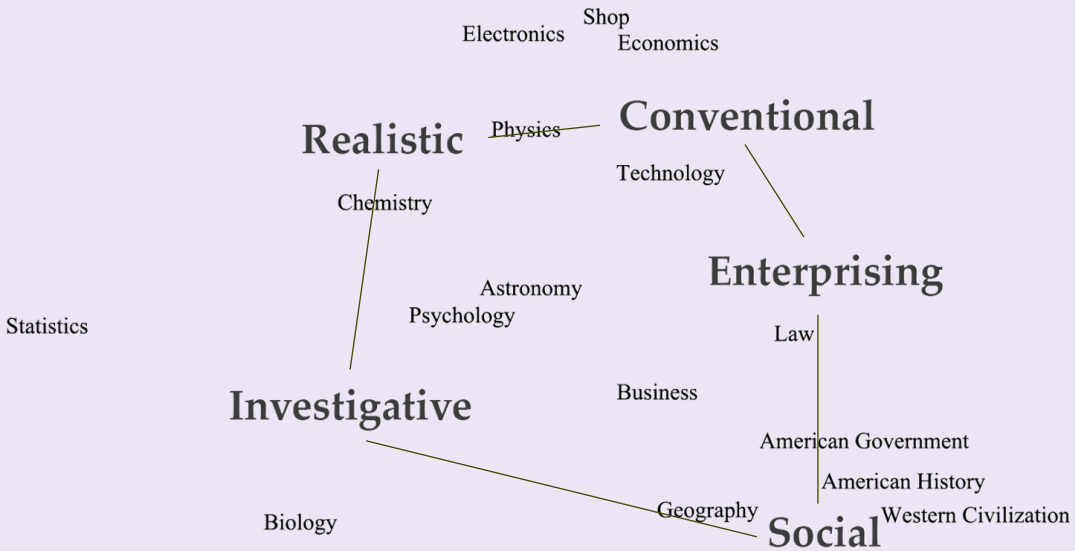




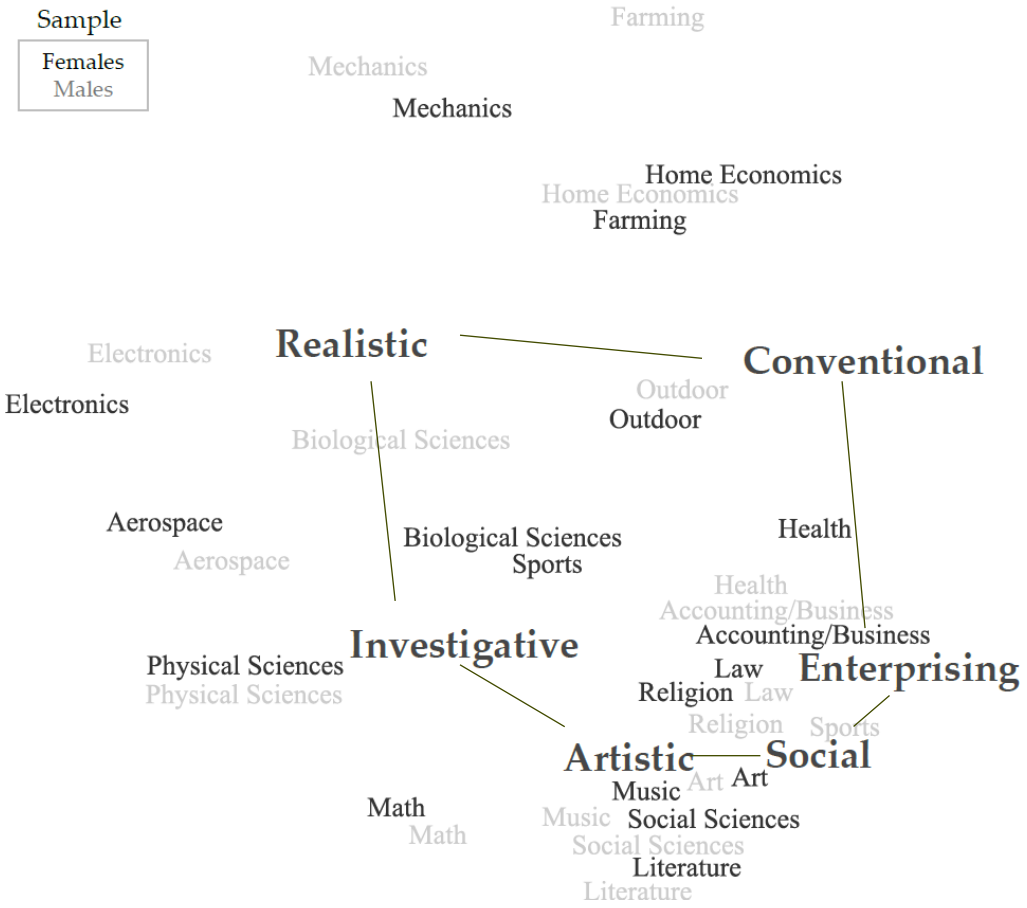
Interest & Experience

Influence Domain-Specific Knowledge



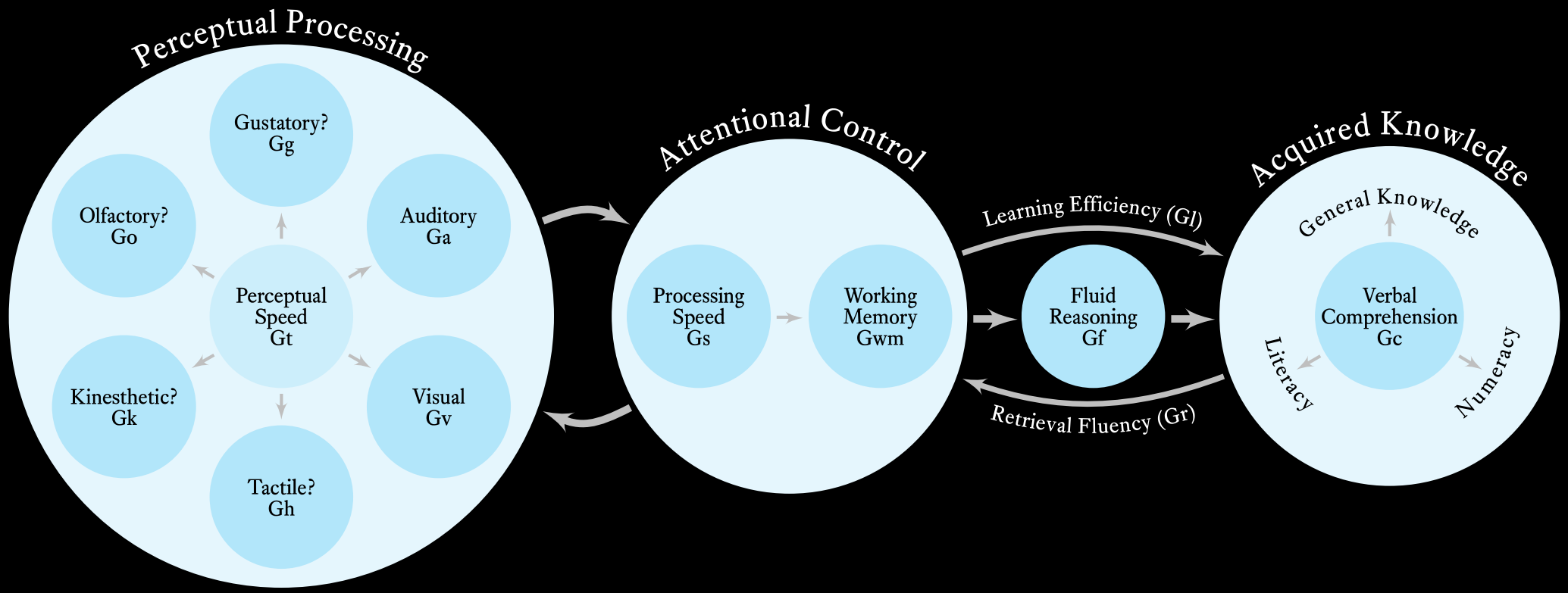


Rolfhus, E. L., & Ackerman, P. L. (1999). Assessing individual differences in knowledge: Knowledge, intelligence, and related traits. Journal of Educational Psychology, 91(3), 511.



Reeve, C. L. (2004). Differential ability antecedents of general and specific dimensions of declarative knowledge: More than g. *Intelligence*, *32*(6), 621–652.

Intelligence Is Dynamic.



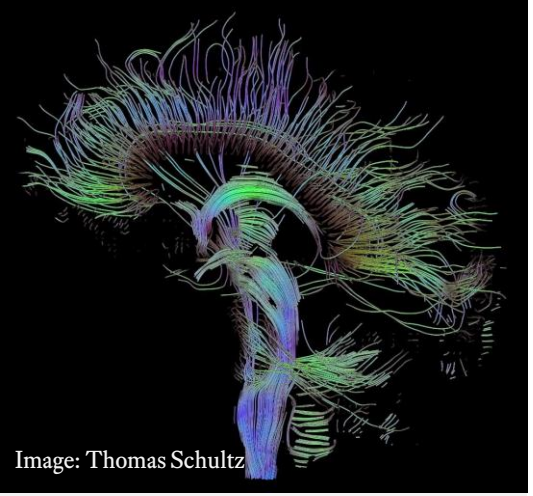


Image: Thomas Schultz

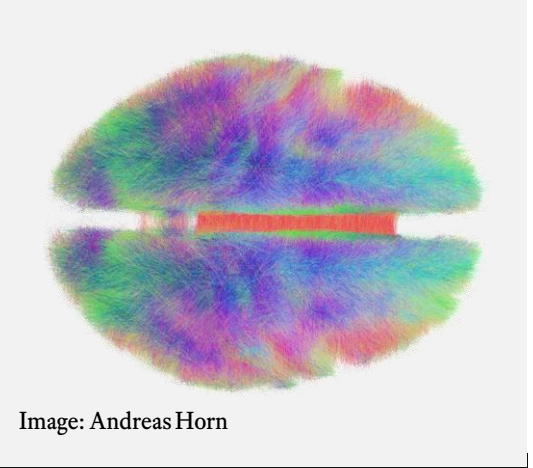


Image: Andreas Horn

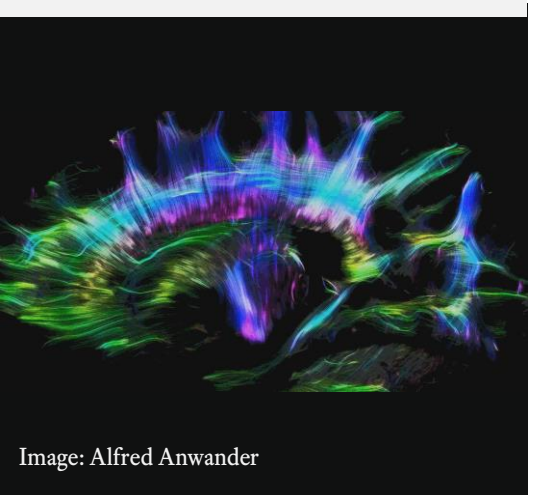


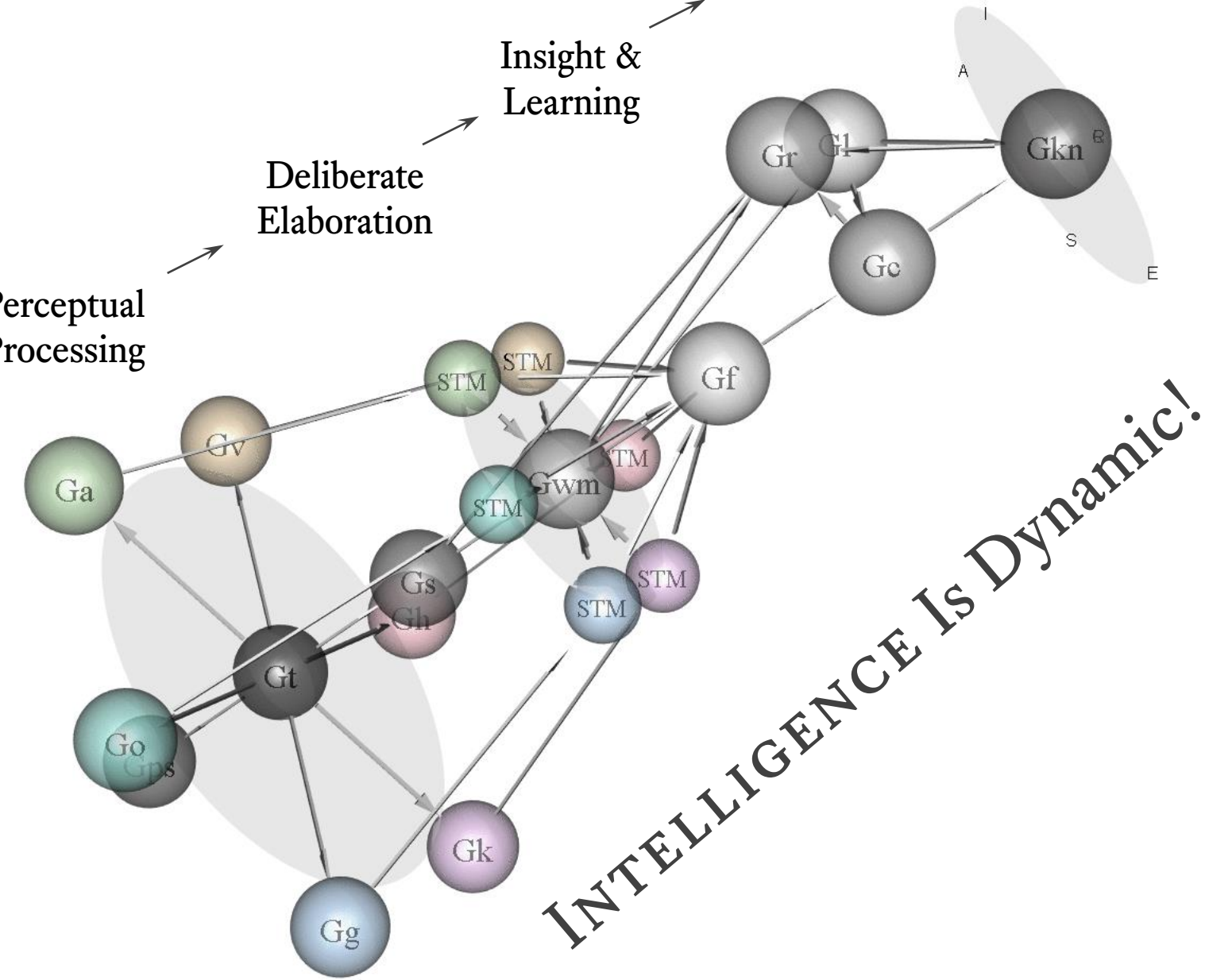
Image: Alfred Anwander

Perceptual Processing

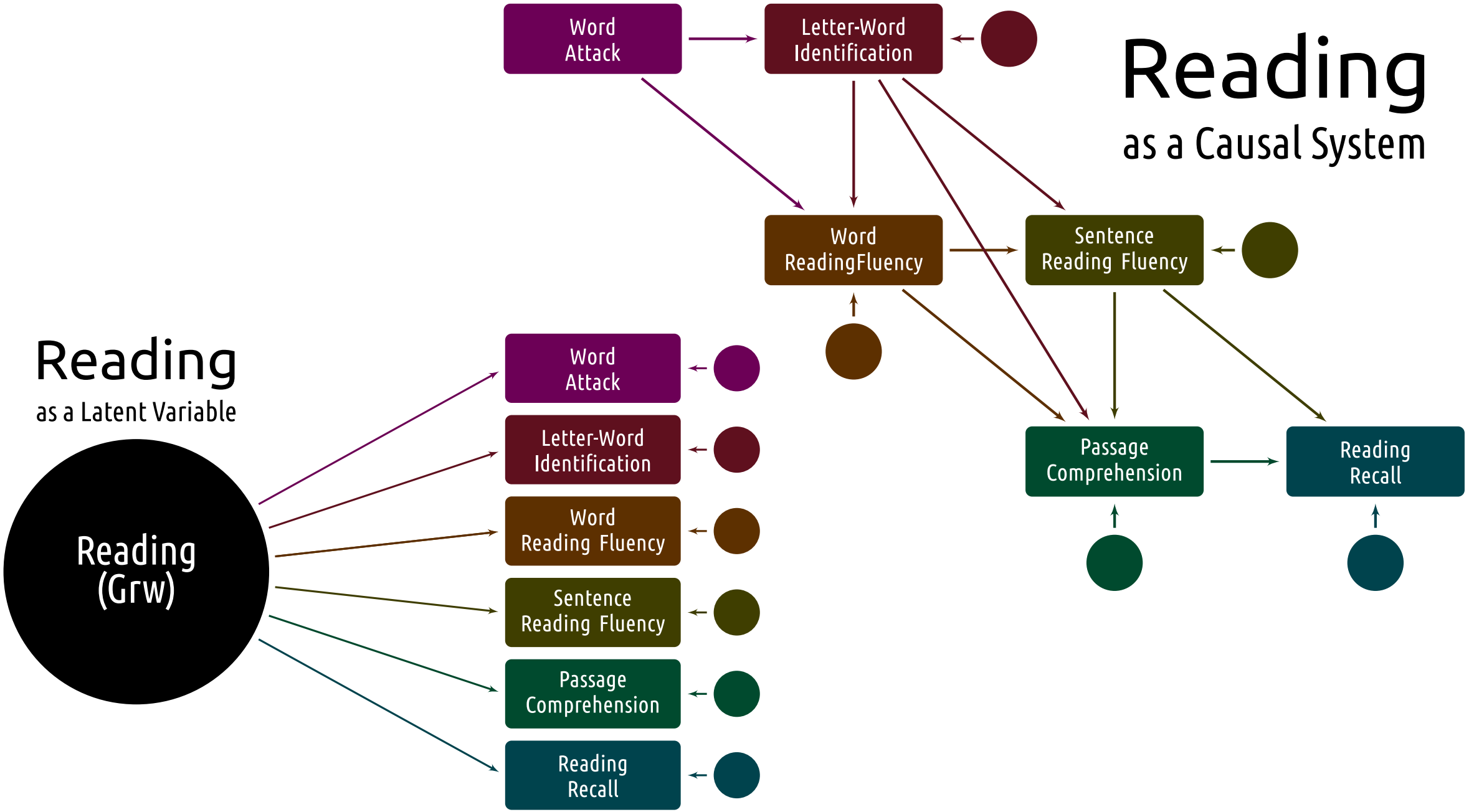
Deliberate Elaboration

Insight & Learning

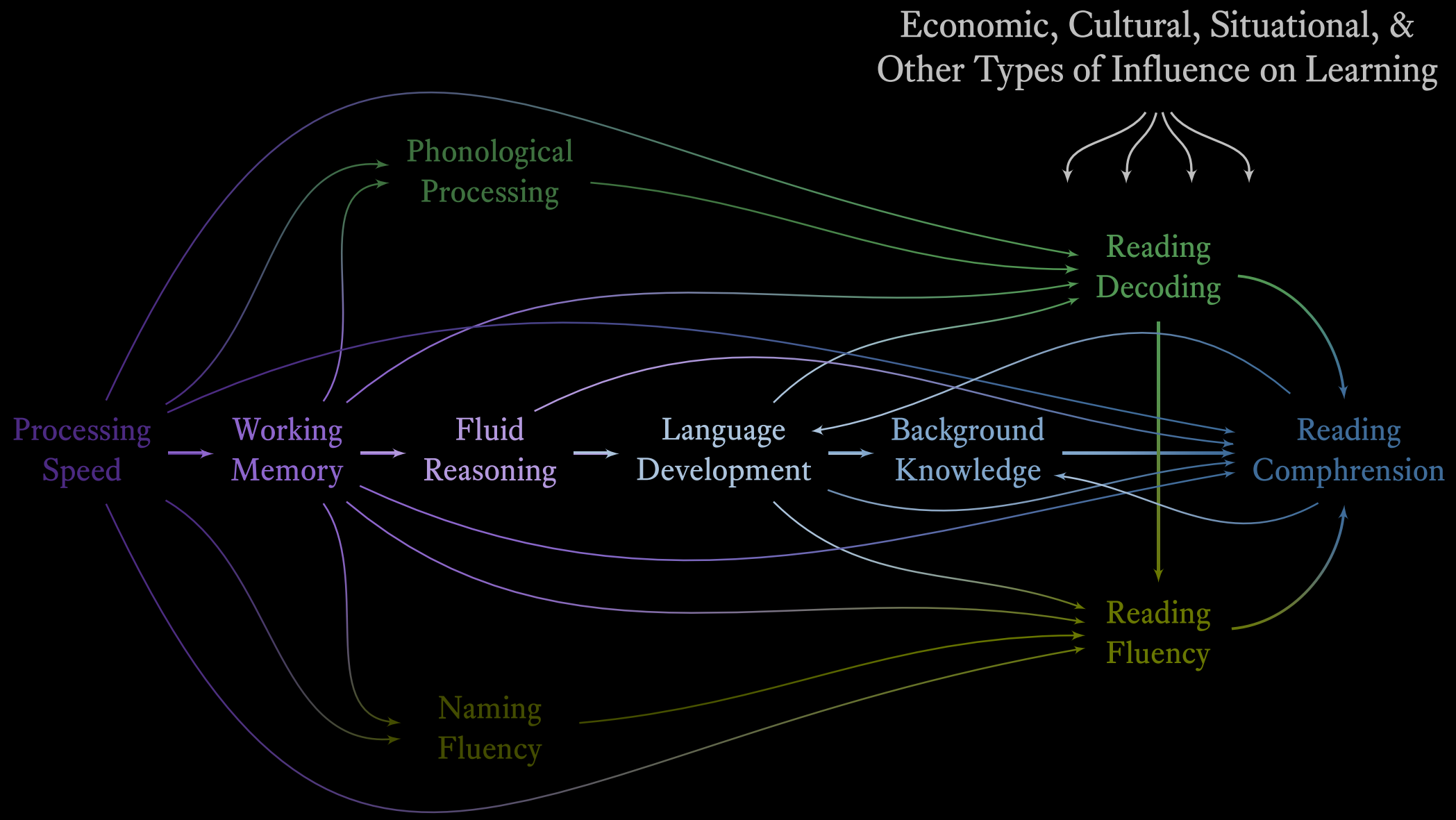
Stored Knowledge



INTELLIGENCE IS DYNAMIC!


Reading
as a Causal System
Word Attack
Letter-Word Identification
Word ReadingFluency
Sentence Reading Fluency
Passage Comprehension
Reading Recall
Reading
as a Latent Variable
Reading (Grw)
Word Attack
Letter-Word Identification
Word Reading Fluency
Sentence Reading Fluency
Passage Comprehension
Reading Recall

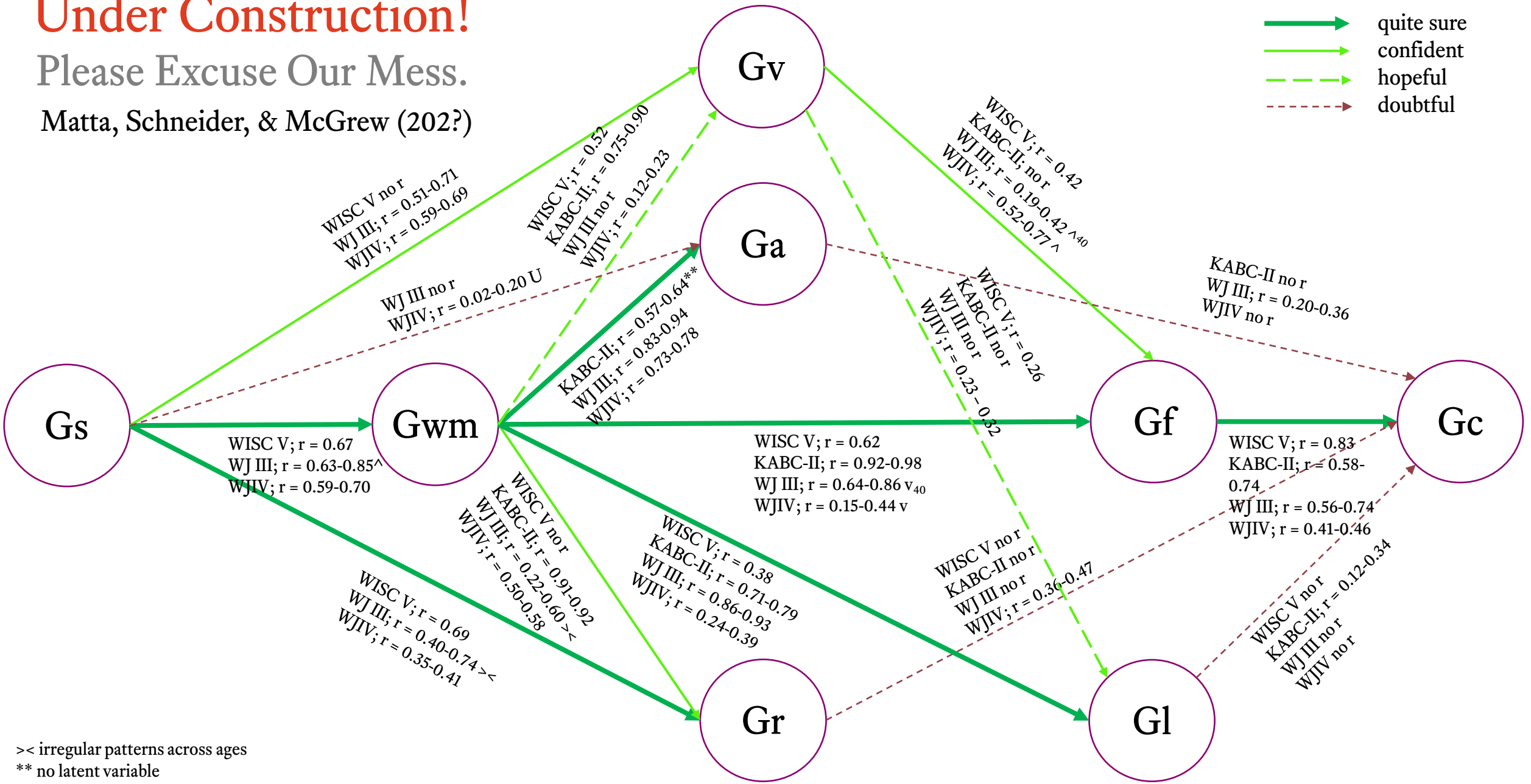
A Simplified Model of Reading Ability



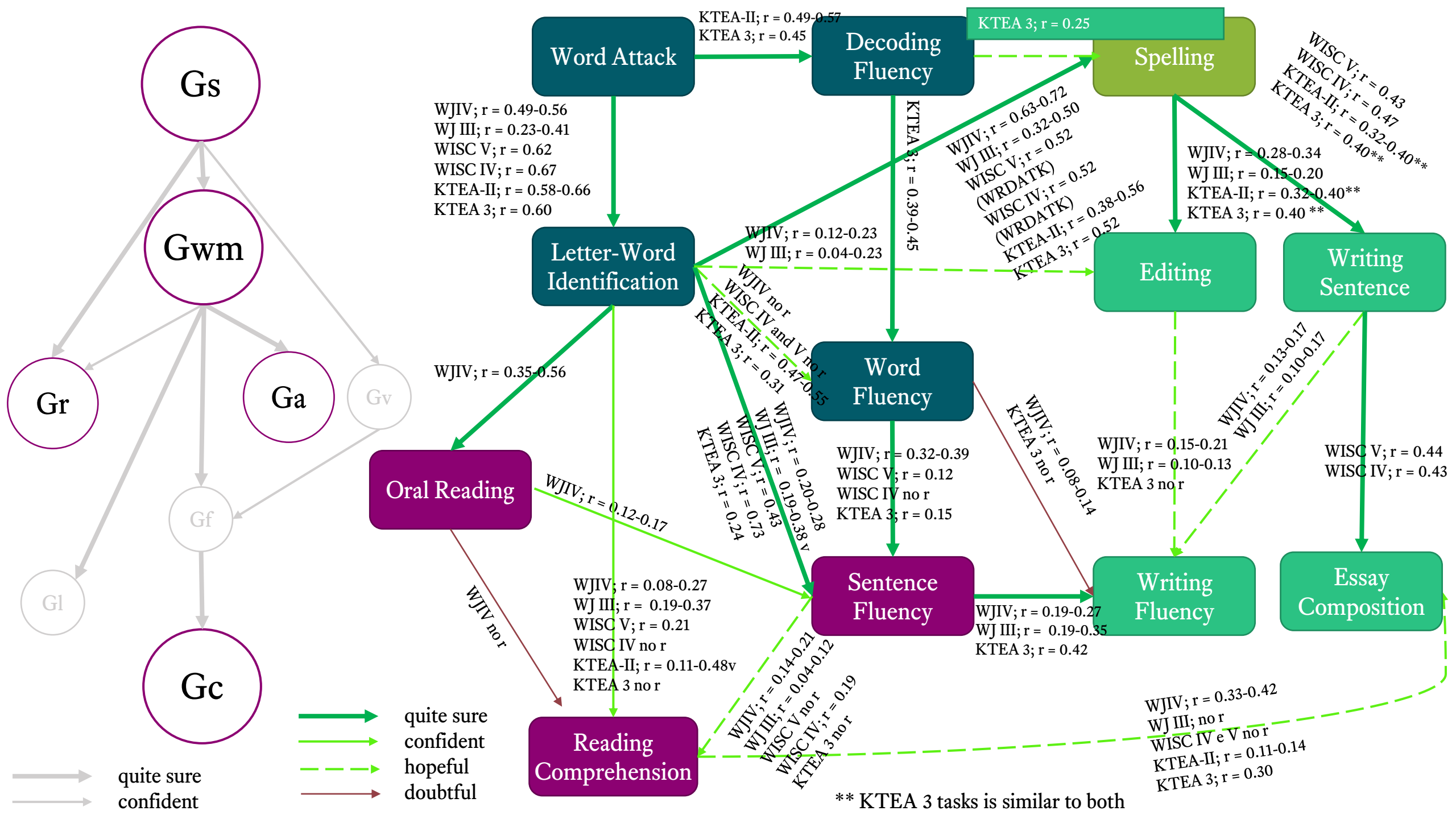
Under Construction!

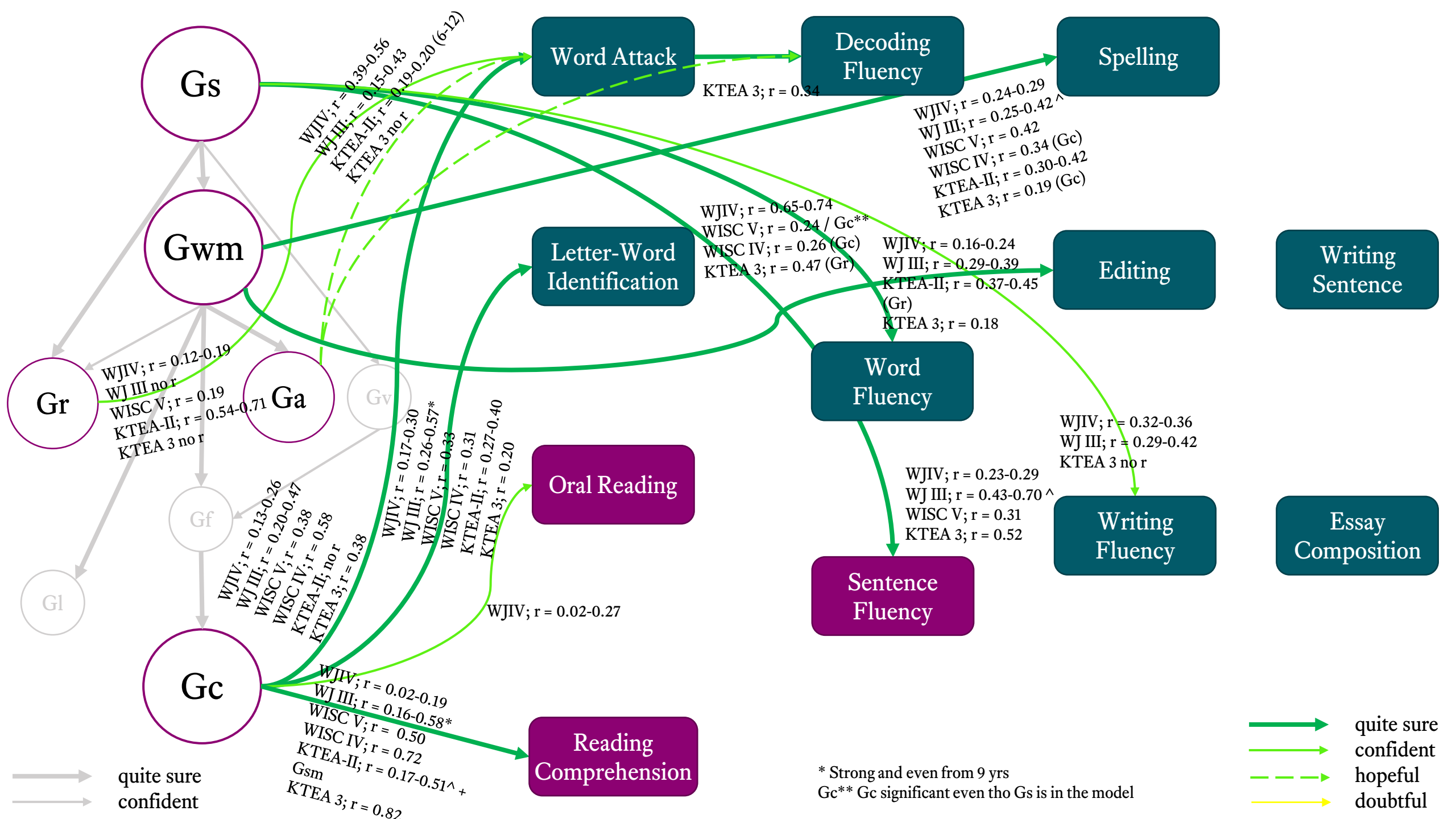
Please Excuse Our Mess.

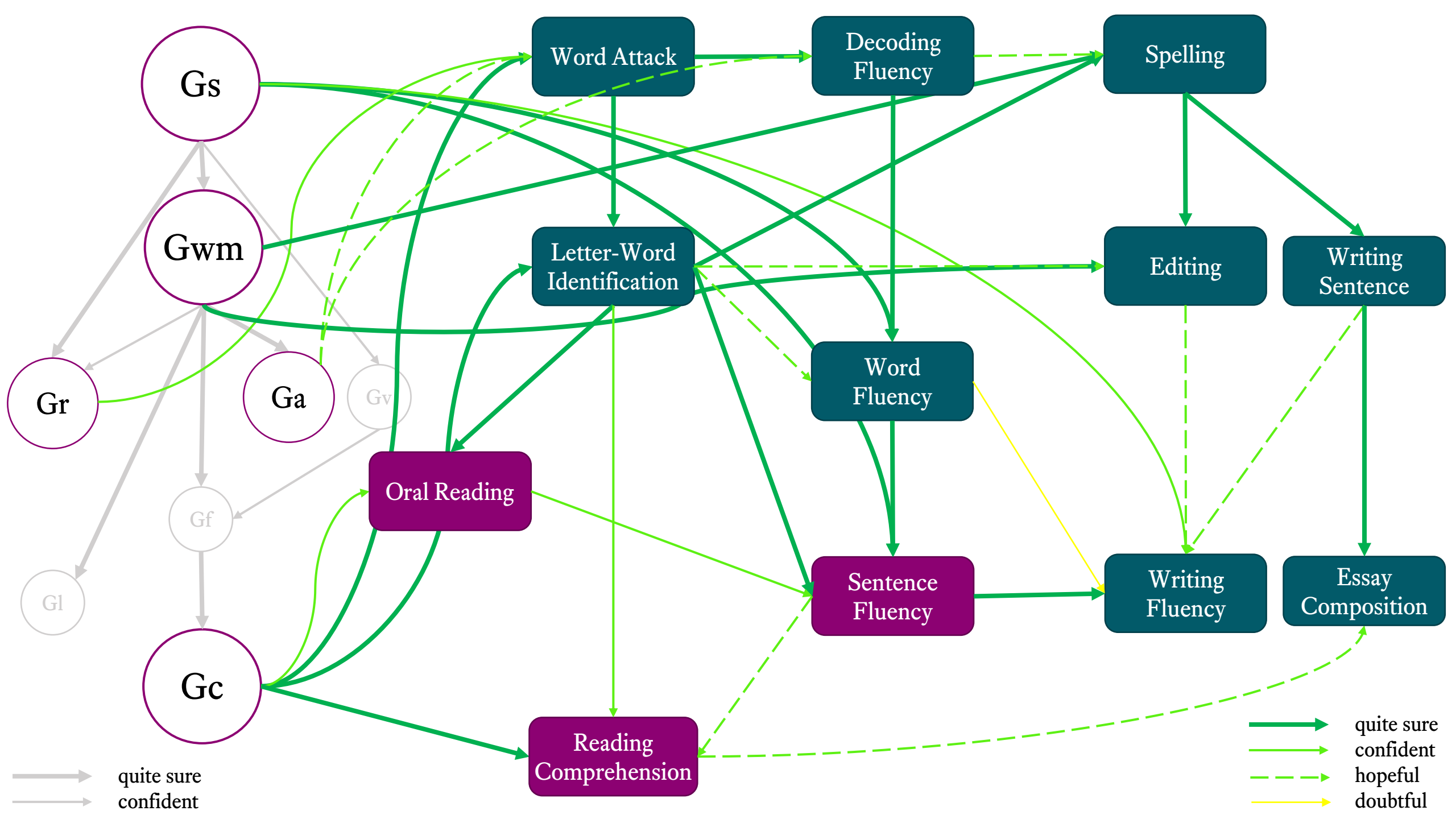
Matta, Schneider, & McGrew (202?)

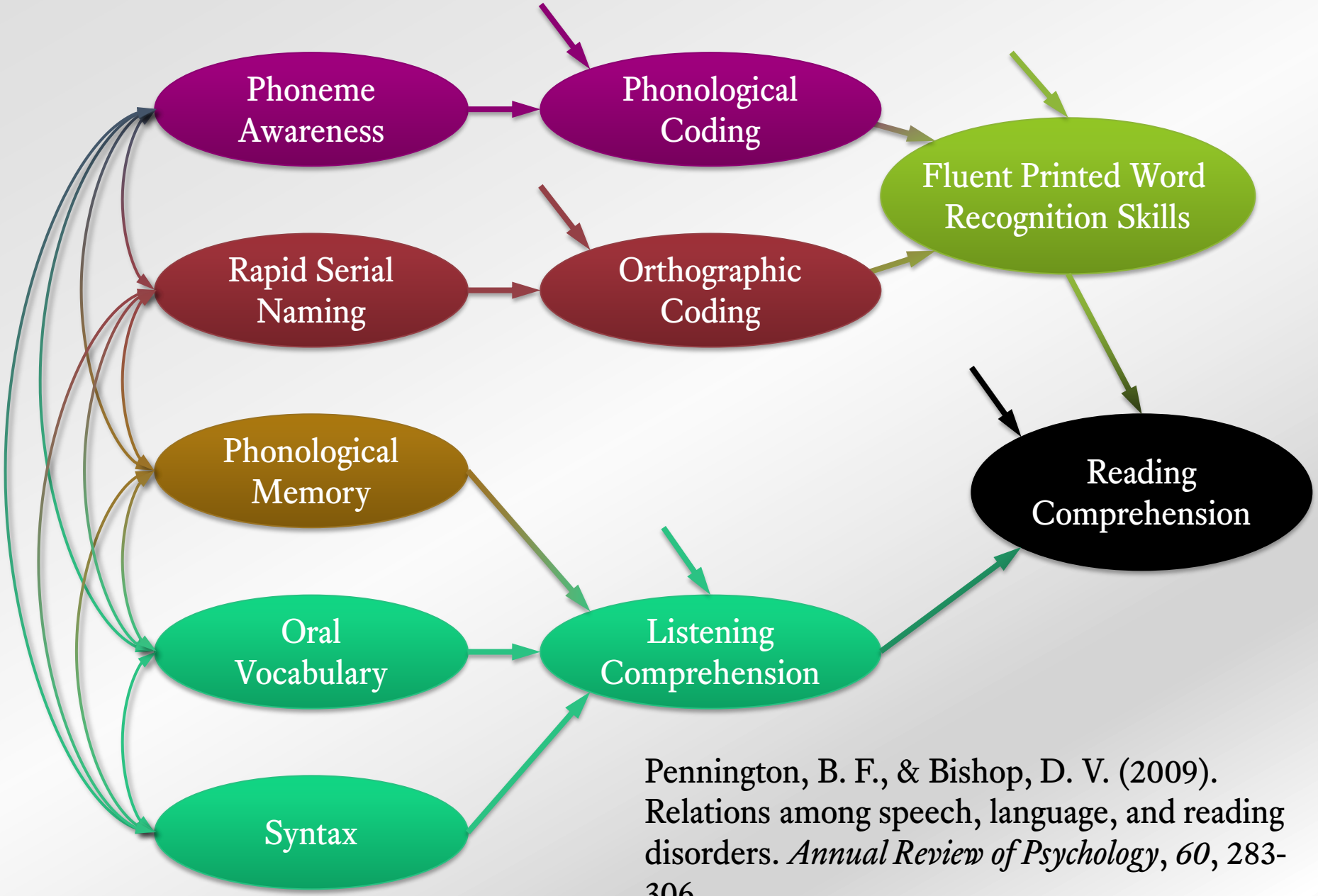


>< irregular patterns across ages
** no latent variable
v or ^ lower or higher across ages
v40 similar by 40 yrs and then lower


Gs
Gwm
Gr
Ga
Gv
Gf
Gl
Gc
quite sure
confident
quite sure
confident
hopeful
doubtful
Word Attack
Decoding Fluency
Spelling
Letter-Word Identification
Editing
Writing Sentence
Word Fluency
Oral Reading
Sentence Fluency
Writing Fluency
Essay Composition
Reading Comprehension
KTEA-II; r = 0.49-0.57
KTEA 3; r = 0.45
KTEA 3; r = 0.25
WJIV; r = 0.49-0.56
WJ III; r = 0.23-0.41
WISC V; r = 0.62
WISC IV; r = 0.67
KTEA-II; r = 0.58-0.66
KTEA 3; r = 0.60
KTEA 3; r = 0.39-0.45
WJIV; r = 0.63-0.72
WJ III; r = 0.32-0.50
WISC V; r = 0.52
(WRDATK)
WISC IV; r = 0.52
(WRDATK)
KTEA-II; r = 0.38-0.56
KTEA 3; r = 0.52
WISC V; r = 0.43
WISC IV; r = 0.47
KTEA-II; r = 0.32-0.40**
KTEA 3; r = 0.40**
WJIV; r = 0.28-0.34
WJ III; r = 0.15-0.20
KTEA-II; r = 0.32-0.40**
KTEA 3; r = 0.40 **
WJIV; r = 0.12-0.23
WJ III; r = 0.04-0.23
WJIV no r
WISC IV and V no r
KTEA-II; r = 0.47-0.55
KTEA 3; r = 0.31
WJIV; r = 0.35-0.56
WJIV; r = 0.32-0.39
WISC V; r = 0.12
WISC IV no r
KTEA 3; r = 0.15
WJIV; r = 0.08-0.14
KTEA 3 no r
WJIV; r = 0.15-0.21
WJ III; r = 0.10-0.13
KTEA 3 no r
WJIV; r = 0.13-0.17
WJ III; r = 0.10-0.17
WISC V; r = 0.44
WISC IV; r = 0.43
WJIV; r = 0.12-0.17
WJIV; r = 0.20-0.28
WJ III; r = 0.19-0.38 v
WISC V; r = 0.43
WISC IV; r = 0.73
KTEA 3; r = 0.24
WJIV no r
WJIV; r = 0.08-0.27
WJ III; r = 0.19-0.37
WISC V; r = 0.21
WISC IV no r
KTEA-II; r = 0.11-0.48v
KTEA 3 no r
WJIV; r = 0.19-0.27
WJ III; r = 0.19-0.35
KTEA 3; r = 0.42
WJIV; r = 0.14-0.21
WJ III; r = 0.04-0.12
WISC V no r
WISC IV; r = 0.19
KTEA 3 no r
WJIV; r = 0.33-0.42
WJ III; no r
WISC IV e V no r
KTEA-II; r = 0.11-0.14
KTEA 3; r = 0.30
** KTEA 3 tasks is similar to both

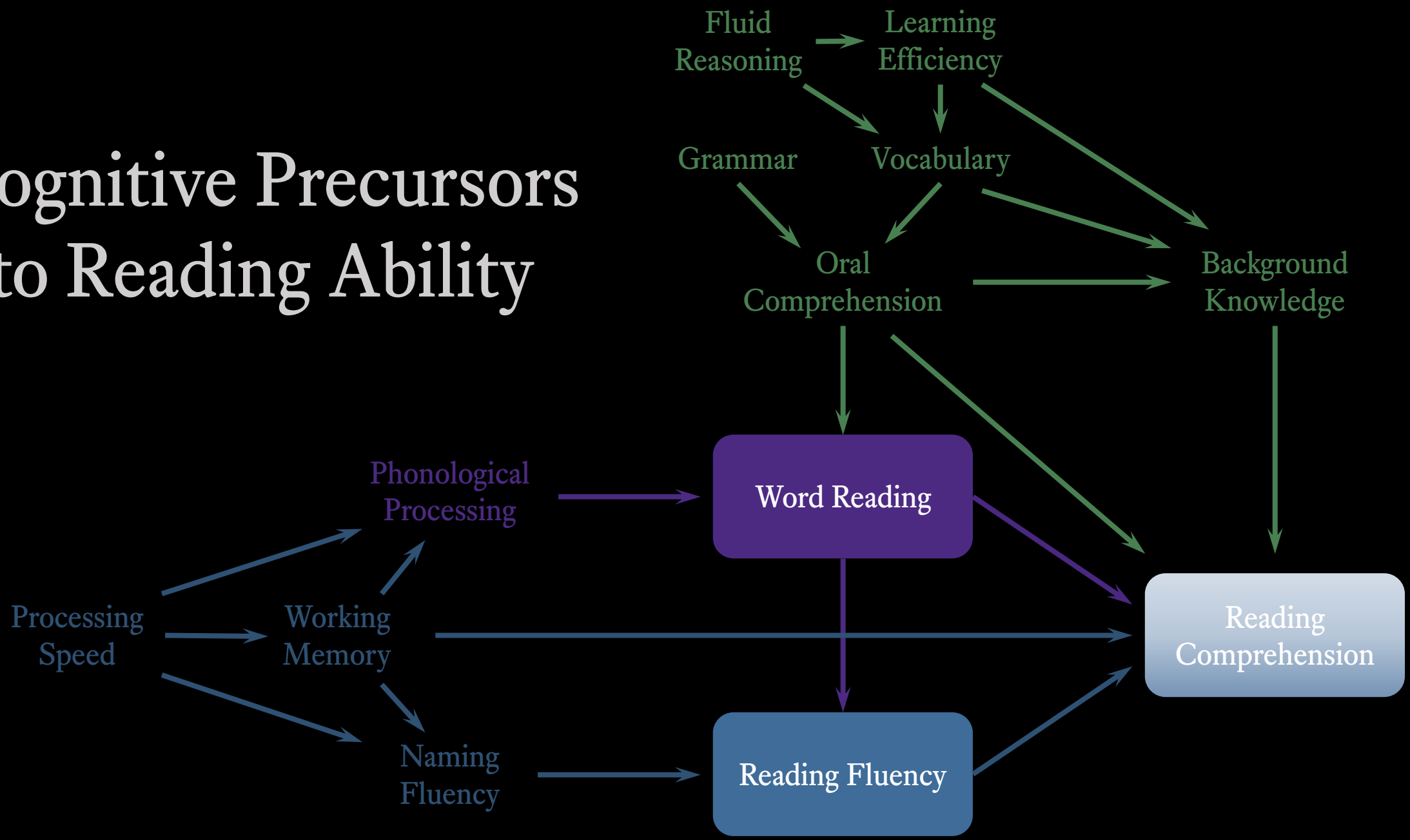

Gs
Gwm
Gr
Ga
Gv
Gf
Gl
Gc
Word Attack
Decoding Fluency
Spelling
Letter-Word Identification
Editing
Writing Sentence
Word Fluency
Oral Reading
Writing Fluency
Essay Composition
Sentence Fluency
Reading Comprehension
WJIV; r = 0.39-0.56
WJ III; r = 0.15-0.43
KTEA-II; r = 0.19-0.20 (6-12)
KTEA 3 no r
KTEA 3; r = 0.34
WJIV; r = 0.24-0.29
WJ III; r = 0.25-0.42 ^
WISC V; r = 0.42
WISC IV; r = 0.34 (Gc)
KTEA-II; r = 0.30-0.42
KTEA 3; r = 0.19 (Gc)
WJIV; r = 0.65-0.74
WISC V; r = 0.24 / Gc**
WISC IV; r = 0.26 (Gc)
KTEA 3; r = 0.47 (Gr)
WJIV; r = 0.16-0.24
WJ III; r = 0.29-0.39
KTEA-II; r = 0.37-0.45 (Gr)
KTEA 3; r = 0.18
WJIV; r = 0.12-0.19
WJ III no r
WISC V; r = 0.19
KTEA-II; r = 0.54-0.71
KTEA 3 no r
WJIV; r = 0.13-0.26
WJ III; r = 0.20-0.47
WISC V; r = 0.38
WISC IV; r = 0.58
KTEA-II; no r
KTEA 3; r = 0.38
WJIV; r = 0.17-0.30
WJ III; r = 0.26-0.57*
WISC V; r = 0.33
WISC IV; r = 0.31
KTEA-II; r = 0.27-0.40
KTEA 3; r = 0.20
WJIV; r = 0.02-0.27
WJIV; r = 0.32-0.36
WJ III; r = 0.29-0.42
KTEA 3 no r
WJIV; r = 0.23-0.29
WJ III; r = 0.43-0.70 ^
WISC V; r = 0.31
KTEA 3; r = 0.52
WJIV; r = 0.02-0.19
WJ III; r = 0.16-0.58*
WISC V; r = 0.50
WISC IV; r = 0.72
KTEA-II; r = 0.17-0.51^ +
Gsm
KTEA 3; r = 0.82
quite sure
confident
quite sure
confident
hopeful
doubtful
* Strong and even from 9 yrs
Gc** Gc significant even tho Gs is in the model

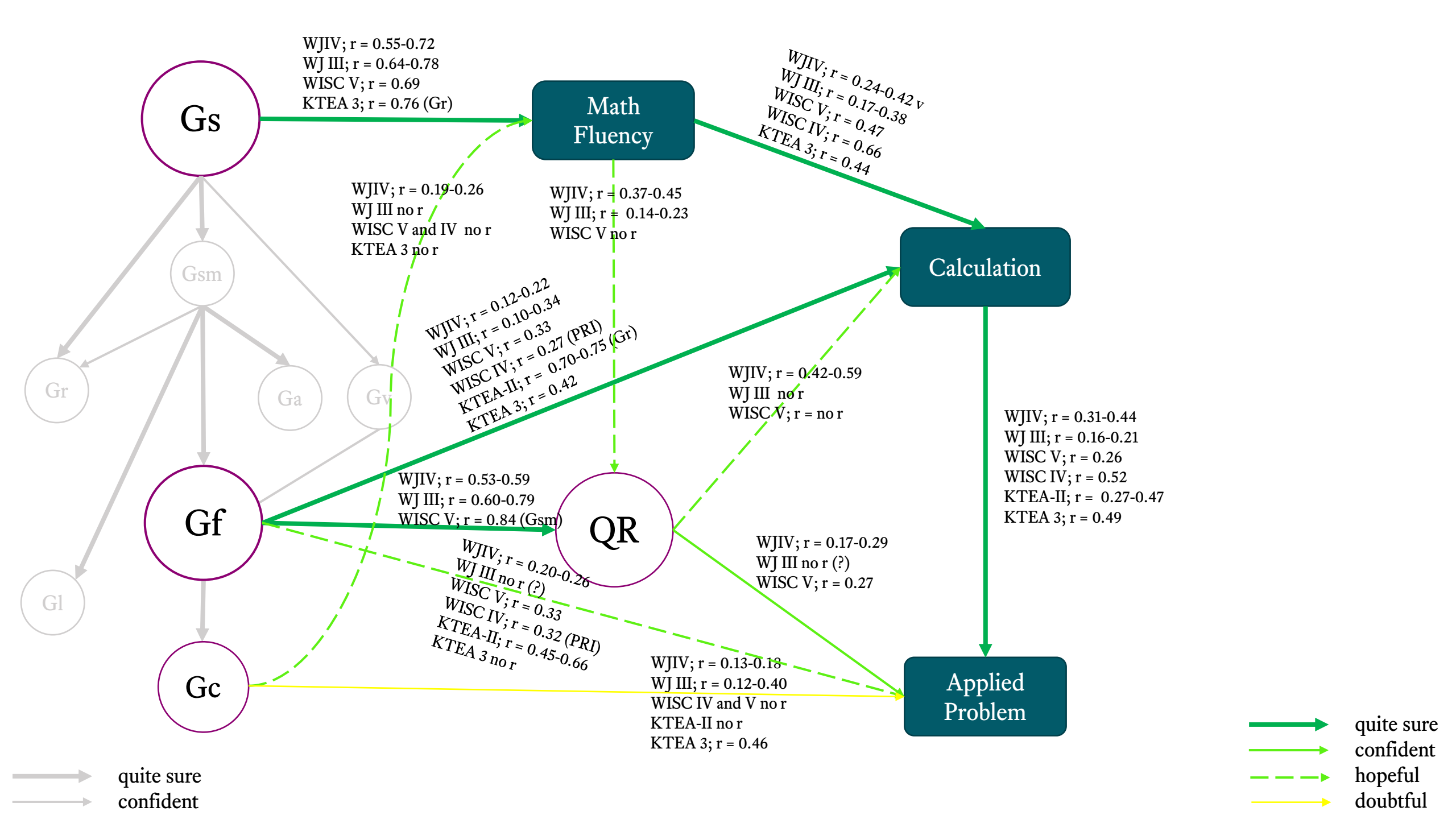

Gs
Gwm
Gr
Ga
Gv
Gf
Gl
Gc
Word Attack
Decoding Fluency
Spelling
Letter-Word Identification
Editing
Writing Sentence
Word Fluency
Oral Reading
Sentence Fluency
Writing Fluency
Essay Composition
Reading Comprehension
quite sure
confident
quite sure
confident
hopeful
doubtful



Pennington, B. F., & Bishop, D. V. (2009). Relations among speech, language, and reading disorders. *Annual Review of Psychology*, *60*, 283-306.

Cognitive Precursors to Reading Ability



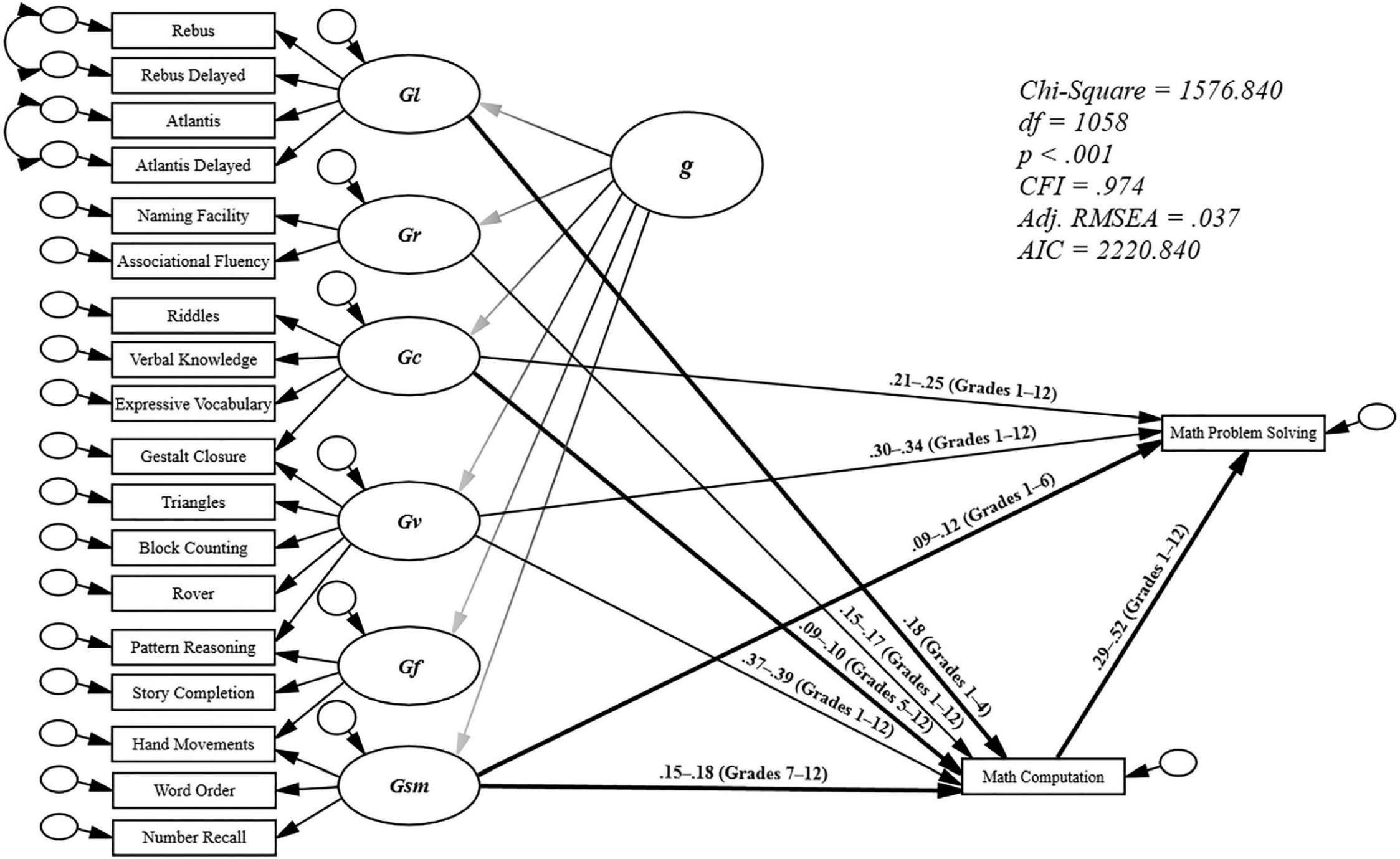

Gs
WJIV; r = 0.55-0.72
WJ III; r = 0.64-0.78
WISC V; r = 0.69
KTEA 3; r = 0.76 (Gr)
Math Fluency
WJIV; r = 0.24-0.42 v
WJ III; r = 0.17-0.38
WISC V; r = 0.47
WISC IV; r = 0.66
KTEA 3; r = 0.44
WJIV; r = 0.19-0.26
WJ III no r
WISC V and IV no r
KTEA 3 no r
WJIV; r = 0.37-0.45
WJ III; r = 0.14-0.23
WISC V no r
Calculation
Gsm
Gr
Ga
Gv
WJIV; r = 0.12-0.22
WJ III; r = 0.10-0.34
WISC V; r = 0.33
WISC IV; r = 0.27 (PRI)
KTEA-II; r = 0.70-0.75 (Gr)
KTEA 3; r = 0.42
WJIV; r = 0.42-0.59
WJ III no r
WISC V; r = no r
WJIV; r = 0.31-0.44
WJ III; r = 0.16-0.21
WISC V; r = 0.26
WISC IV; r = 0.52
KTEA-II; r = 0.27-0.47
KTEA 3; r = 0.49
Gf
WJIV; r = 0.53-0.59
WJ III; r = 0.60-0.79
WISC V; r = 0.84 (Gsm)
QR
WJIV; r = 0.17-0.29
WJ III no r (?)
WISC V; r = 0.27
Gl
WJIV; r = 0.20-0.26
WJ III no r (?)
WISC V; r = 0.33
WISC IV; r = 0.32 (PRI)
KTEA-II; r = 0.45-0.66
KTEA 3 no r
Gc
WJIV; r = 0.13-0.18
WJ III; r = 0.12-0.40
WISC IV and V no r
KTEA-II no r
KTEA 3; r = 0.46
Applied Problem
quite sure
confident
quite sure
confident
hopeful
doubtful

Cognitive ability and math computation developmental relations with math problem solving: An integrated, multigroup approach.

Villeneuve, Ethan F.,Hajovsky, Daniel B.,Mason, Benjamin A.,Lewno, Brittany M.

School Psychology, Vol 34(1), Jan 2019, 96-108

Individual differences in Cattell-Horn-Carroll (CHC) cognitive abilities are related to individual differences in math problem solving. However, it is less clear whether cognitive abilities are associated with math problem solving directly or indirectly via math component skills and whether these relations differ across grade levels. We used multigroup structural equation models to examine direct and indirect CHC-based cognitive ability relations with math problem solving across six grade-level groups using the Kaufman Assessment Battery for Children, Second Edition and the Kaufman Tests of Educational Achievement, Second Edition co-normed standardization sample data (*N* = 2,117). After testing factorial invariance of the cognitive constructs across grade levels, we assessed whether the main findings were similar across higher-order and bifactor models. In the higher-order model, the Crystallized Ability, Visual Processing, and Short-Term Memory constucts had direct and indirect relations with math problem solving, whereas the Learning Efficiency and Retrieval Fluency constructs had only indirect relations with math problem solving via math computation. The integrated cognitive ability and math achievement relations were generally consistent across the CHC models of intelligence. In the higher-order model, the g factor operated indirectly on math computation and math problem solving, whereas in the bifactor model, the first-order *G* factor had direct relations with math computation and math problem solving. In both models, *g/G* was the most consistent and largest cognitive predictor of math skills. Last, the relation of math computation with math problem solving increased as grade level increased. Theoretical implications for math development and considerations for school psychologists are discussed. (PsycINFO Database Record (c) 2019 APA, all rights reserved)


Rebus
Rebus Delayed
Atlantis
Atlantis Delayed
Naming Facility
Associational Fluency
Riddles
Verbal Knowledge
Expressive Vocabulary
Gestalt Closure
Triangles
Block Counting
Rover
Pattern Reasoning
Story Completion
Hand Movements
Word Order
Number Recall
Gl
Gr
Gc
Gv
Gf
Gsm
g
Chi-Square = 1576.840
df = 1058
p < .001
CFI = .974
Adj. RMSEA = .037
AIC = 2220.840
.21–.25 (Grades 1–12)
.30–.34 (Grades 1–12)
.09–.12 (Grades 1–6)
.15–.17 (Grades 1–12)
.09–.10 (Grades 5–12)
.37–.39 (Grades 1–12)
.18 (Grades 1–4)
.29–.52 (Grades 1–12)
.15–.18 (Grades 7–12)
Math Problem Solving
Math Computation

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Cognitive and numerosity predictors of mathematical skills in middle school

Paul T. Cirino [a,*], Tammy D. Tolar [a], Lynn S. Fuchs [b], Emily Huston-Warren [a]

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Numerosity
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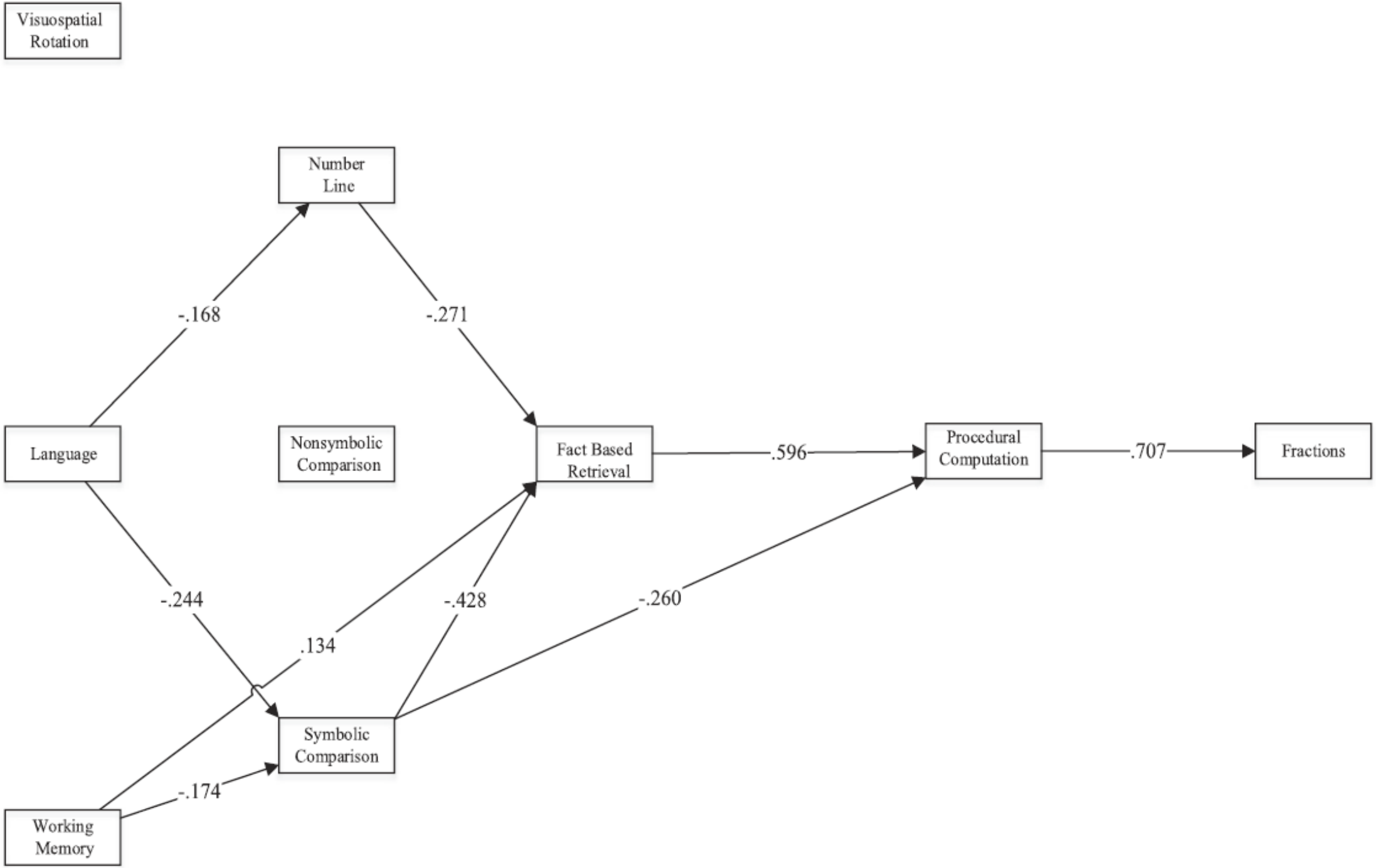
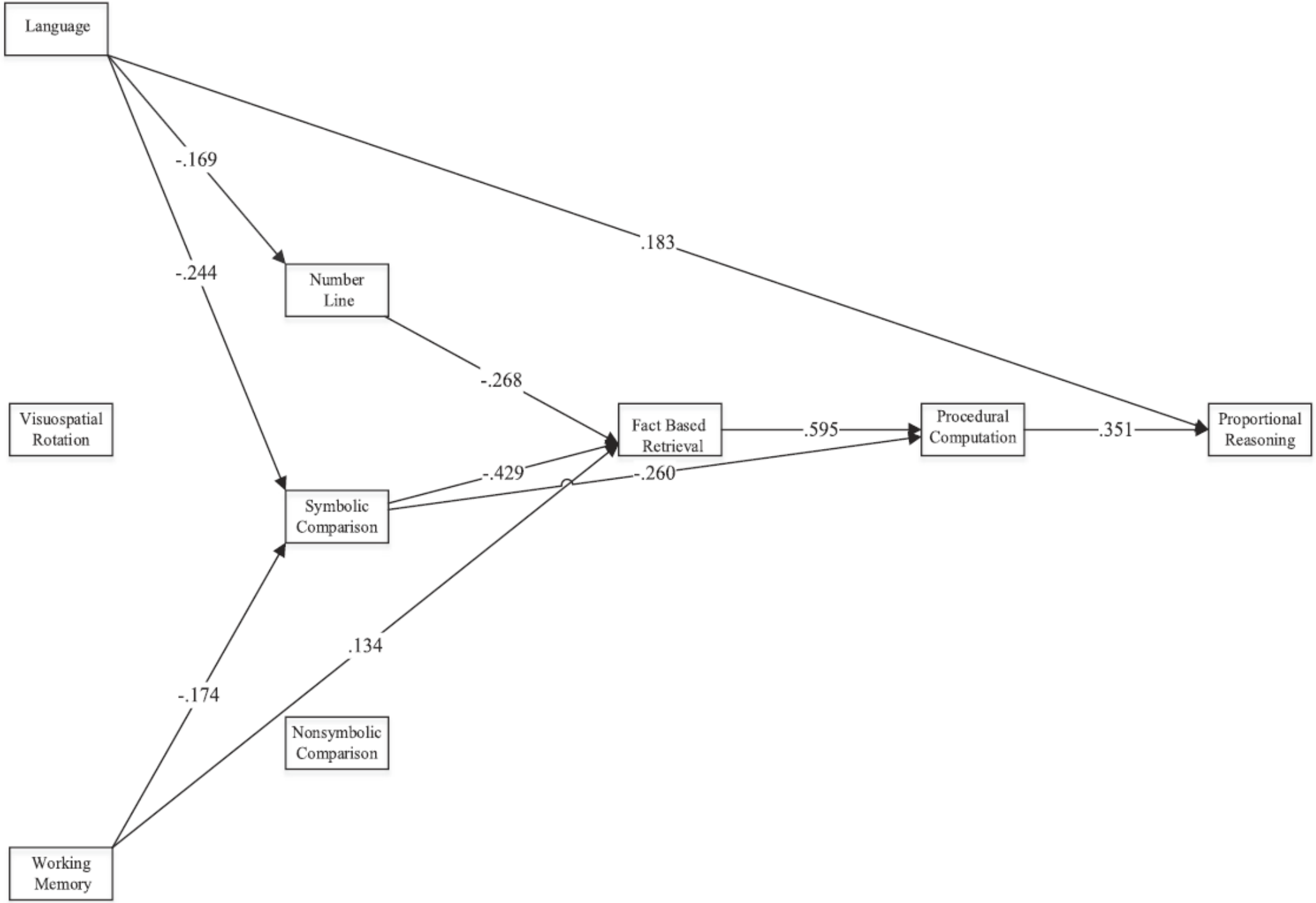
Proportional reasoning
Mathematics
Middle school

ABSTRACT

There is a strong research base on the underlying concomitants of early developing math skills. Fewer studies have focused on later developing skills. Here, we focused on direct and indirect contributions of cognitive measures (e.g., language, spatial skills, working memory) and numerosity measures, as well as arithmetic proficiency, on key outcomes of fraction performance, proportional reasoning, and broad mathematics achievement at sixth grade ($N = 162$) via path analysis. We expected a hierarchy of skill development, with predominantly indirect effects of cognitive factors via number and arithmetic. Results controlling for age showed that the combination of cognitive, number, and arithmetic variables cumulatively accounted for 38% to 44% of the variance in fractions, proportional reasoning, and broad mathematics. There was consistency across outcomes, with more proximal skills providing direct effects and with the effects of cognitive skills being mediated by number and by more proximal skills. Results support a hierarchical progression from domain-general cognitive processes through numerosity and arithmetic skills to proportional reasoning to broad mathematics achievement.


Visuospatial Rotation
Number Line
-.168
-.271
Language
Nonsymbolic Comparison
Fact Based Retrieval
.596
Procedural Computation
.707
Fractions
-.244
.134
-.428
-.260
Symbolic Comparison
-.174
Working Memory


Language
-.169
.183
-.244
Number Line
-.268
Visuospatial Rotation
Fact Based Retrieval
.595
Procedural Computation
.351
Proportional Reasoning
-.429
-.260
Symbolic Comparison
.134
-.174
Nonsymbolic Comparison
Working Memory

File Function Sort Options Statistics Options Help

Case, Sample

	COMPOSITE / Subtest	SS	Composite Variability	P
	Ga~6	62	1.92	
	Ga-Sound Discrimination...	73	1.35	
	Gc/Grw-Language Devel...	98	1.91	
	Gc/Grw-Lexical Knowled...	112	0.27	
	Gc~4	125	2.78	
	Gc~5	119	3.87	
	Gc~8	117	3.78	
	Gc-Language Developm...	106	1.03	
	Gc-Lexical Knowledge~2	111	0.32	
	Gf/Gq Quantitative Reas...	116	5.50	
	Gf~4	108	1.01	
	Glr~8	92	1.75	
	Glr-Associative Learning~4	93	1.02	
	Glr-Fluency~2	80	1.24	
	Glr-Learning (Delayed)~3	100	1.24	
	Glr-Learning (Immediate)...	100	1.04	
	Glr-Learning~6	100	1.31	
	Gq~4	102	4.47	
	Gq~6	108	6.27	
	Grw-Grammar~2	87	1.48	
	Grw-Reading~5	89	2.43	
	Grw-Spelling~2	78	0.69	
	Grw-Writing~6	84	3.04	
	Gs~3	85	4.01	
	Gs~4	74	4.50	
▸	Gsm~5	101	1.75	

All ☐ Missing

Composite Statistics | Normal Curve | Subtest Graph | Composite Graph | Differences | Relative Proficiency | Scree Plot | Correlations | Added Reliability | Predictions | Path Diagram | What if? | Tables

Passage Comprehension

Add Model | – | Update

- Passage Comprehension
- Gs~4
- Glr-Fluency~2
- Letter-Word Identification
- Gc~5
- Word Attack
- Ga~4
- Reading Fluency
- Gsm~5

Add ▫ | – ☐ Filter

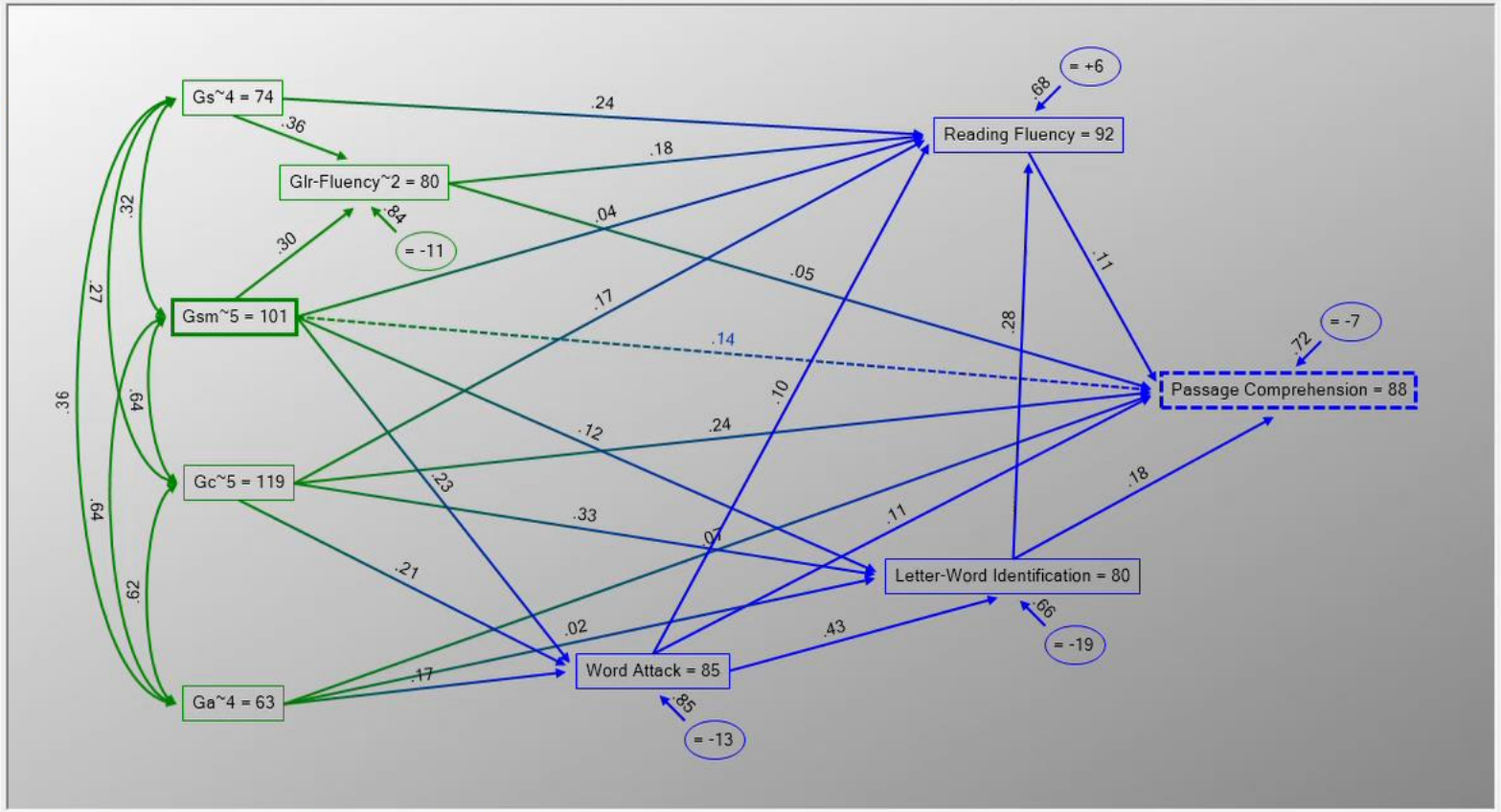
Gsm~5 → Passage Comprehension

0.1374 ☑ Free

Add → | –

Free

Add → | –

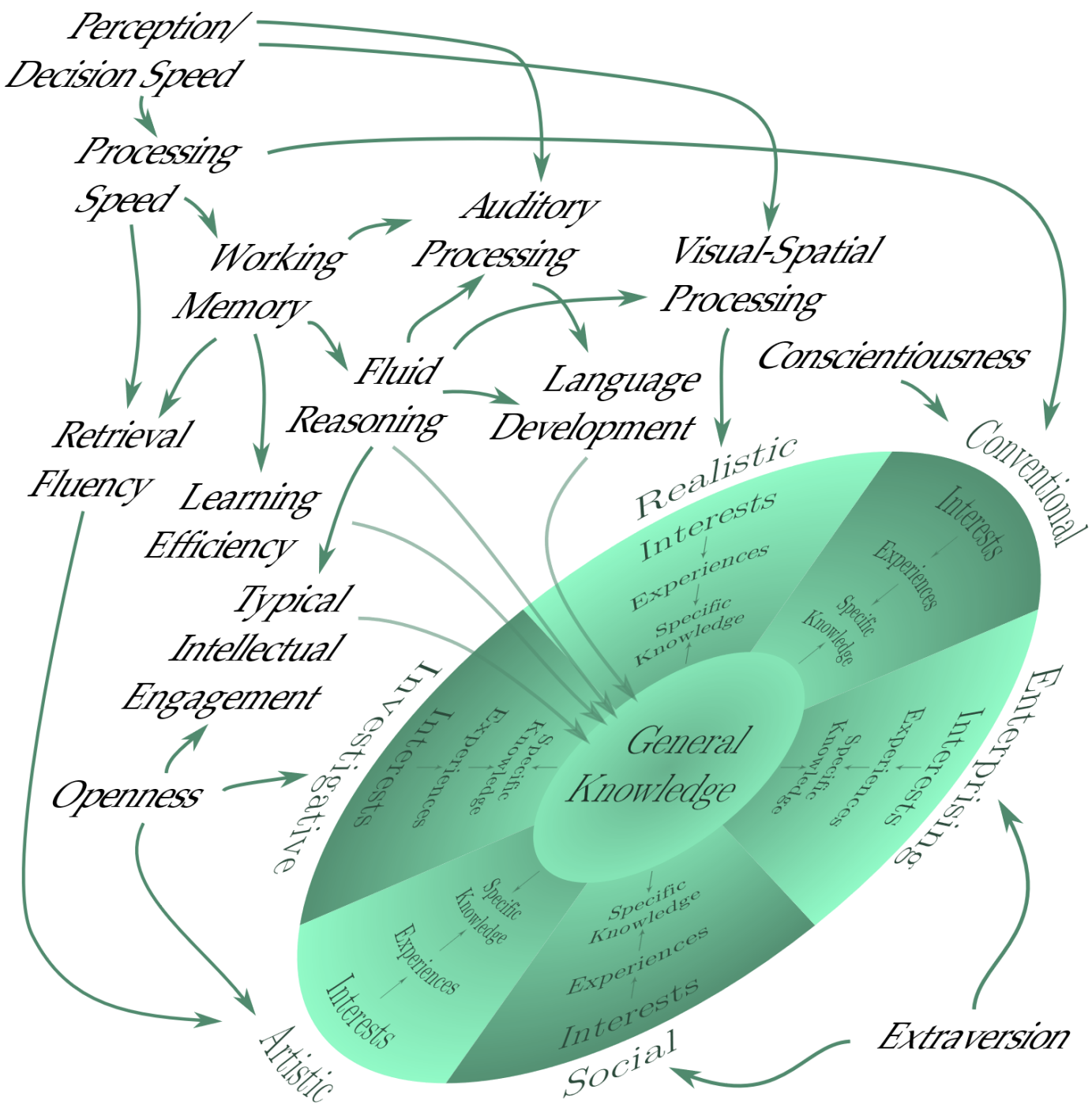


◉ Move Variables ○ Draw Paths ☑ Highlights ☐ Equal Size

	Path	Computation	Effect	Type
▸	Total Model-Implied Relationship	.32 + .24	0.56	Model-Implied
	Total Causal Effect	.14 + .10	0.24	Causal
	Gsm~5 → Passage Comprehension	.14	0.14	Direct
	Total Indirect Effect	.01 + .01 + .02 + ...	0.10	Indirect
	Gsm~5 → Letter-Word Identification → Reading Fluency → Passage Comprehension	.12 * .28 * .11	0.00	Indirect
	Gsm~5 → Letter-Word Identification → Passage Comprehension	.12 * .18	0.02	Indirect
	Gsm~5 → Word Attack → Letter-Word Identification → Reading Fluency → Passage Comprehension	.23 * .43 * .28 * .11	0.00	Indirect

Intelligence Is Dynamic!

Cascading Developmental Investment Theory

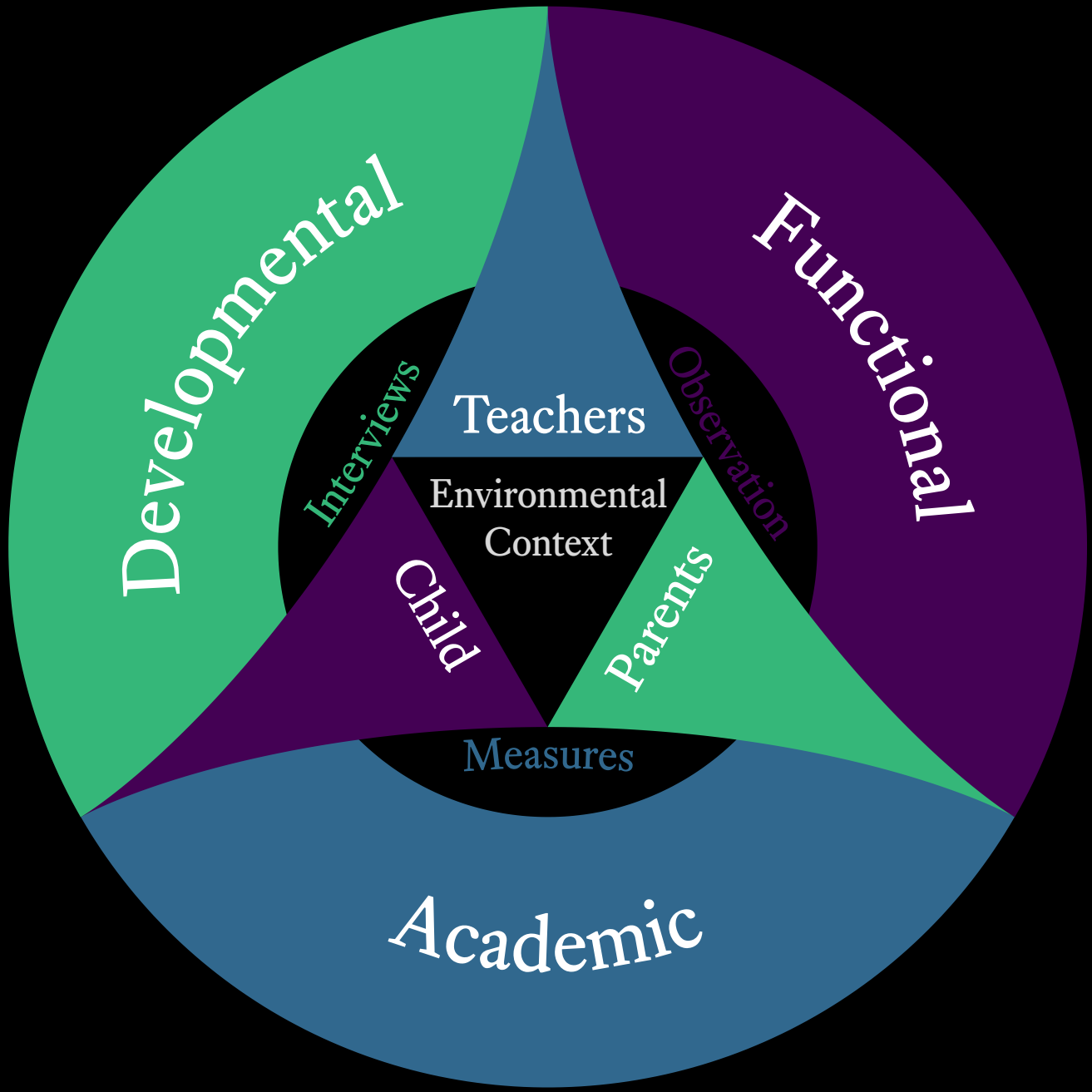


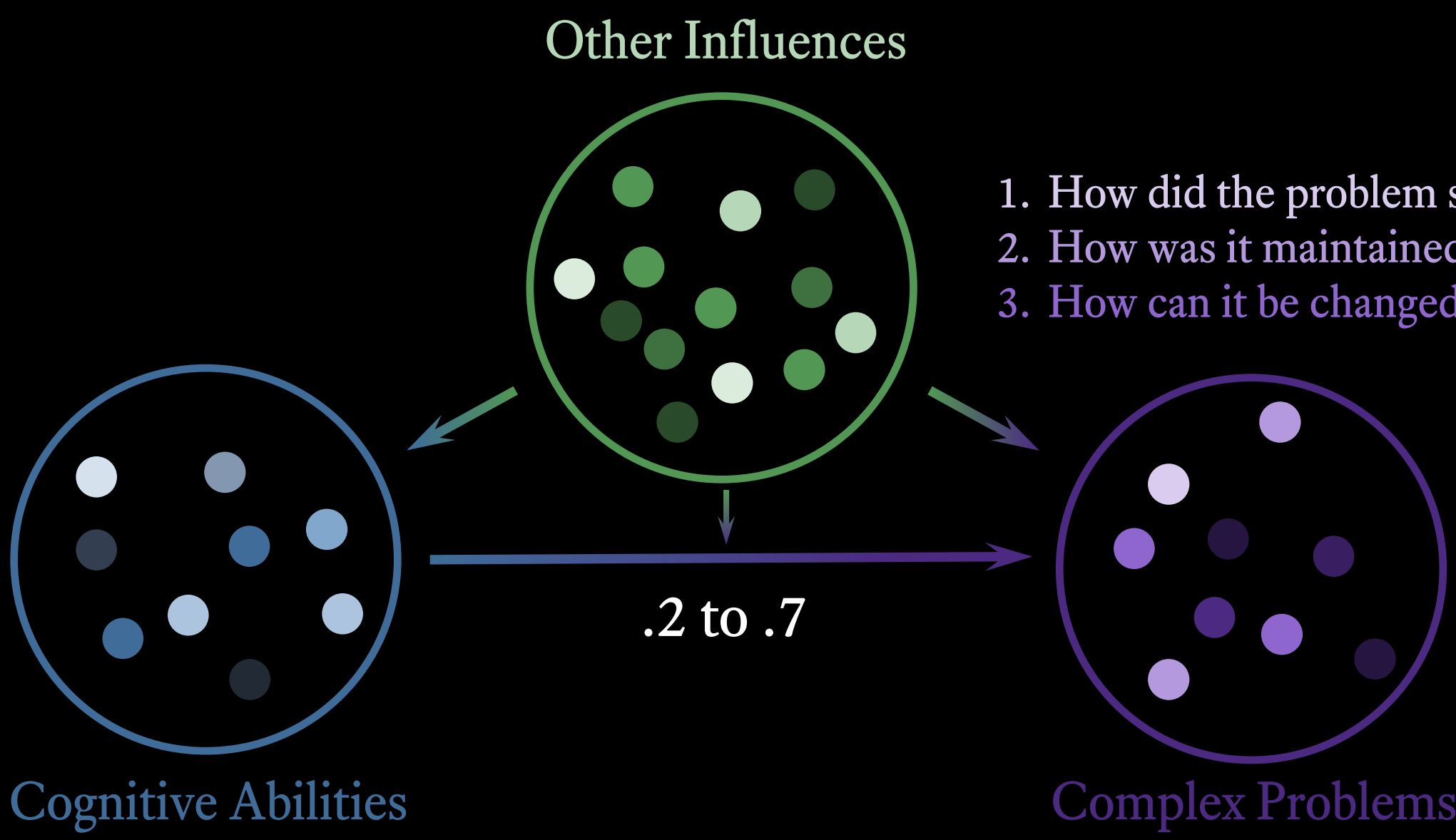
IDEA
Individuals with Disabilities Education Act

Comprehensive evaluations include

"a variety of assessment tools and strategies to gather relevant functional, developmental, and academic information about the child, including information provided by the parent."

IDEA Sec. 300.304
Evaluation procedures




Other Influences
1. How did the problem start?
2. How was it maintained?
3. How can it be changed?
.2 to .7
Cognitive Abilities
Complex Problems

Every individual
is a singularity,
a one-time existing being,
nowhere else
and never before present.

William Stern
1871–1938

To be sure,
certain law-like regularities
apply to the individual,
certain types
are embodied
in the individual,…

William Stern
1871–1938

But the individual
is not exhausted
by these laws
and types;

William Stern
1871–1938

There remains
ever something more,
through which the individual
is distinct from others
who conform to
the same laws and types.

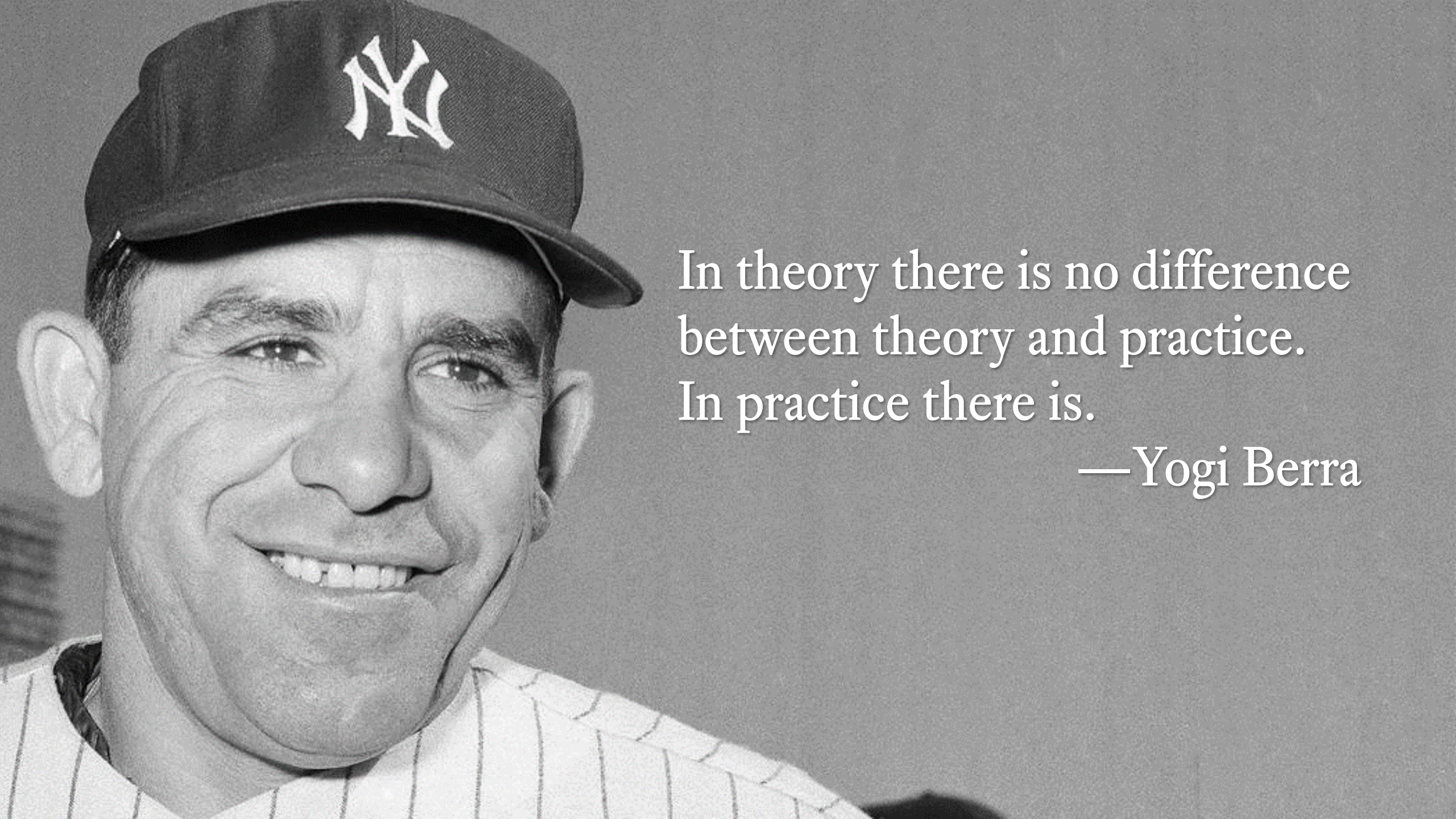
William Stern
1871–1938

And this last kernel of being,
which reveals the individual
to be thus and so,
distinct from all others,
is not expressible
in the language
of scientific concepts,
it is unclassifiable,
incommensurable.

William Stern
1871–1938

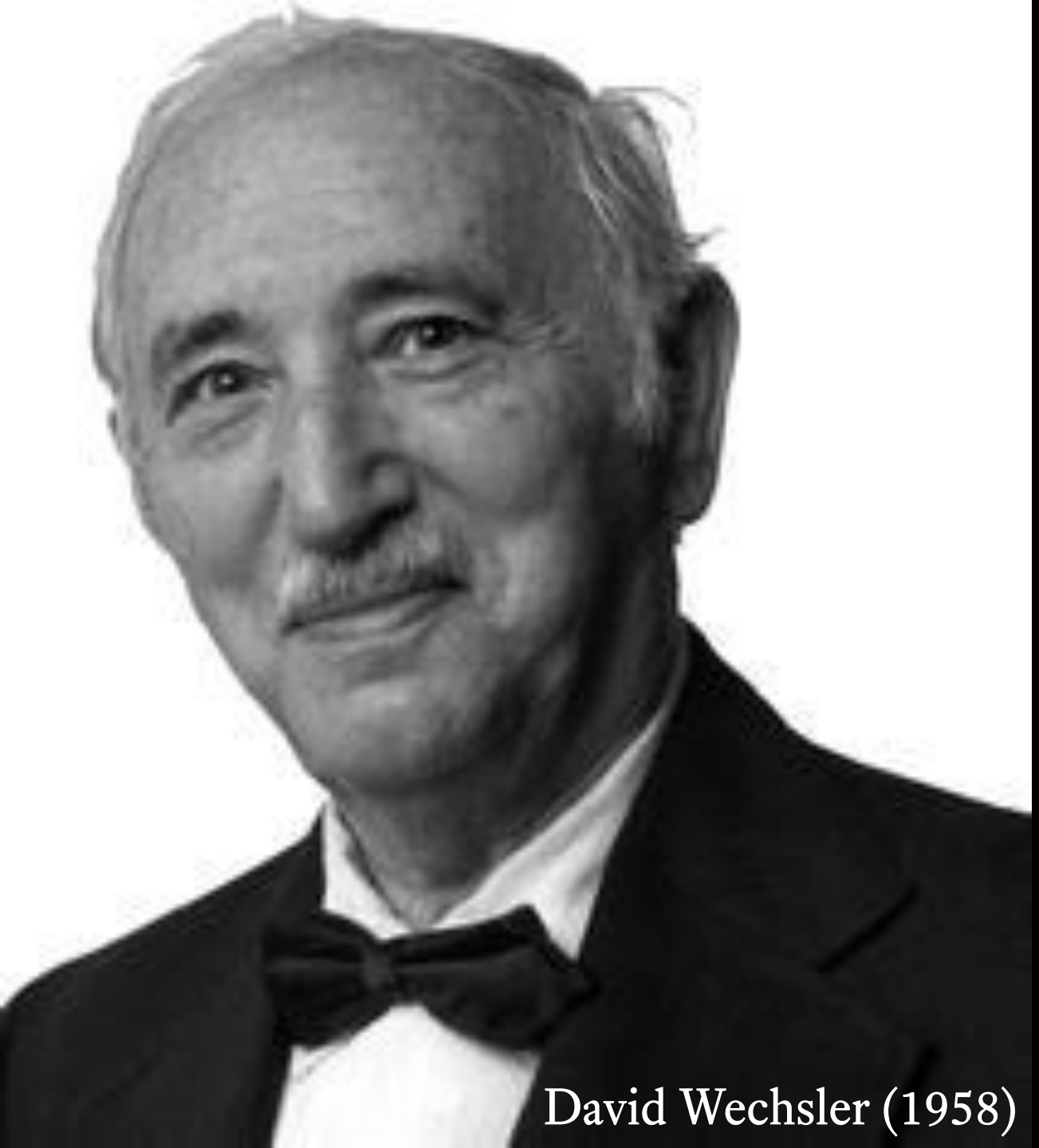
In this sense,
the individual
is a limiting concept,
toward which
theoretical investigation strives
but can never reach;
it is, one could say,
the asymptote of science.

William Stern
1871–1938


In theory there is no difference
between theory and practice.
In practice there is.
—Yogi Berra

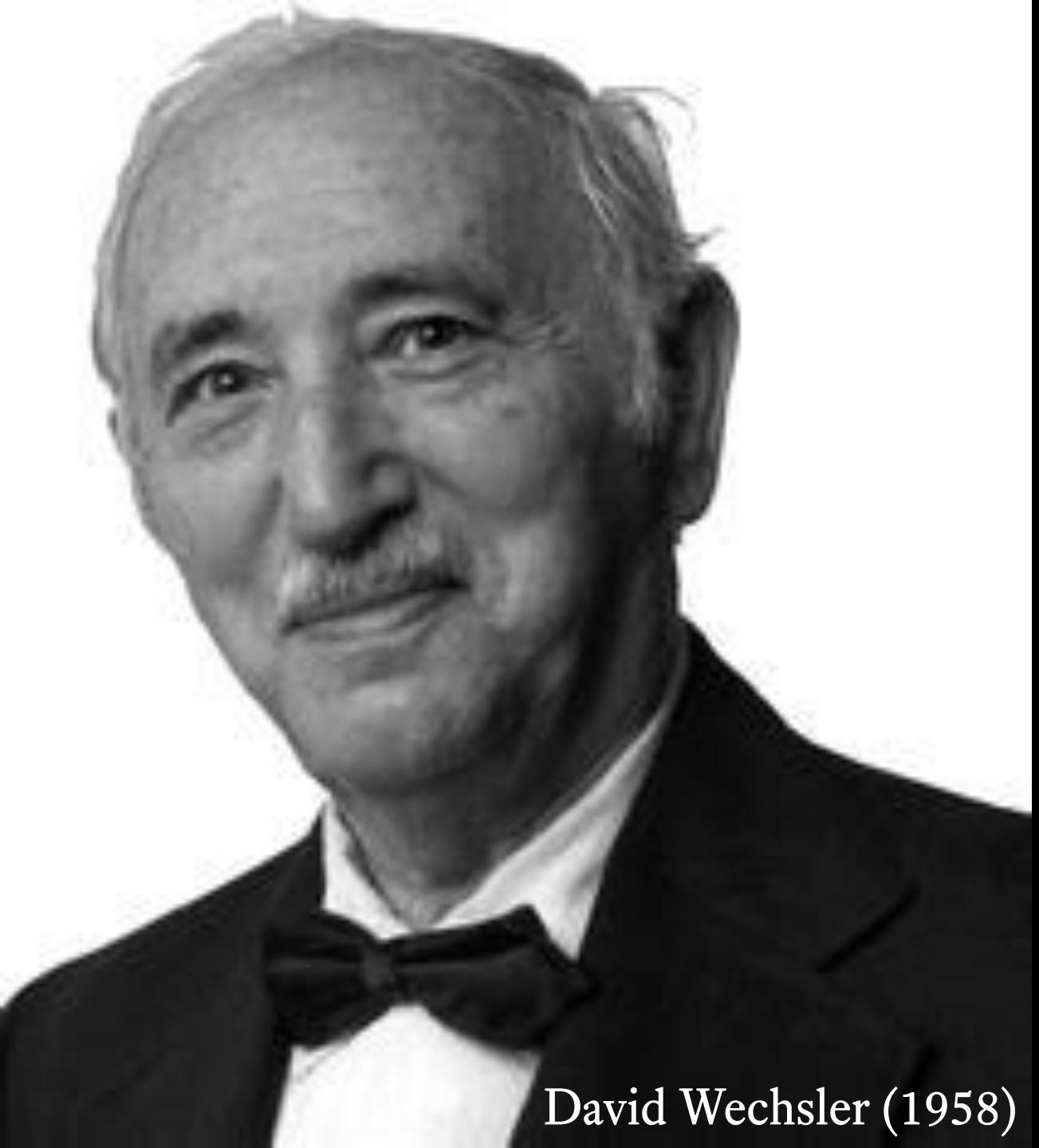
Assessment Dark Matter

Assessment Dark Matter



David Wechsler (1958)

We begin with a series of aptitude measures but somehow end up with an IQ. How is this possible? The suggested answer is that in the process we are using measures of ability primarily as a tool, that is, not as an end in itself but as a means for discovering something more fundamental. Then, when an examiner employs an arithmetic or a vocabulary test as part of an intelligence scale, the object of the examiner is not to discover the subject's aptitude for arithmetic or extent of his word knowledge, although these are inevitably involved, but his capacity to function in overall areas which are assumed to require intelligence. (p. 15)



David Wechsler (1958)

[…] while intellective abilities can be shown to contain several independent factors, intelligence cannot be so broken up. Hence, no amount of refinement of tests or addition of factors will account for the total variance of an intelligence test battery, because the variance in intelligence test performance is due not only to the direct contributions of the factors themselves but also to their collective behavior or integration. (p. 23)

We Have Much to Learn from Qualitative Researchers

Narratives Are the Beginning

Interview

Empathize

Listen to People

Investigate

Clarify

Gather data

Do the math

Learn from Data

Interpret the data

Forget the math

Induce empathy

Explain problems

Retell the Story

Restore hope

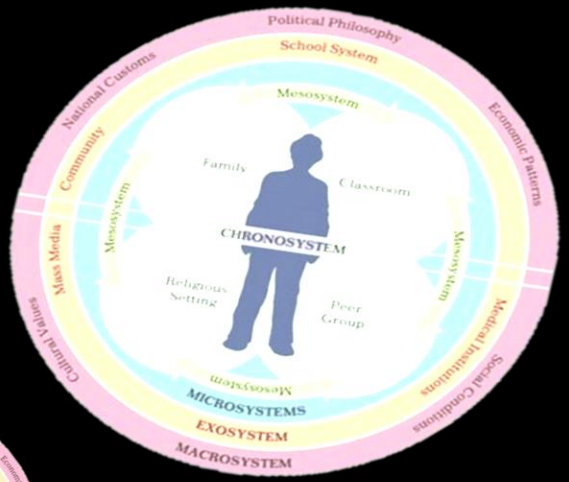
Inspire change

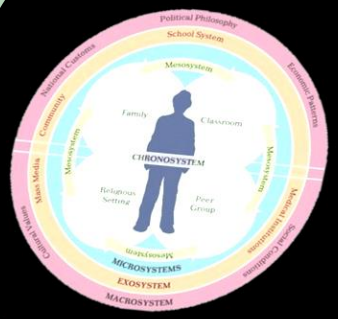
and Ending of Assessment

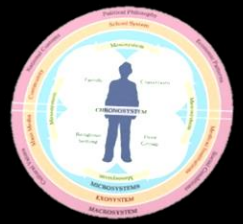
Current Context

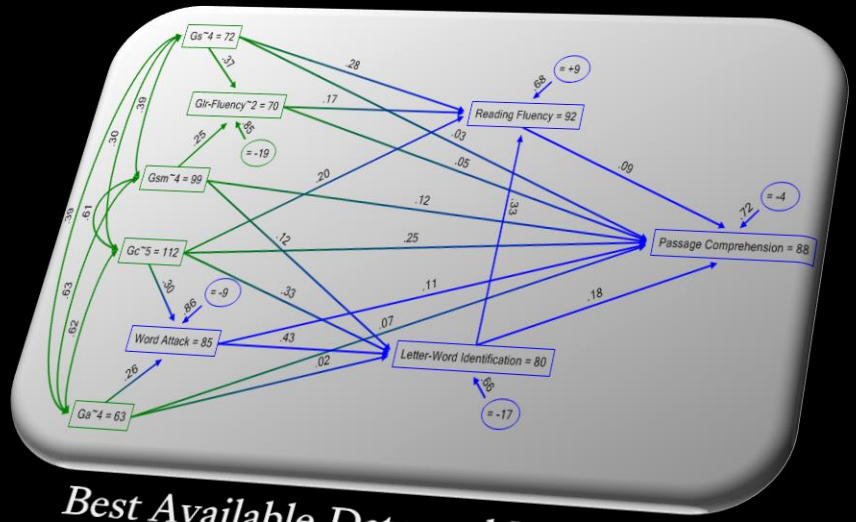
Narrative ↔ Test Scores

Development & Learning History



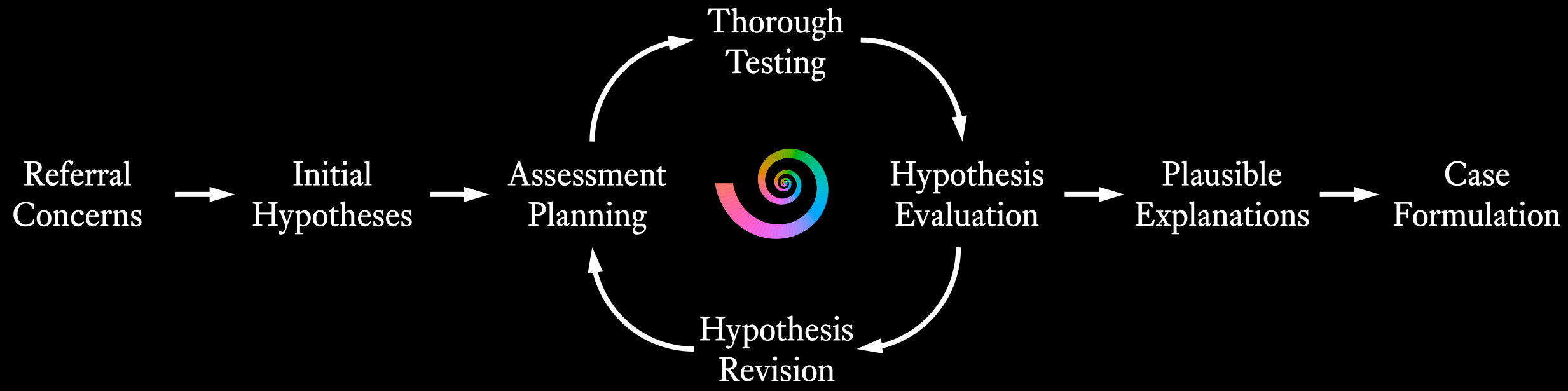


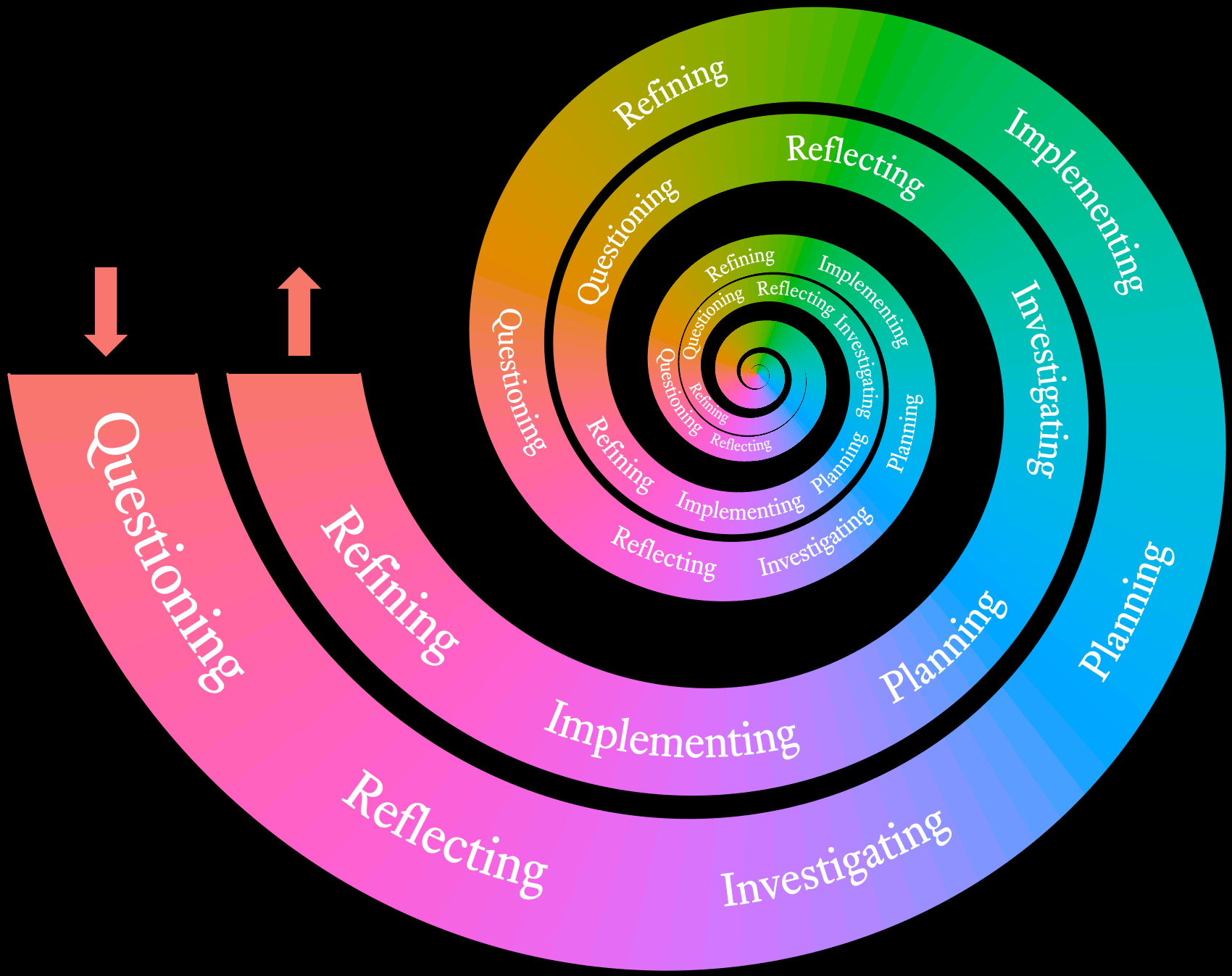




Best Available Data and Models

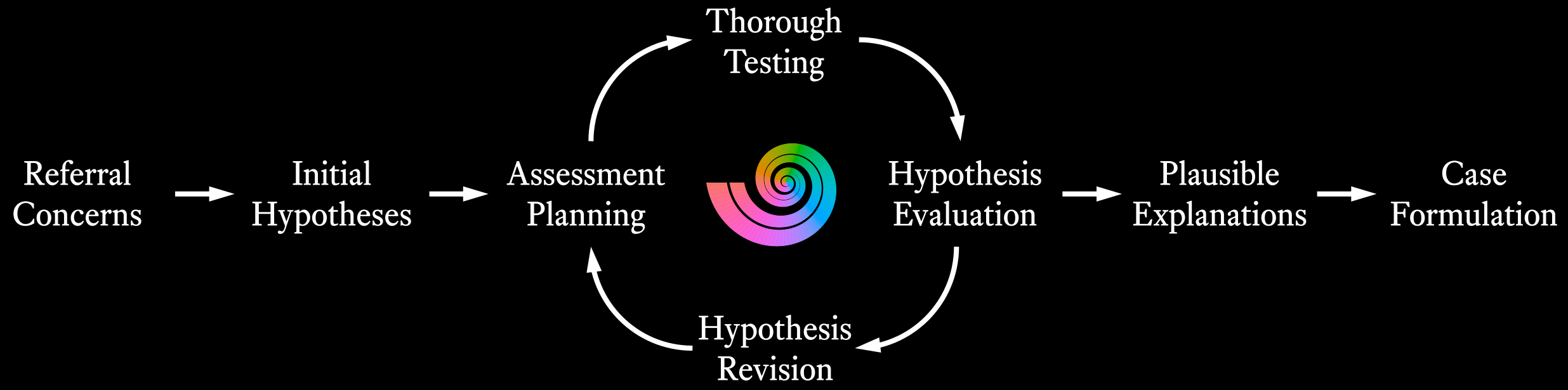
Procedure for a Theory-Centric Assessment





McIntyre (2008, p. 7)

Procedure for a Theory-Centric Assessment



DAS-II

WJ IV

WISC V

KABC-II

Teammates

Rivals

UNIT 2

SB5

CAS-2

RIAS-2

Leiter III

Screening

Screening

Assessing *G*

Broad Abilities

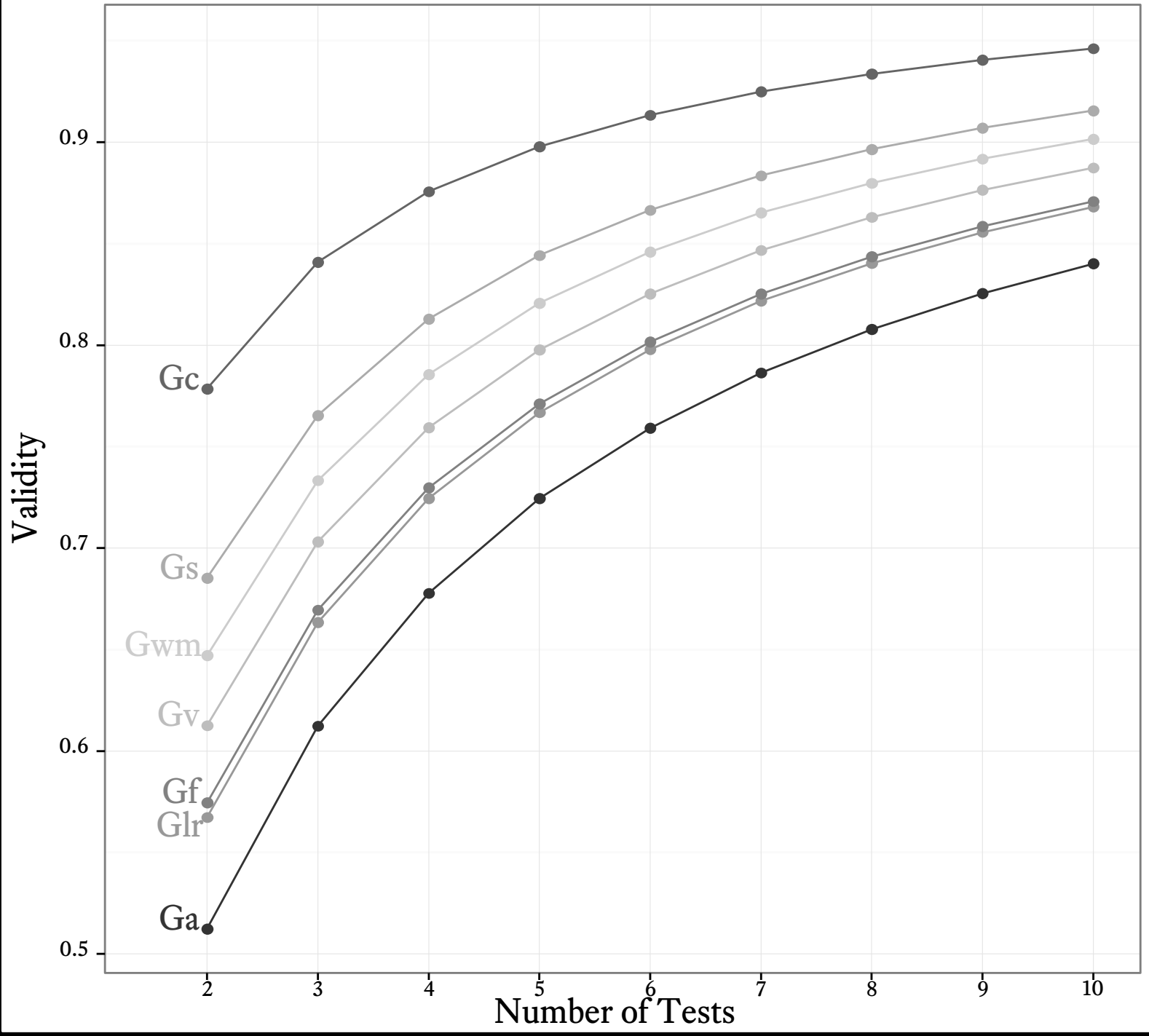
Follow-Up Testing

Follow-up Testing Is Your Best Defense Against Overconfidence

Recommendation:

Confirm Any Deficits You Identify with at Least One More Test

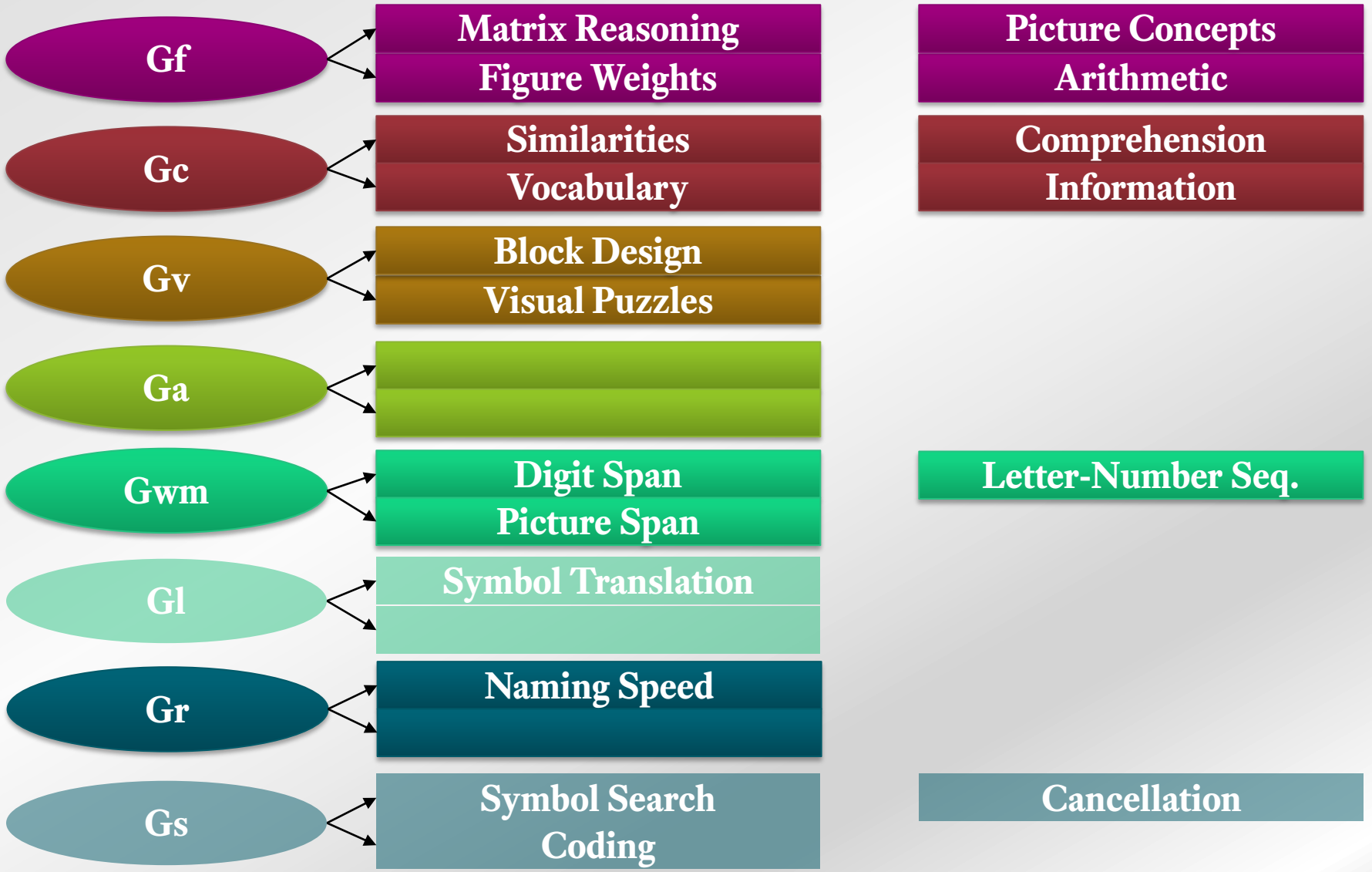
Roman (2016)



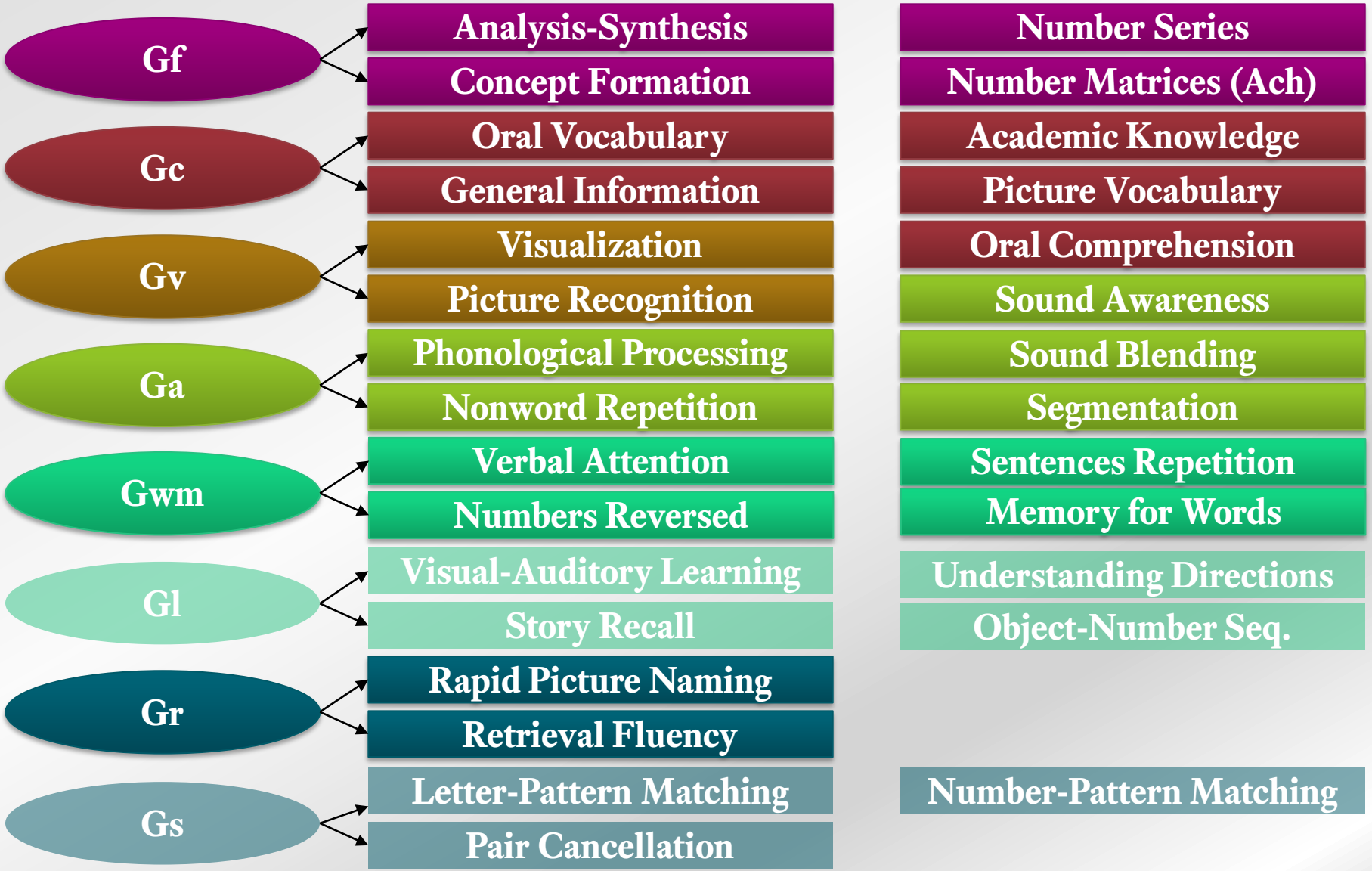
Core Batteries

1. Pick a core battery.
2. Identify the holes.
3. Fill the holes.

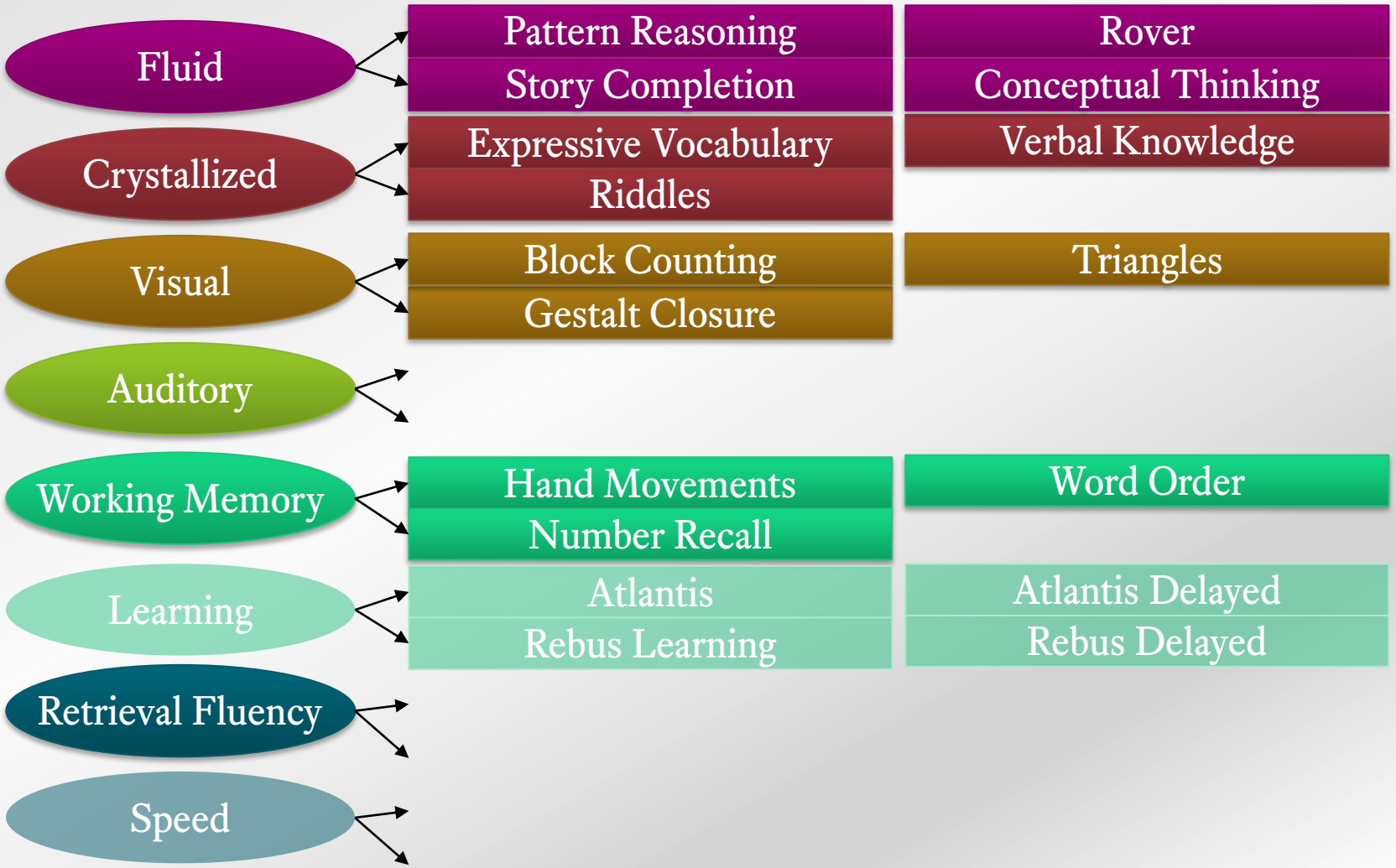
WISC-V as Core Battery



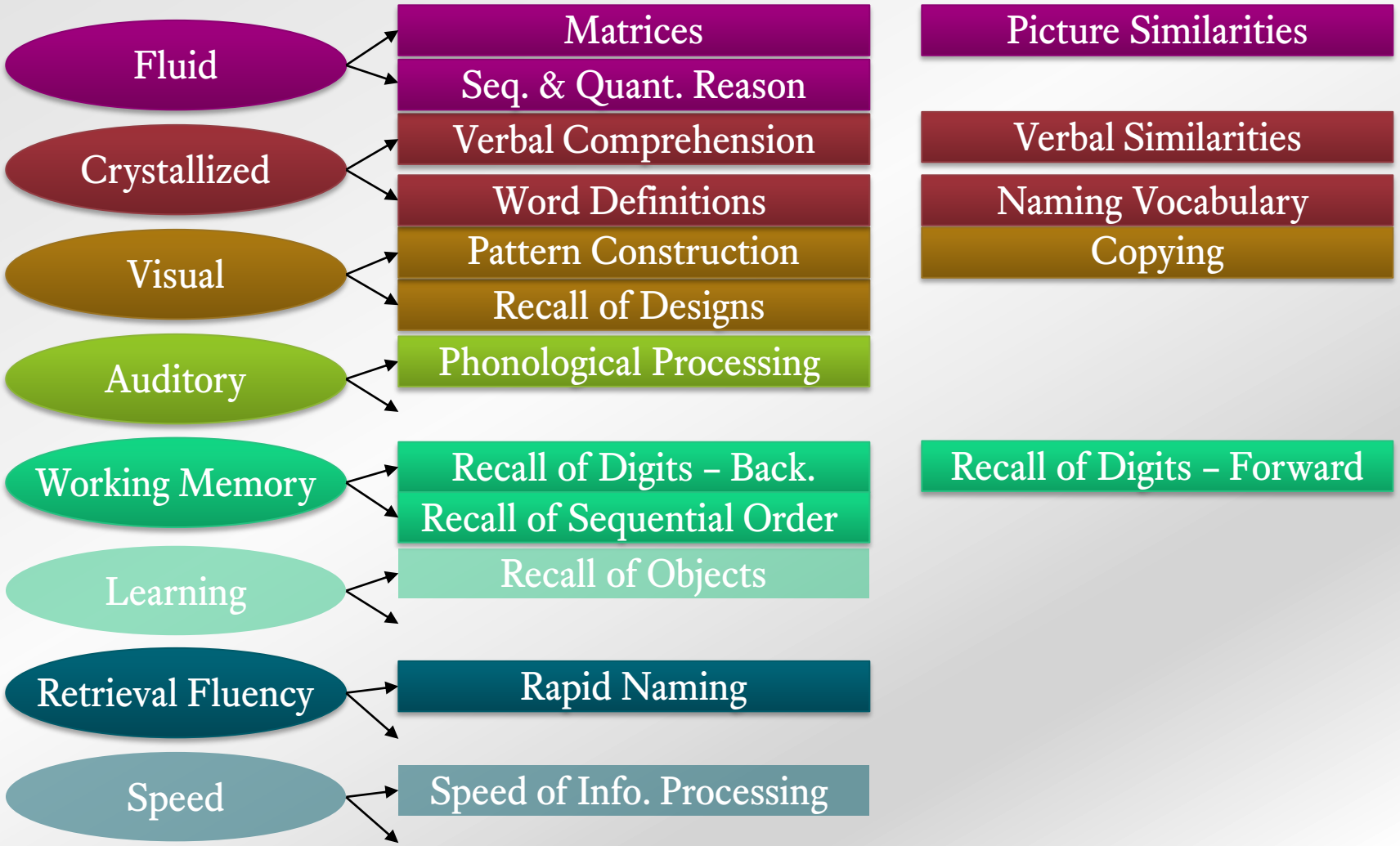
WJ IV as Core Battery



KABC-II as Core Battery

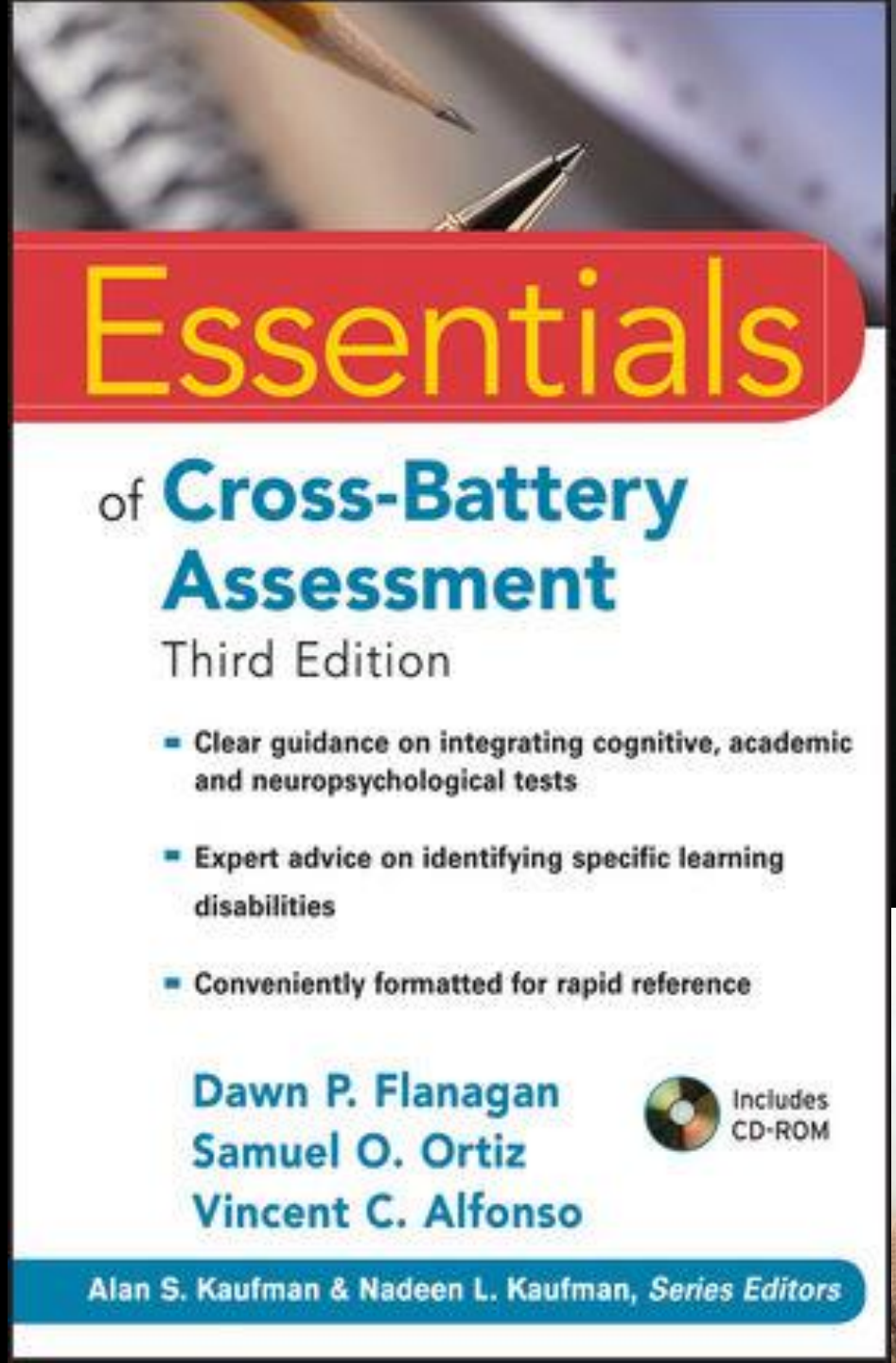


DAS-II as Core Battery

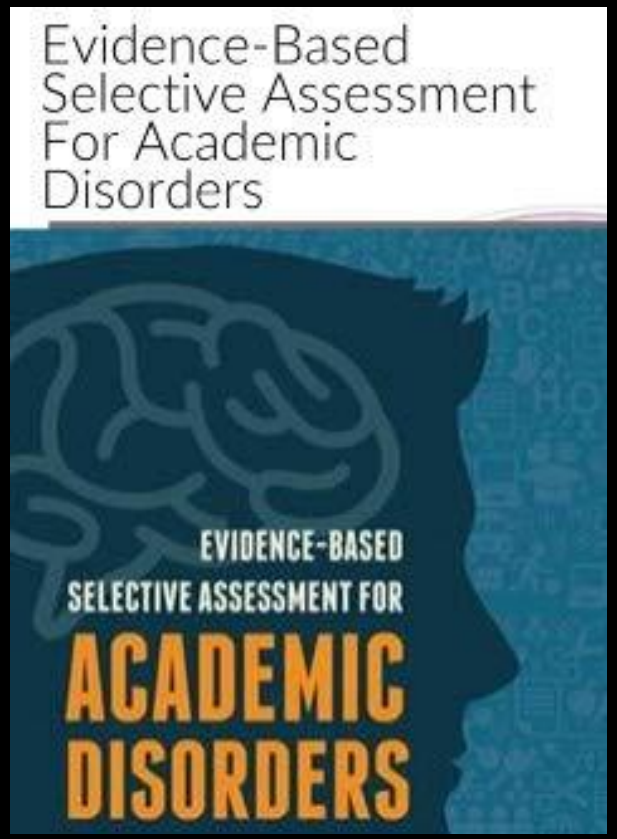


Cross-Battery Assessment

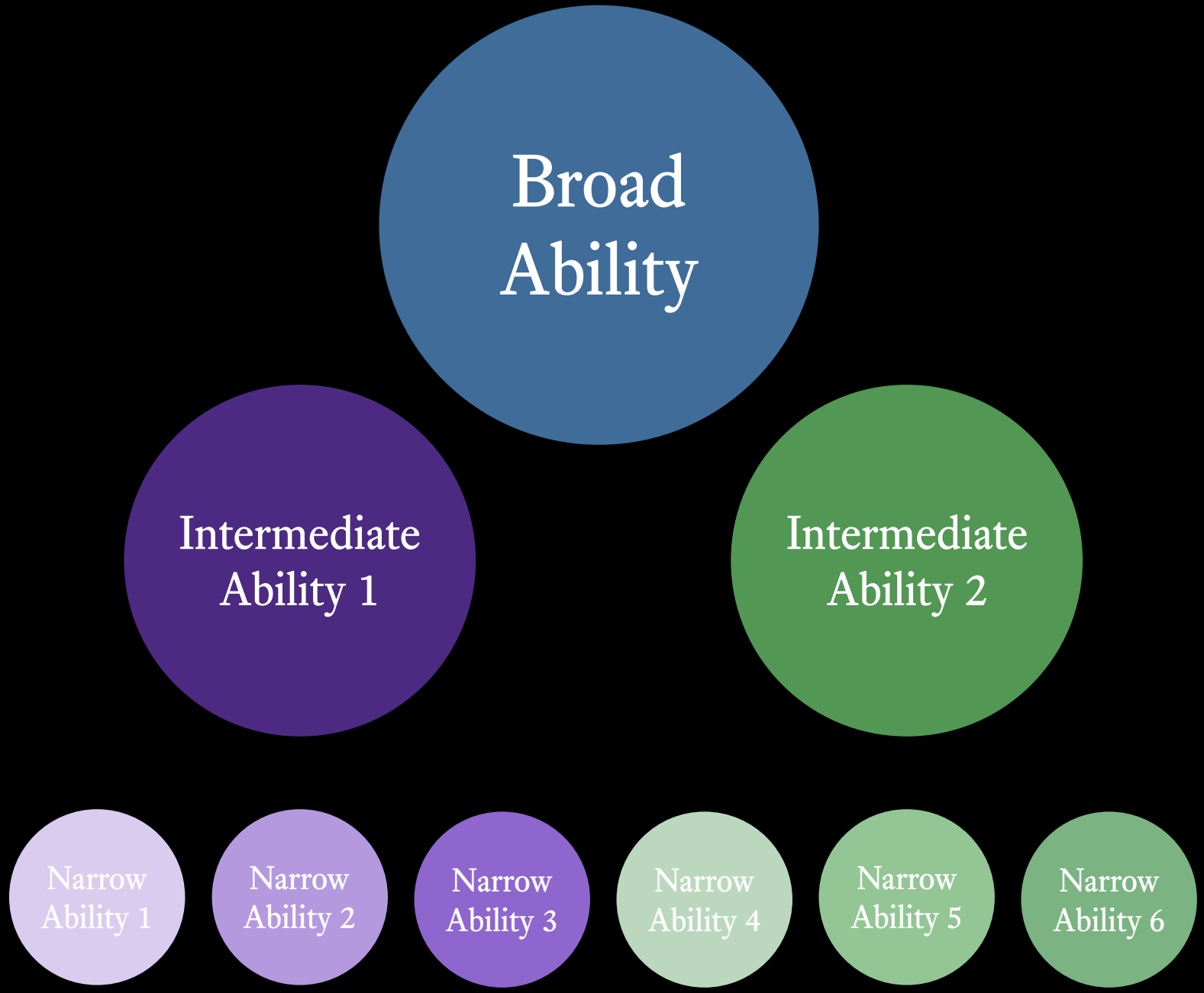
A Comprehensive Approach to CHC Theory-Based Measurement of Cognitive Abilities



If measuring 8 broad abilities is not nuanced enough and assessing 70+ narrow abilities is just impossible, try Functional CHC Theory. Measurement emphasizes 2 intermediate clusters of abilities for each of the broad CHC constructs.



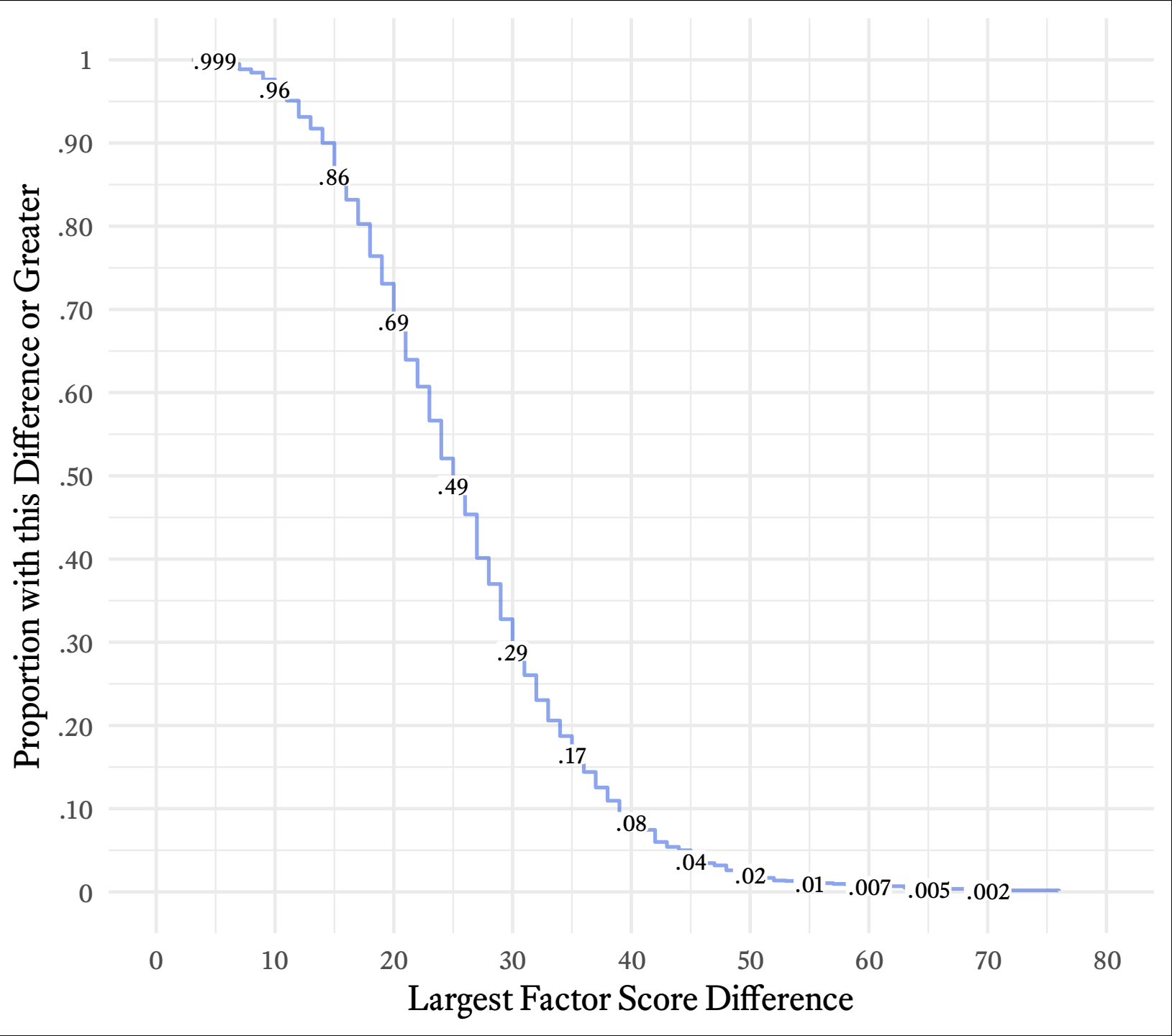
Woodcock, Miller, Maricle, & McGill



What Should We Do with Divergent Scores?

Uncommonly Large WISC-V Factor Score Differences Are Surprisingly Common

```
Max(VCI, VSI, FRI, WMI, PSI) –
Min(VCI, VSI, FRI, WMI, PSI)
```



Uncommonly Large WISC-V Factor Score Differences Are Surprisingly Common

```
Max(VCI, VSI, FRI, WMI, PSI) -
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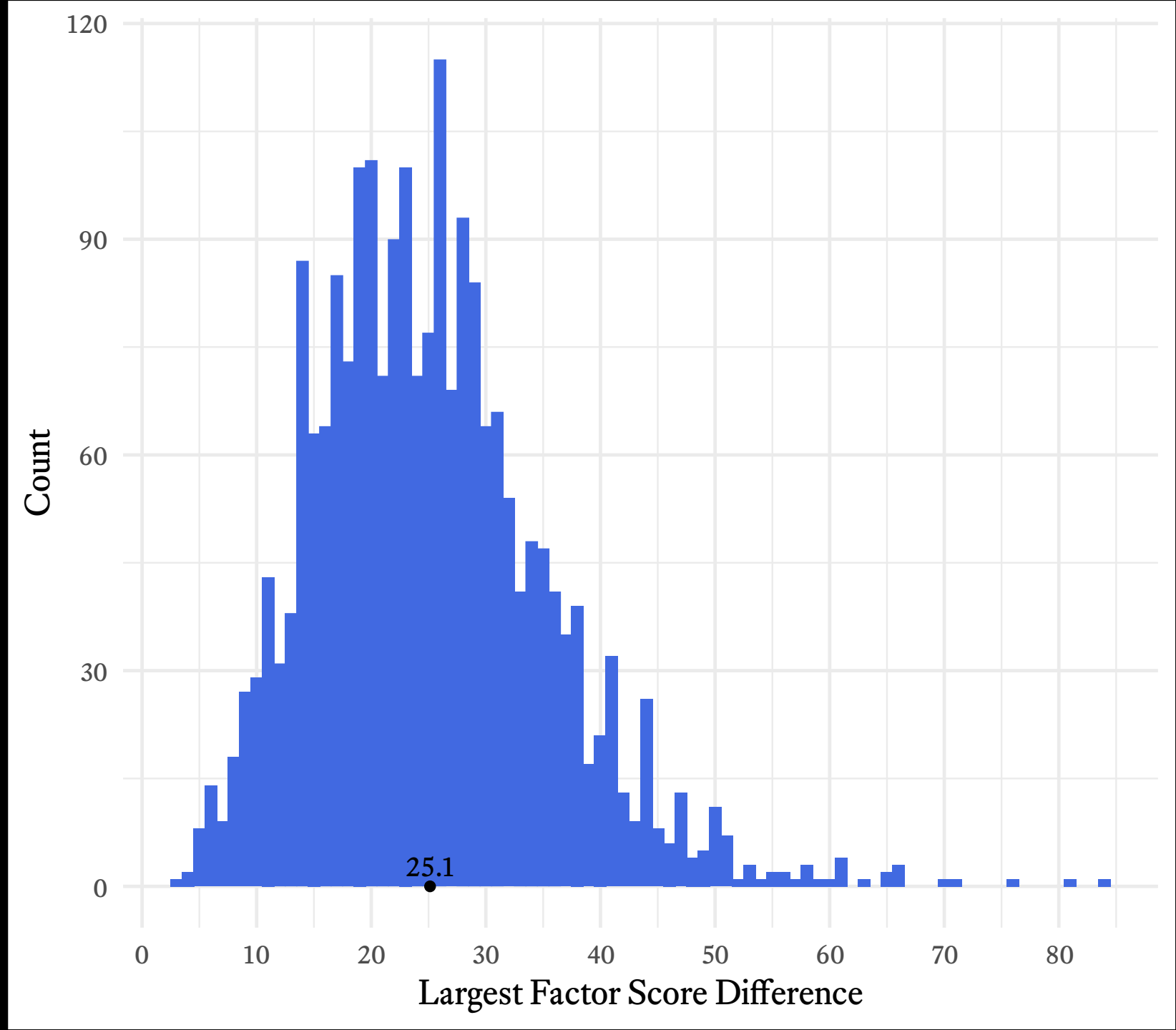

Uncommonly Large WISC-V Factor Score Differences Are Surprisingly Common

```
Max(VCI, VSI, FRI, WMI, PSI) –
Min(VCI, VSI, FRI, WMI, PSI)
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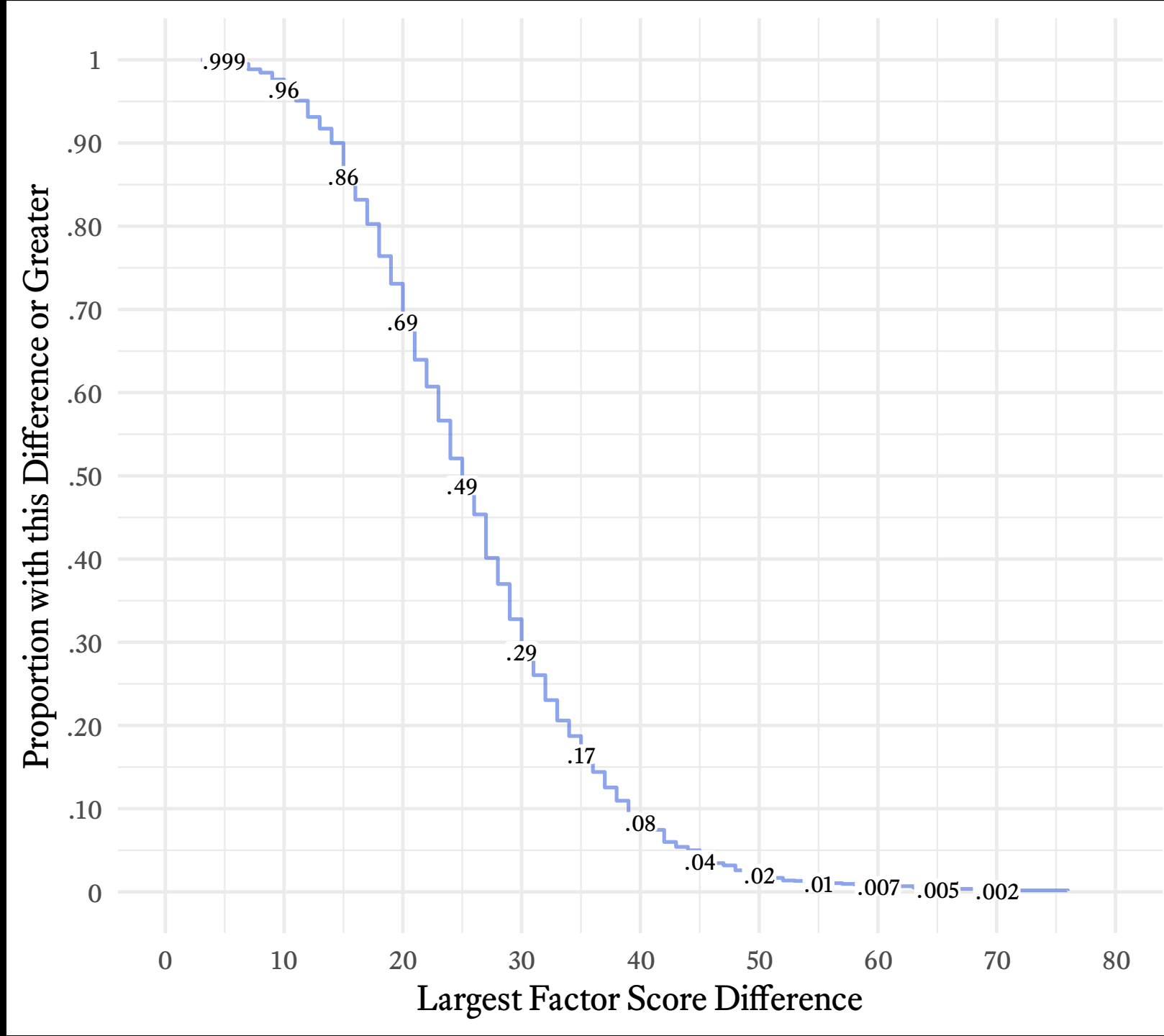
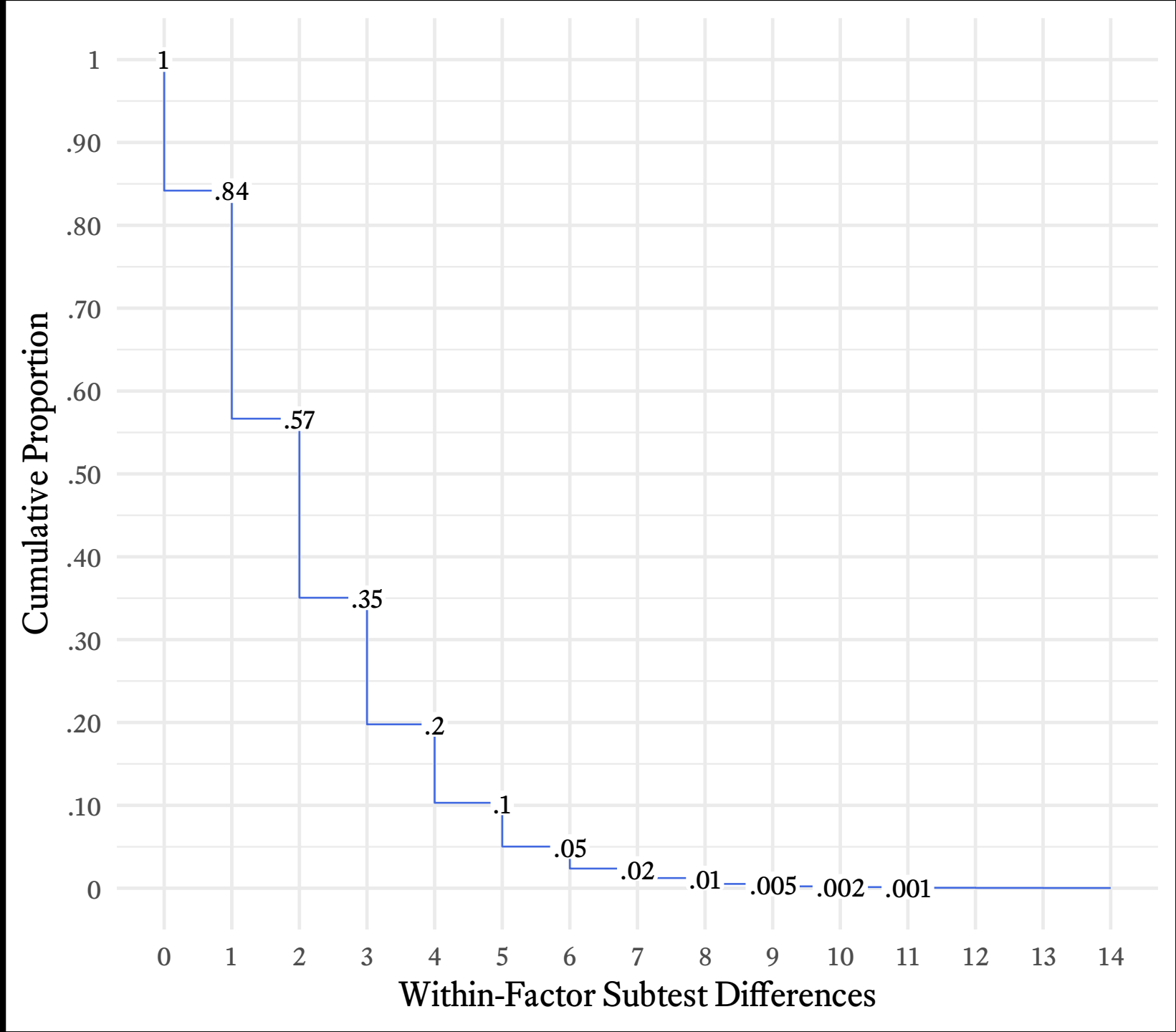


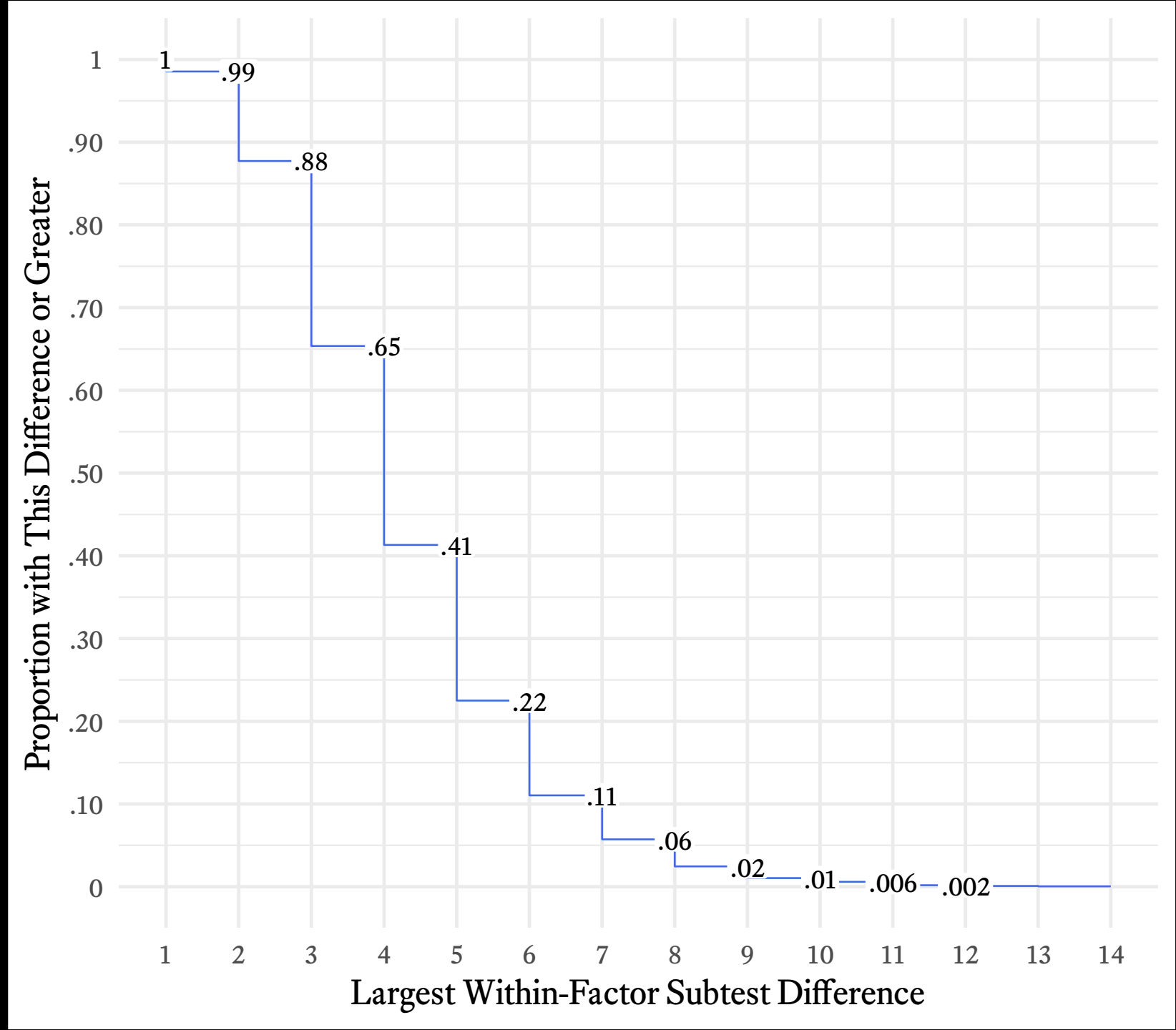
Within-Factor Subtest Differences (WISC-V)

VO – SI
BD – VP
MR – FW
DS – PS
CD – SS



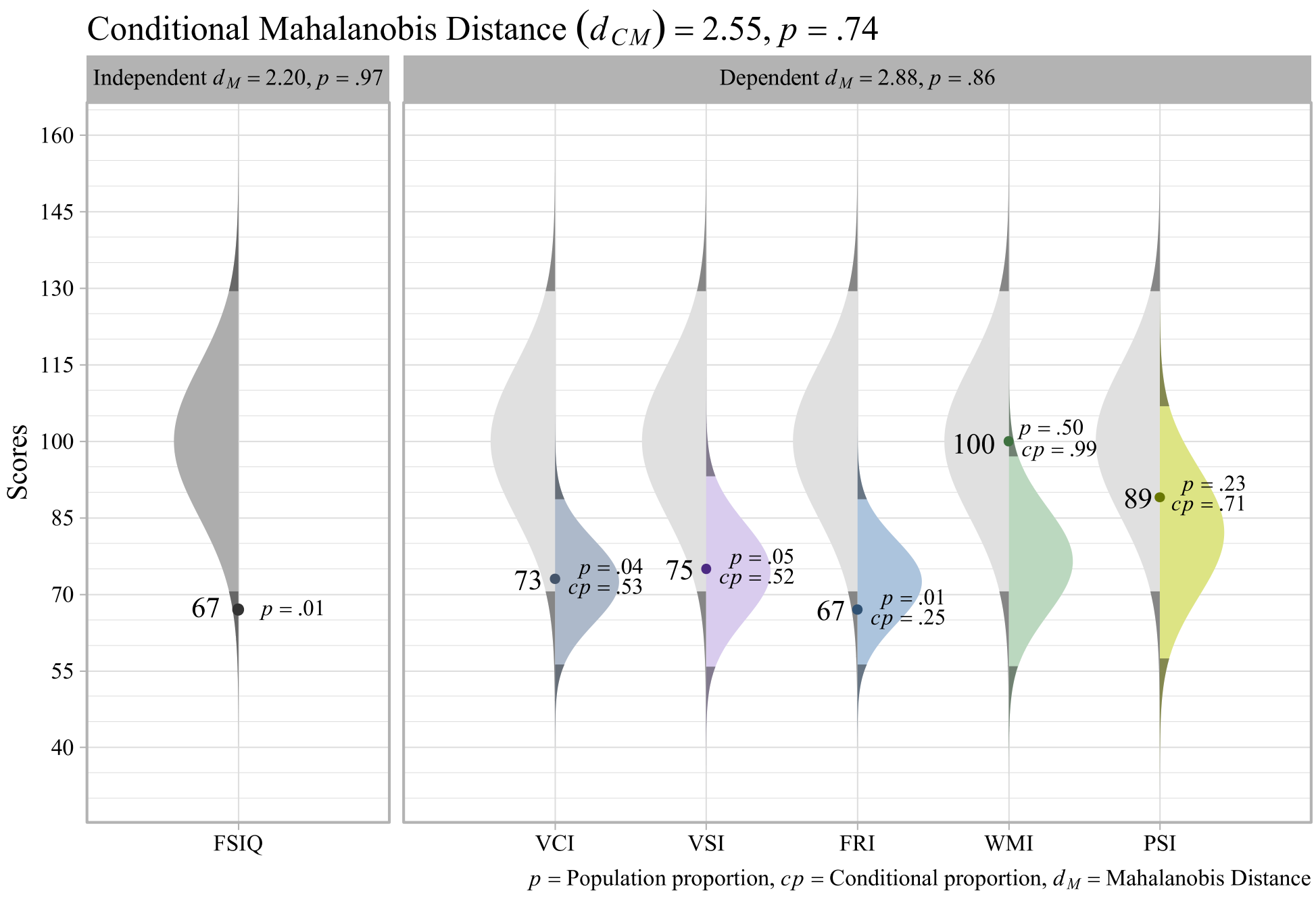
Largest Within-Factor Subtest Differences (WISC-V)

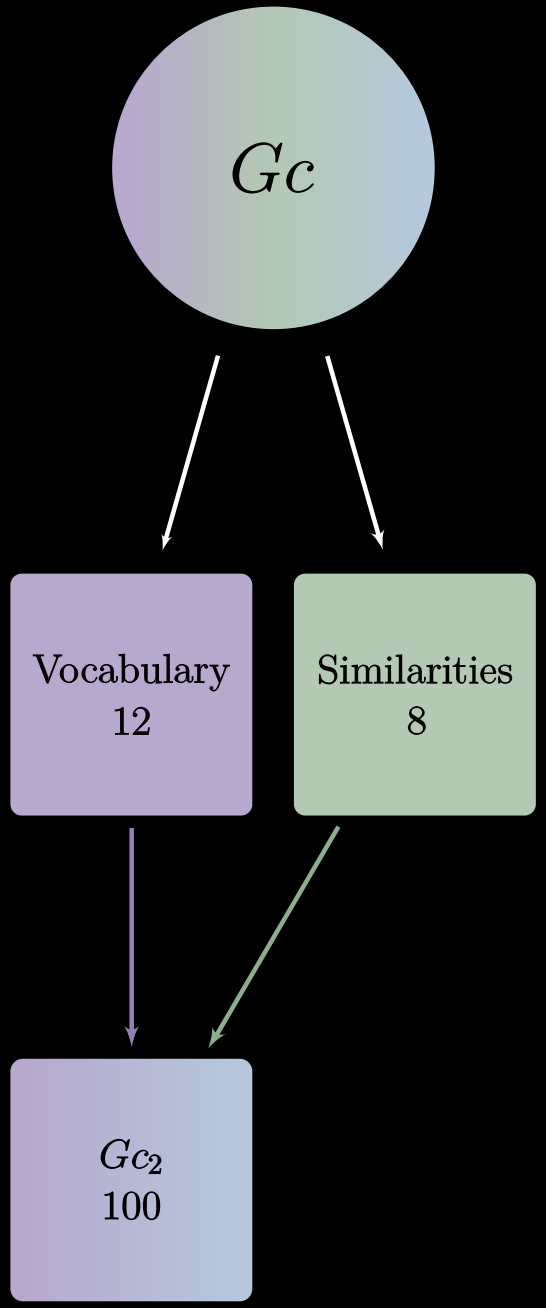
VO – SI
BD – VP
MR – FW
DS – PS
CD – SS



Conditional Profiles

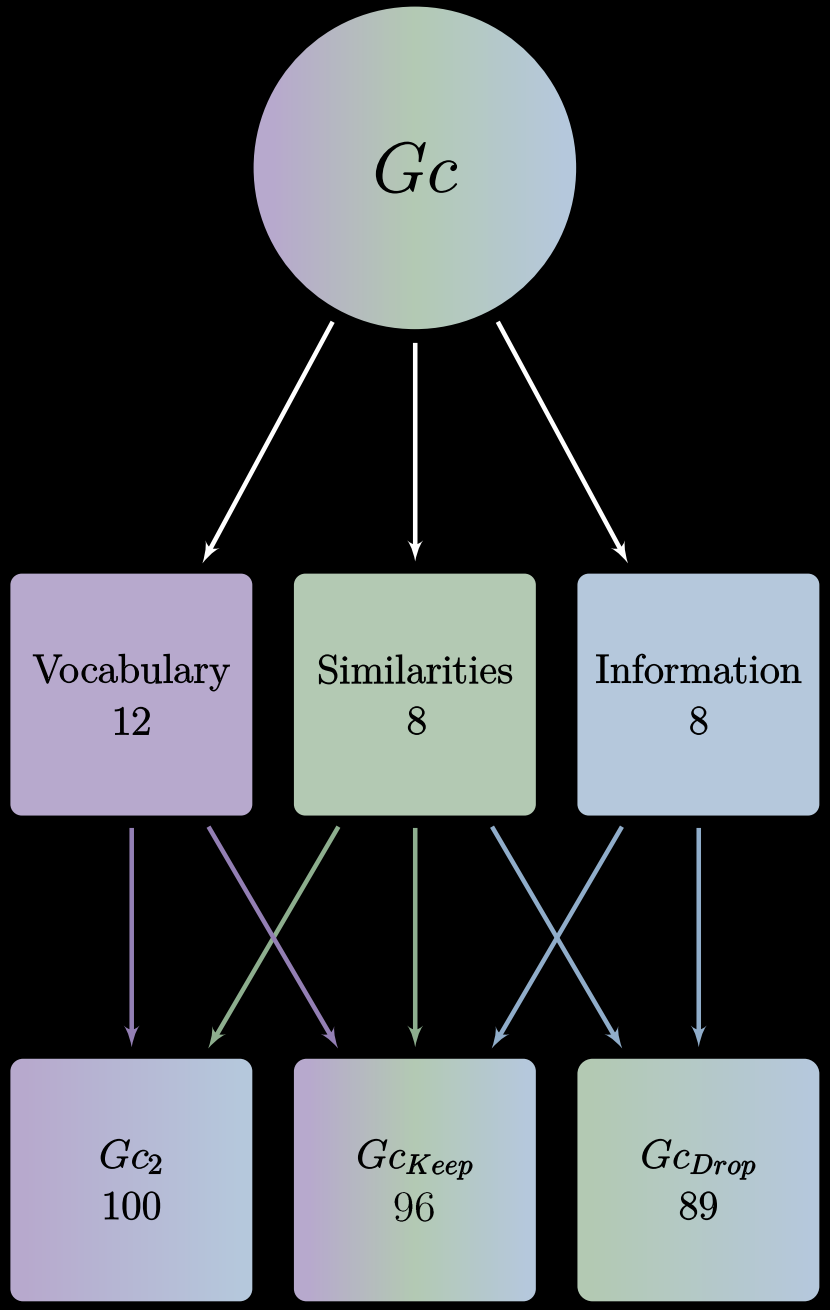
Feng & Schneider unusualprofile package: wjschne.github.io/unusualprofile





These Scores Are Different!

Is this Composite Valid?

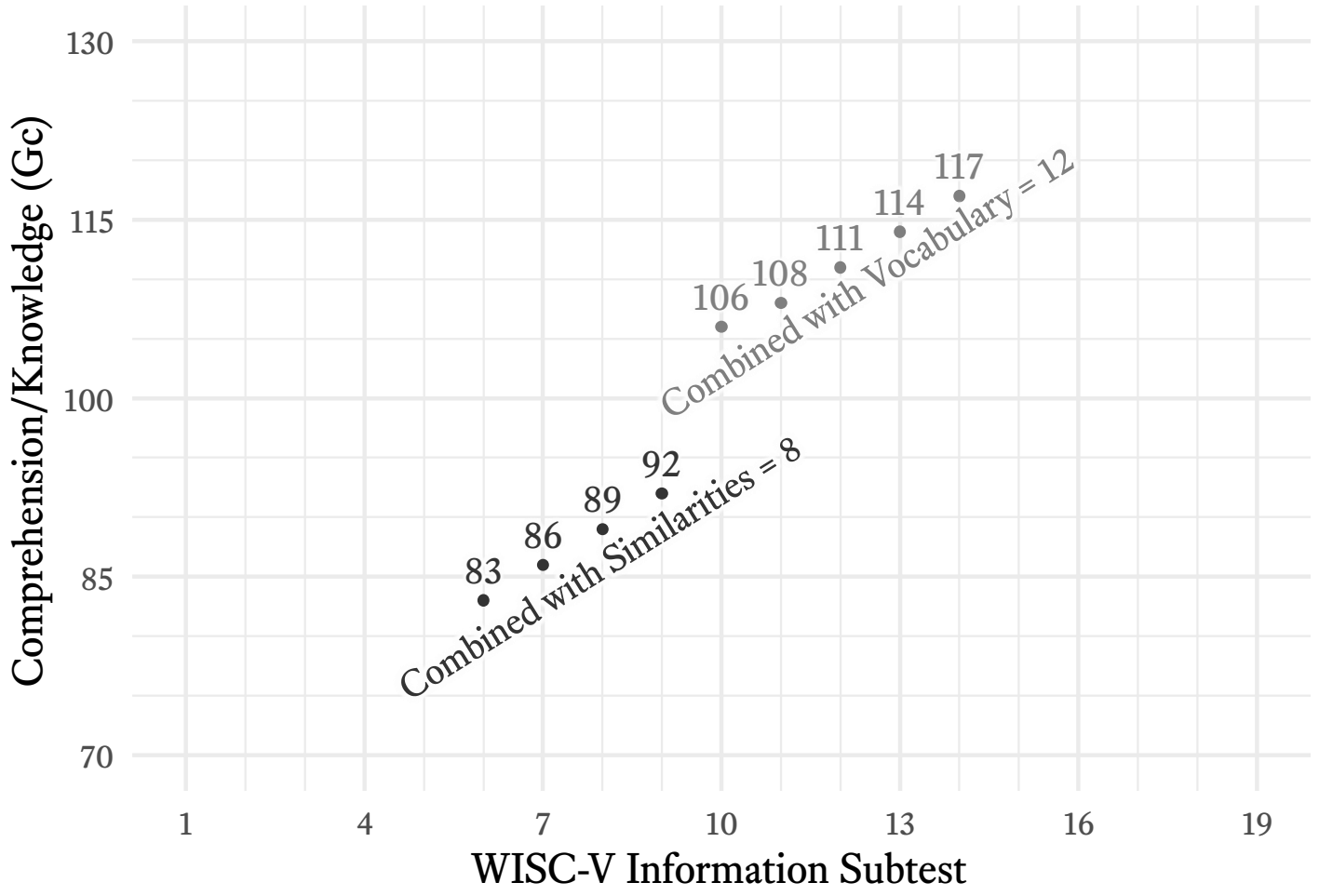


Give Follow-up Test!

Vocabulary > Similarities & Information

Should We Keep or
Drop Vocabulary?

What Happens to Our Estimate When We Drop the Divergent Score?



Archives of Assessment Psychology, Vol. 6, No. 1, (49-79)

Invalidating the Full Scale IQ Score in the Presence of Significant Factor Score Variability: Clinical Acumen or Clinical Illusion?

Ryan J. McGill, Ph.D., BCBA-D, NCSP

Abstract

Within the professional literature, it is frequently suggested that significant variability in lower-level factor and index scores on IQ tests renders the resulting FSIQ an inappropriate focus for clinical interpretation and diagnostic decision-making. To investigate the tenability of this popular interpretive heuristic, the present study examined the structural and predictive validity of the KABC-II for participants in the normative sample who were observed to have significant variability in their factor scores. Participants were children and adolescents, ages 7-18, (N = 2,025) drawn from the KABC-II/KTEA-II standardization sample. The sample was nationally stratified and proportional to U.S. census estimates for sex, ethnicity, geographic region, and parent education level. Using exploratory factor analysis and multiple factor extraction criteria, support for a five-factor extraction was obtained consistent with publisher theory. As recommended by Carroll (1993; 1995) hierarchical structure was explicated by sequentially partitioning variance appropriately to higher- and lower-order dimensions. Results showed the largest portions of total and common variance were accounted for by the second-order general factor with meaningful residual variance accounted for by Short-Term Memory at ages 7-12 and 13-18. As a result, the Fluid-Crystallized Index (FCI) accounted for large predictive effects across measures of academic achievement whereas the five first-order CHC factor scores consistently accounted for trivial proportions of incremental predictive variance beyond the FCI. Implications for clinical practice and the correct interpretation of the KABC-II and other related measurement instruments in the presence of significant scatter are discussed.

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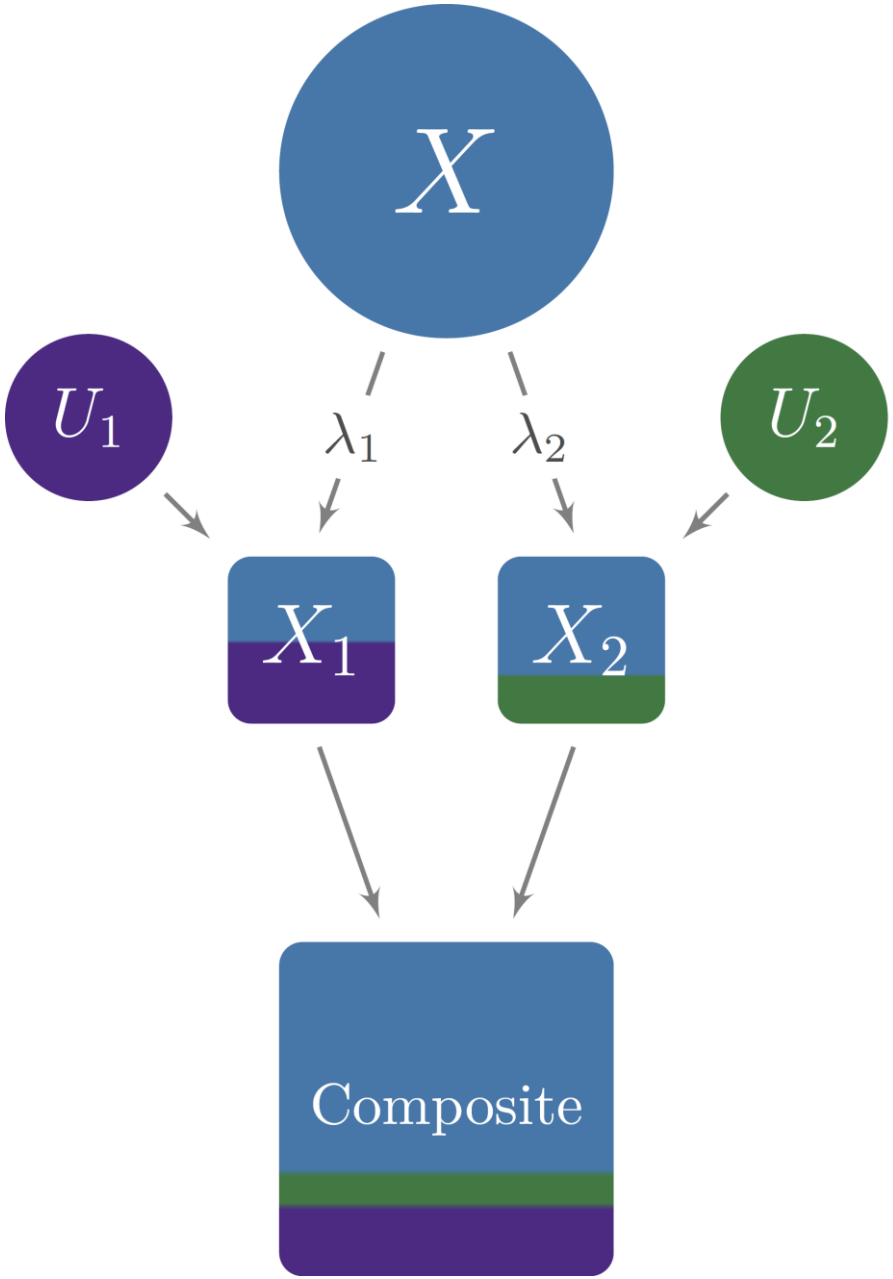
journals.sagepub.com/home/jpa
SAGE

Fine-Tuning Cross-Battery Assessment Procedures: After Follow-Up Testing, Use All Valid Scores, Cohesive or Not

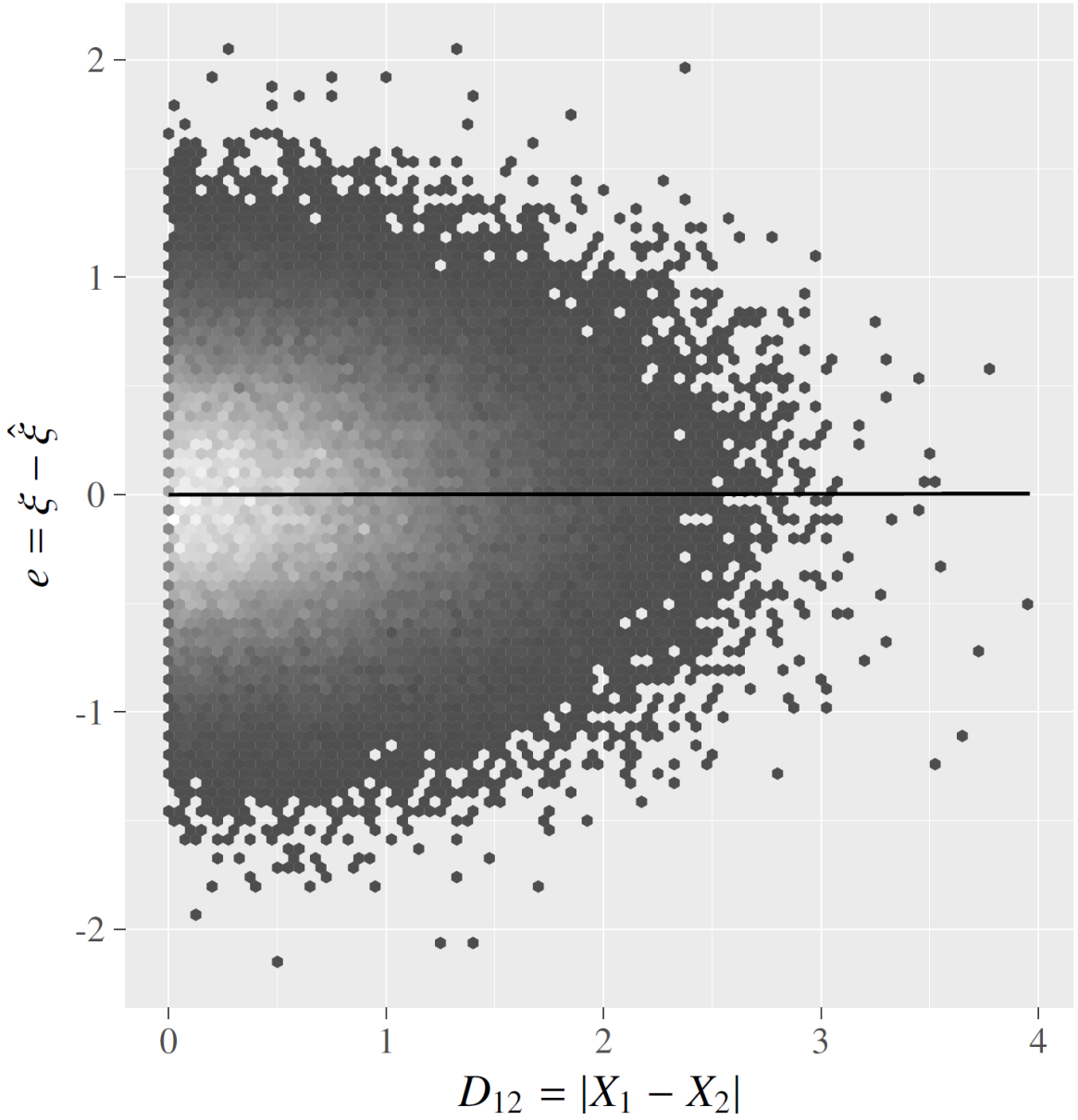
W. Joel Schneider[1] and Zachary Roman[2]

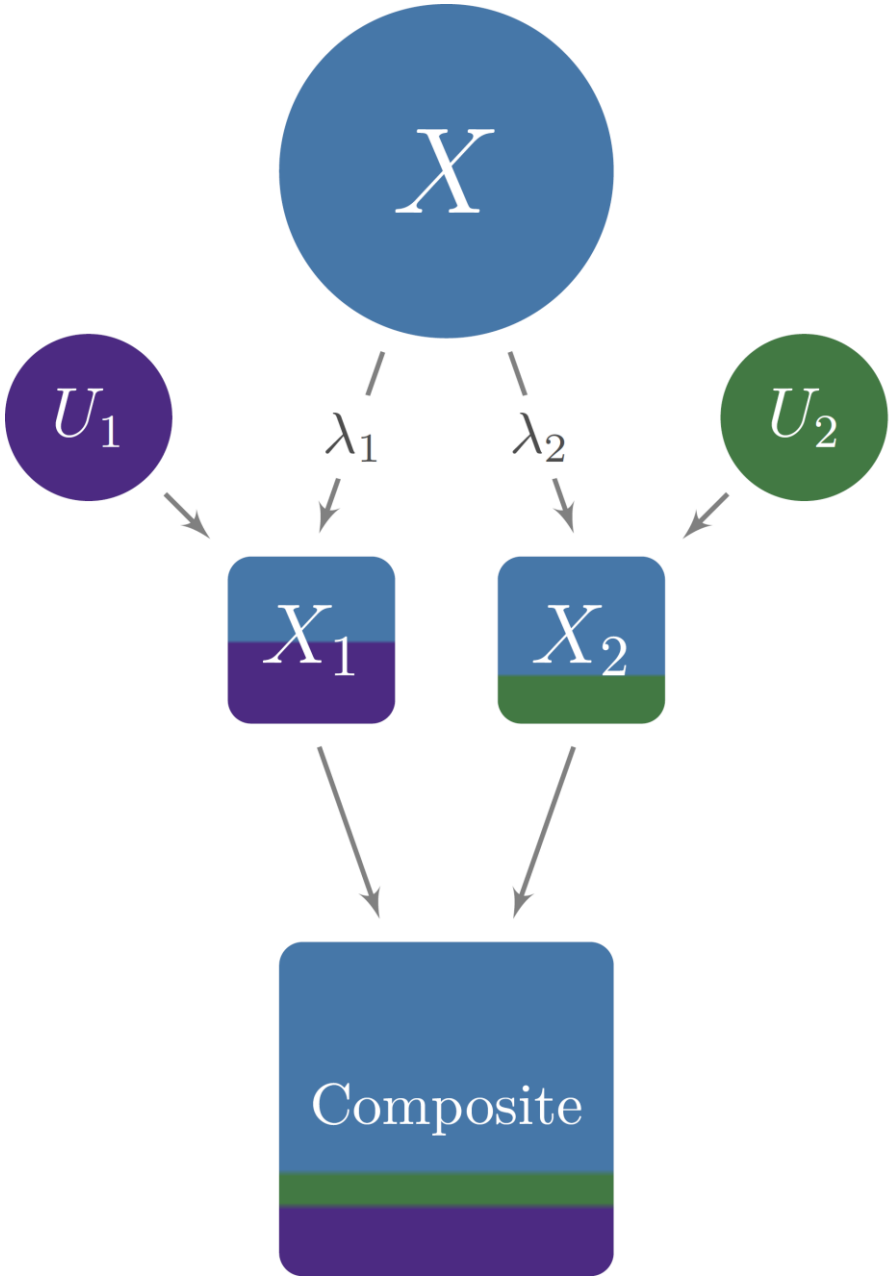
Abstract

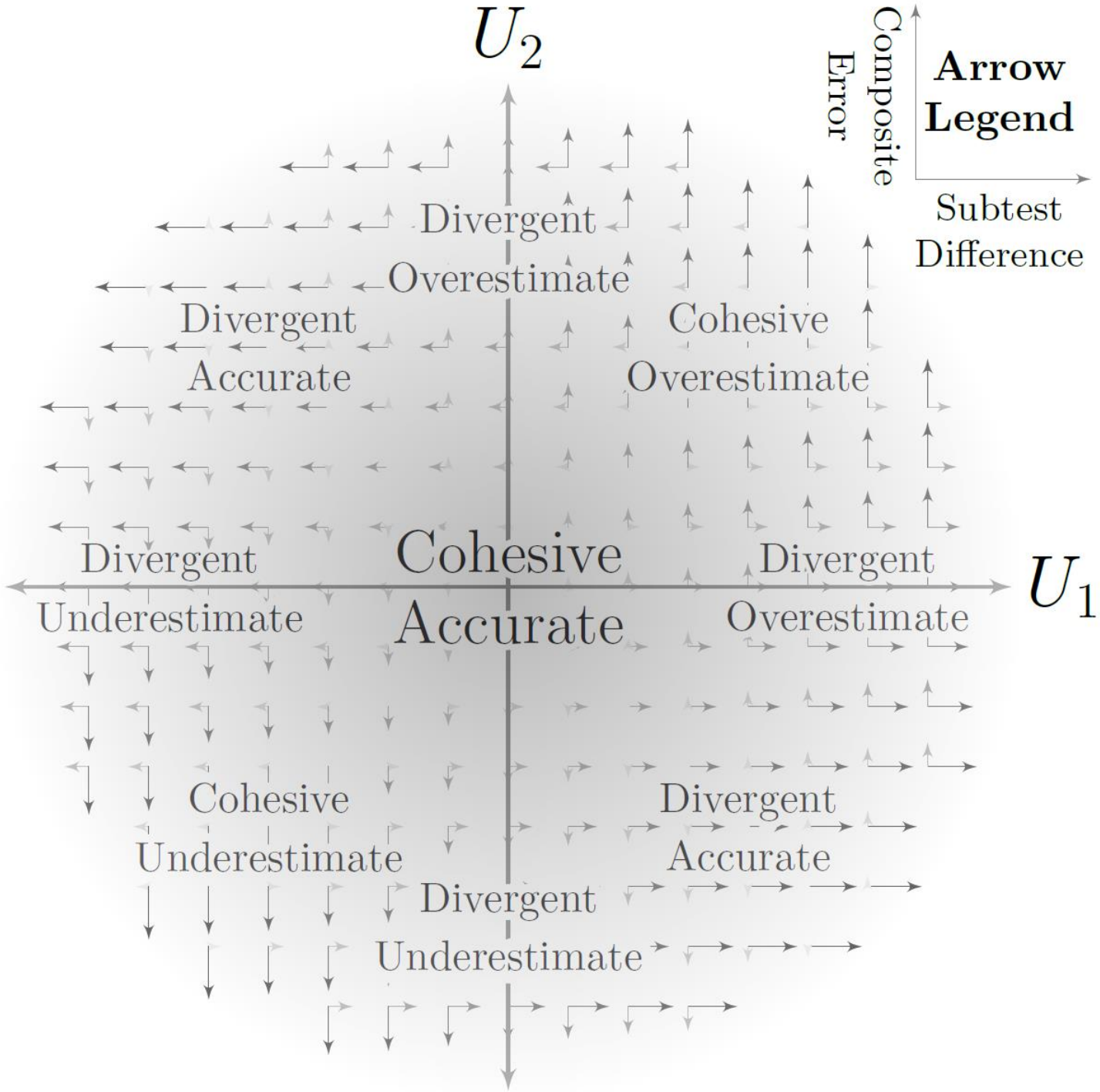
We used data simulations to test whether composites consisting of cohesive subtest scores are more accurate than composites consisting of divergent subtest scores. We demonstrate that when multivariate normality holds, divergent and cohesive scores are equally accurate. Furthermore, excluding divergent scores results in biased estimates of construct scores. We show that obtaining divergent scores should prompt additional testing under some conditions. Although there are many valid reasons to exclude scores from consideration (e.g., malingering, fatigue, and misunderstood directions), no score should be removed from a composite simply because it is different from other scores in the composite.

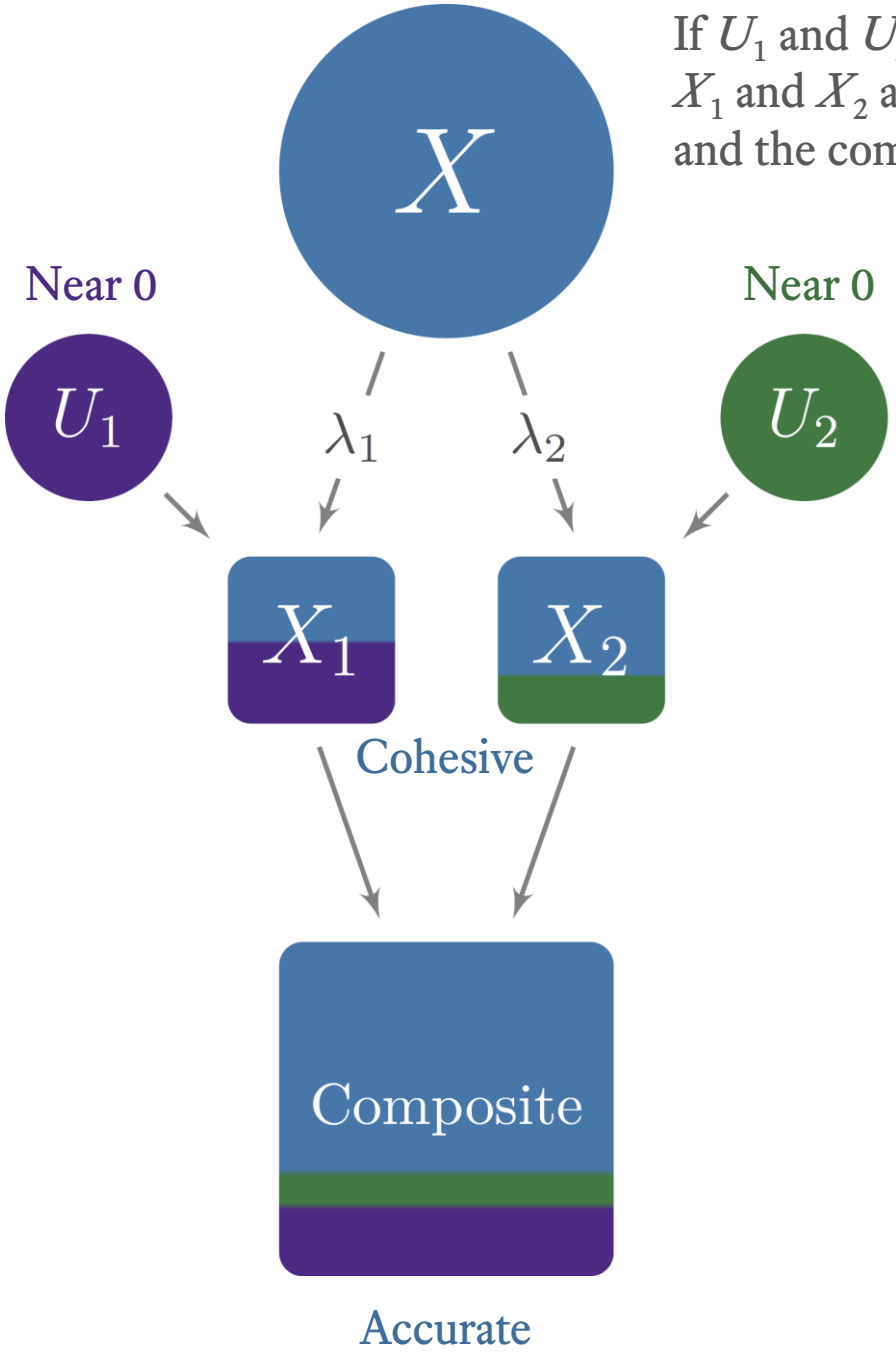


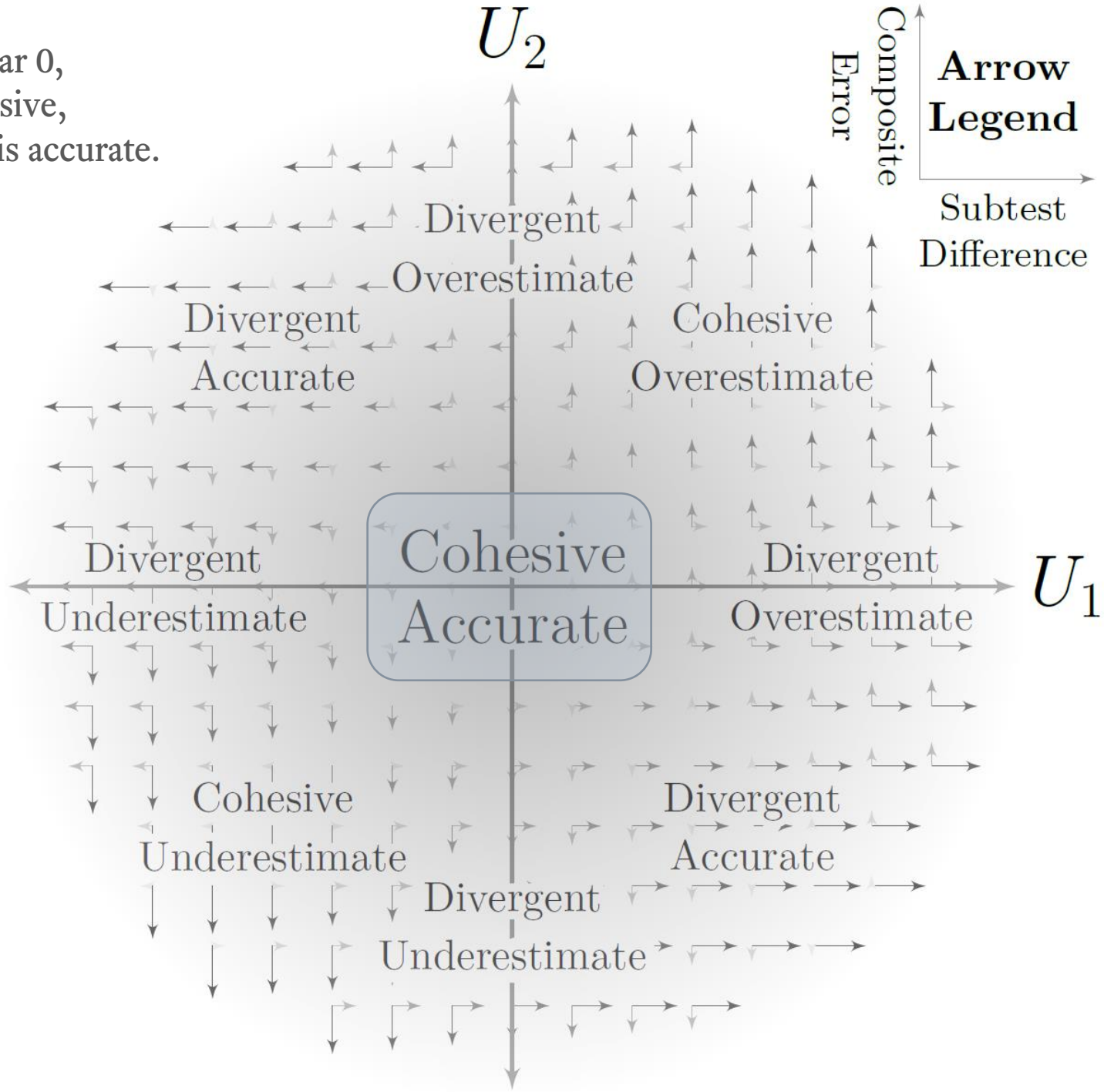
Subtest Score Differences Are Unrelated to Composite Accuracy



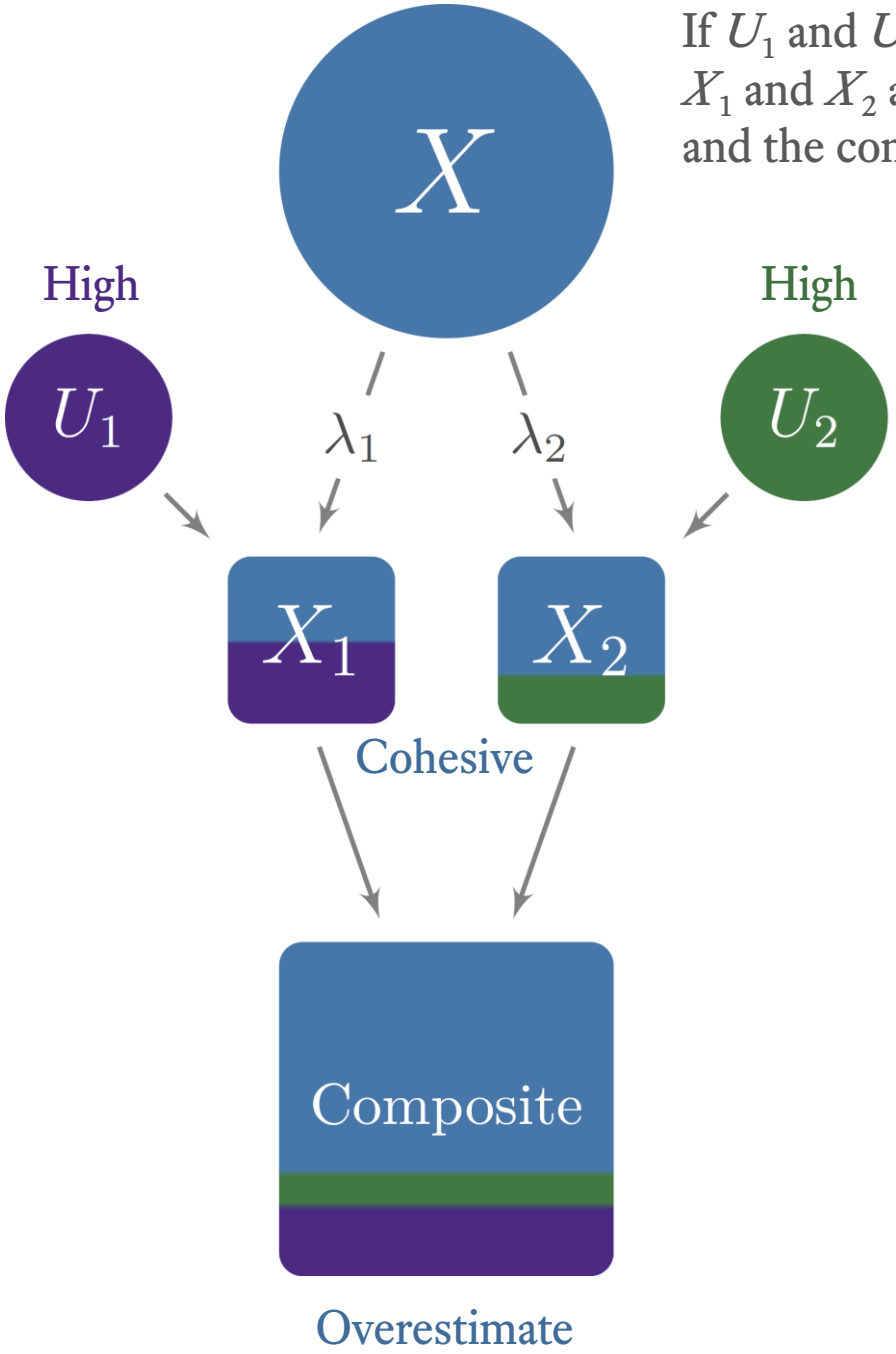

X
U_1
λ_1
λ_2
U_2
X_1
X_2
Composite

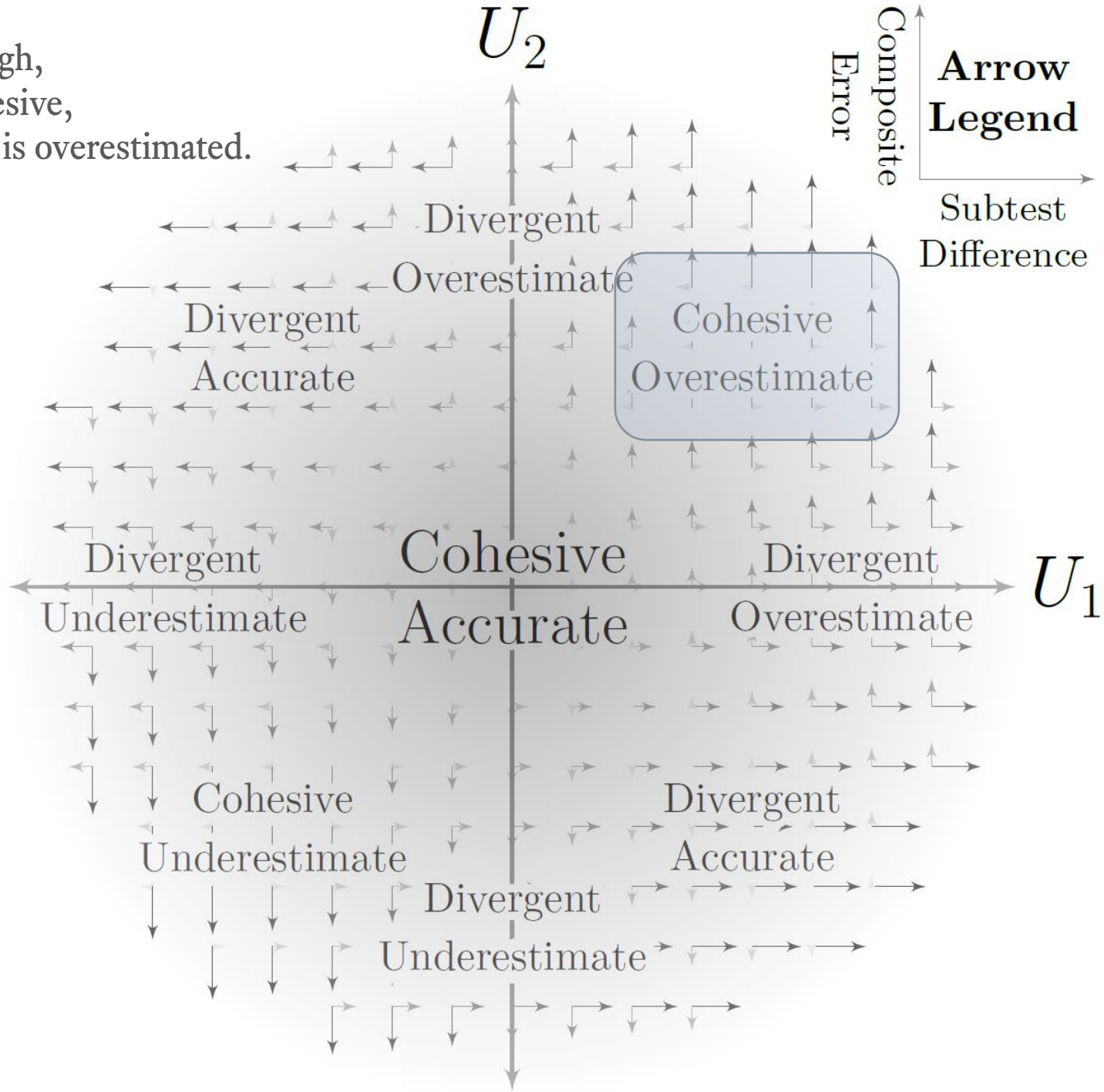

U_2
Composite Error
Arrow Legend
Subtest Difference
Divergent Overestimate
Divergent Accurate
Cohesive Overestimate
Divergent Underestimate
Cohesive Accurate
Divergent Overestimate
Cohesive Underestimate
Divergent Accurate
Divergent Underestimate
U_1


If U_1 and U_2 are near 0,
X_1 and X_2 are cohesive,
and the composite is accurate.
X
Near 0
Near 0
U_1
U_2
λ_1
λ_2
X_1
X_2
Cohesive
Composite
Accurate

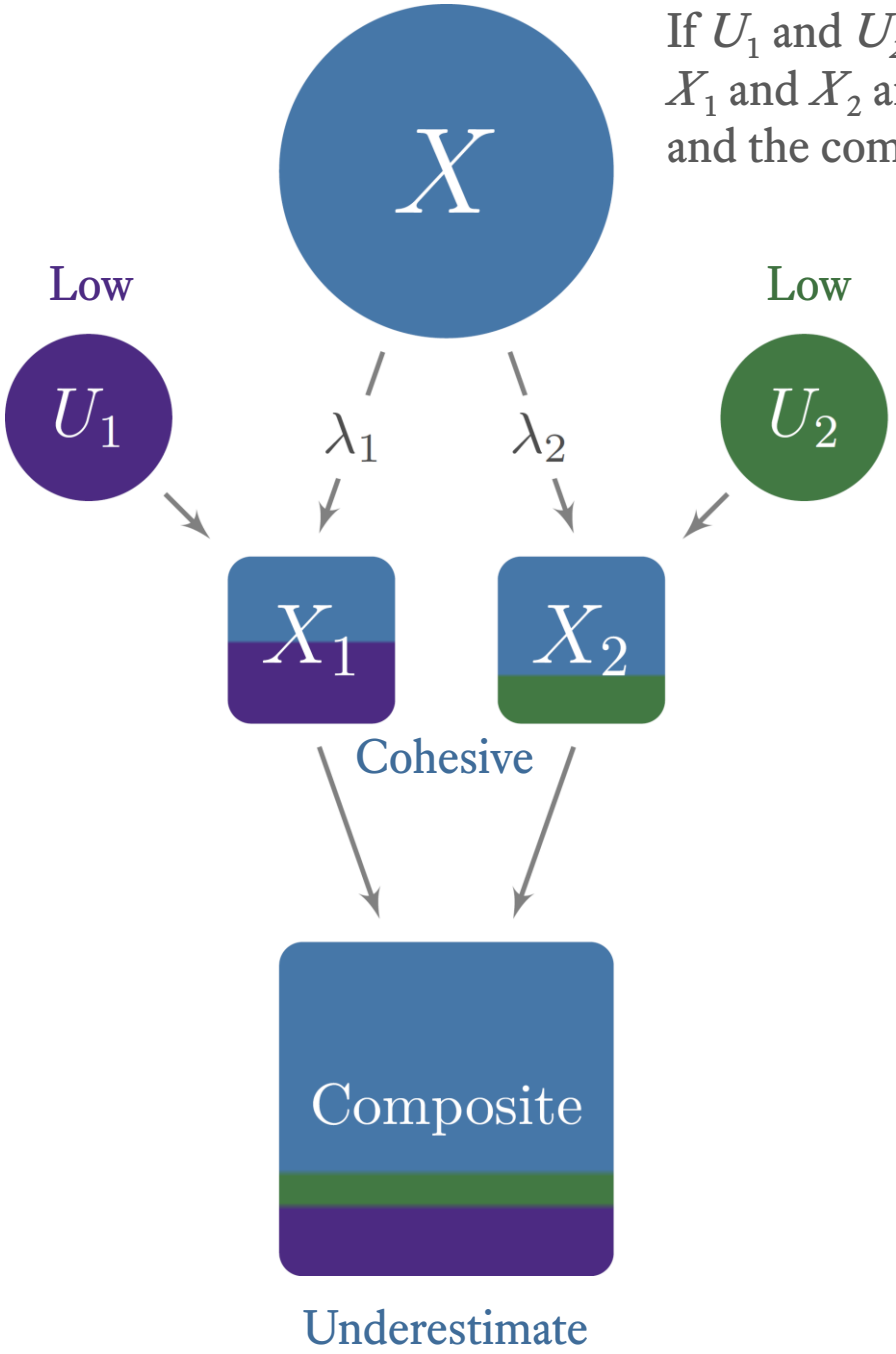

U_2
Composite Error
Arrow Legend
Subtest Difference
Divergent Overestimate
Divergent Accurate
Cohesive Overestimate
Divergent Underestimate
Cohesive Accurate
Divergent Overestimate
Cohesive Underestimate
Divergent Accurate
Divergent Underestimate
U_1

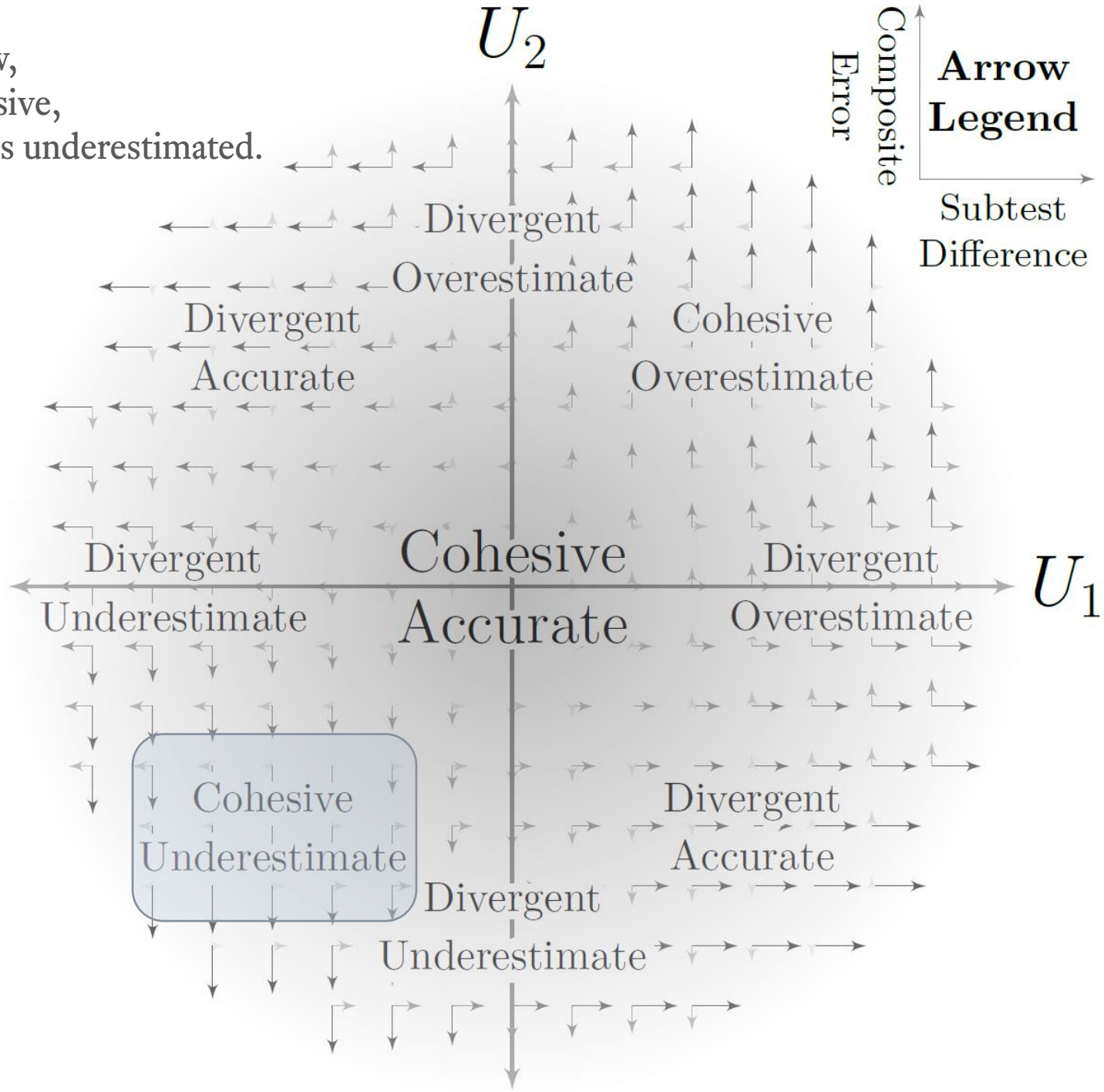
If U_1 and U_2 are high,
X_1 and X_2 are cohesive,
and the composite is overestimated.



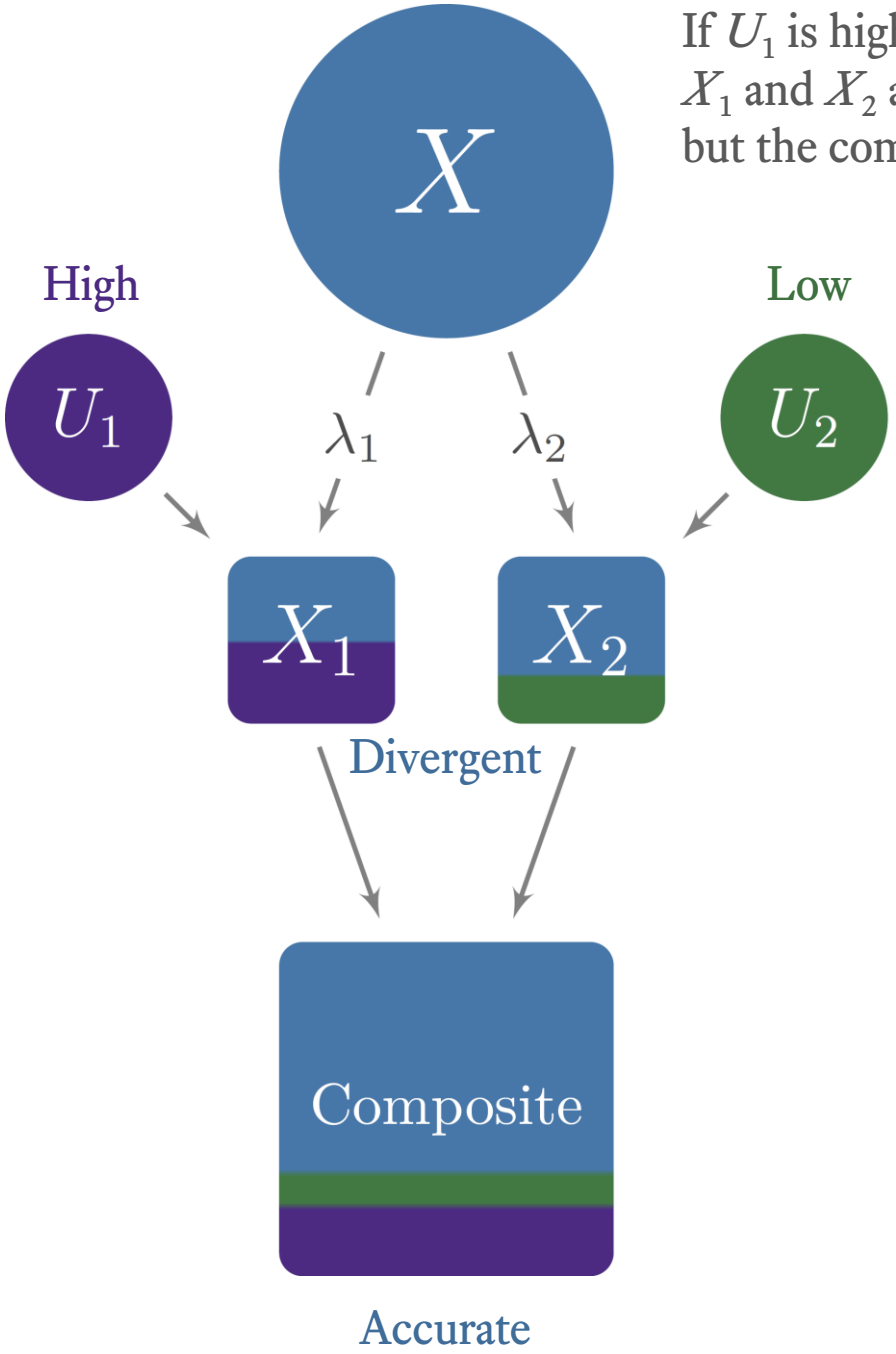


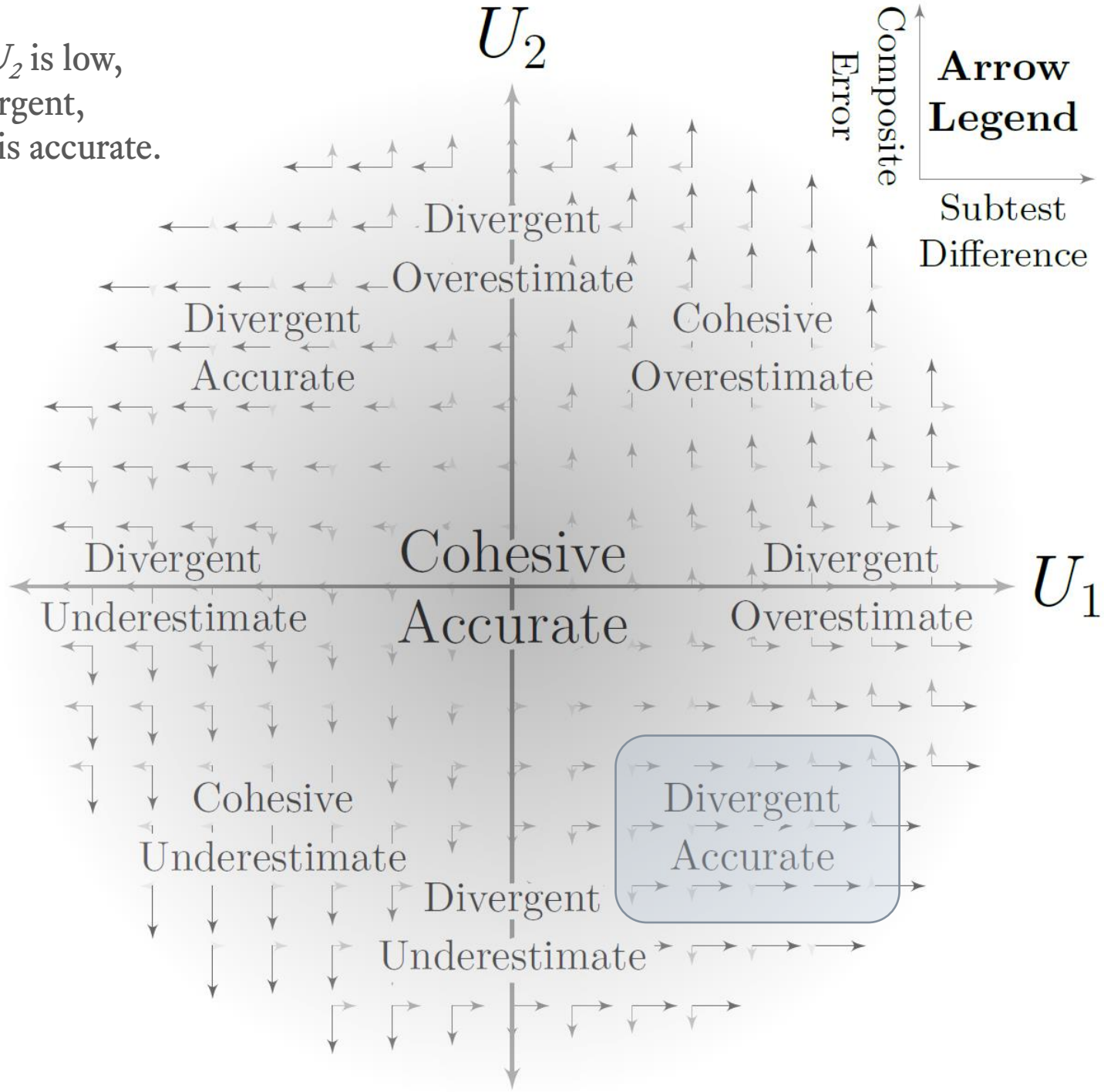
If U_1 and U_2 are low,
X_1 and X_2 are cohesive,
and the composite is underestimated.



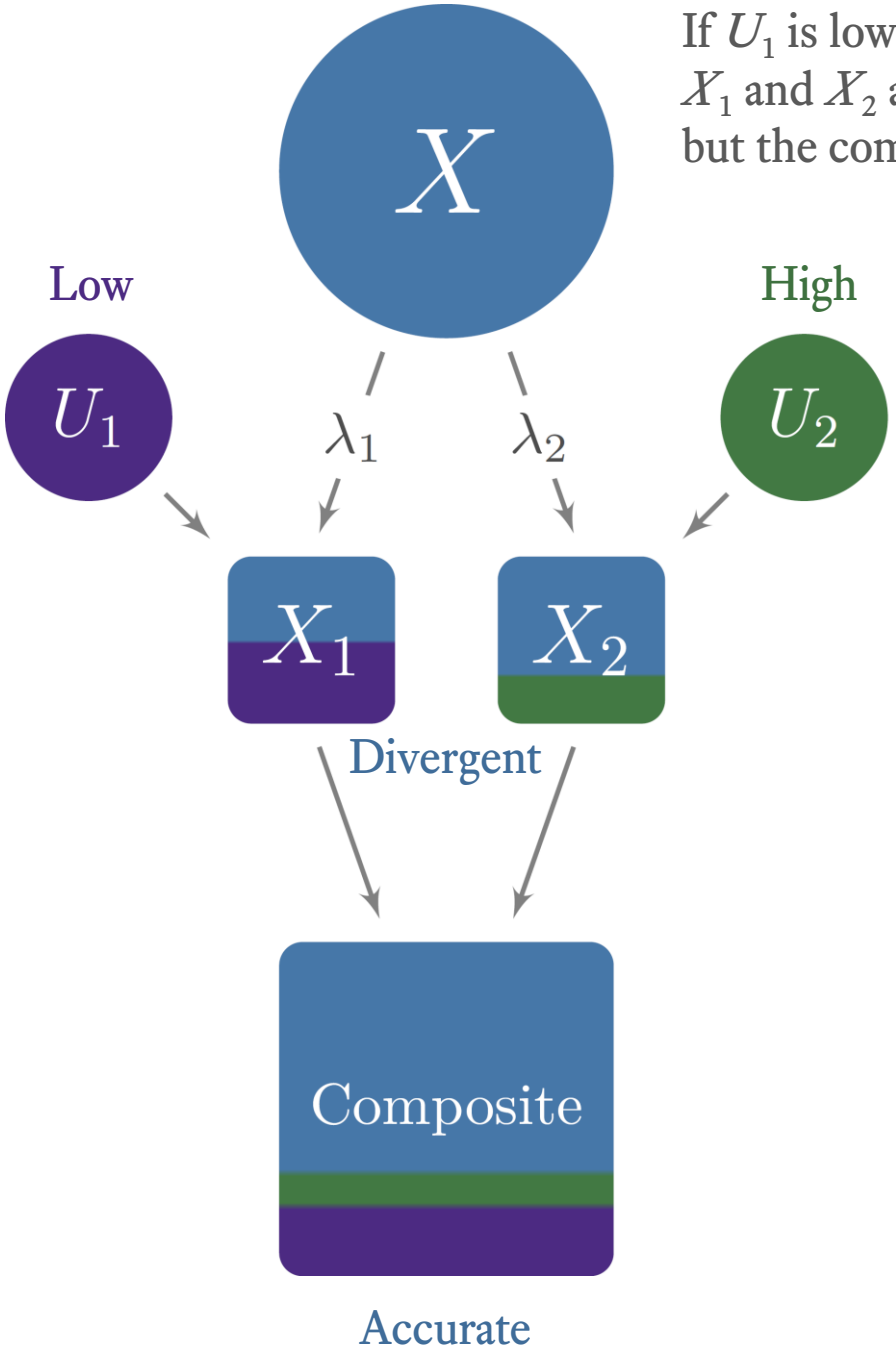


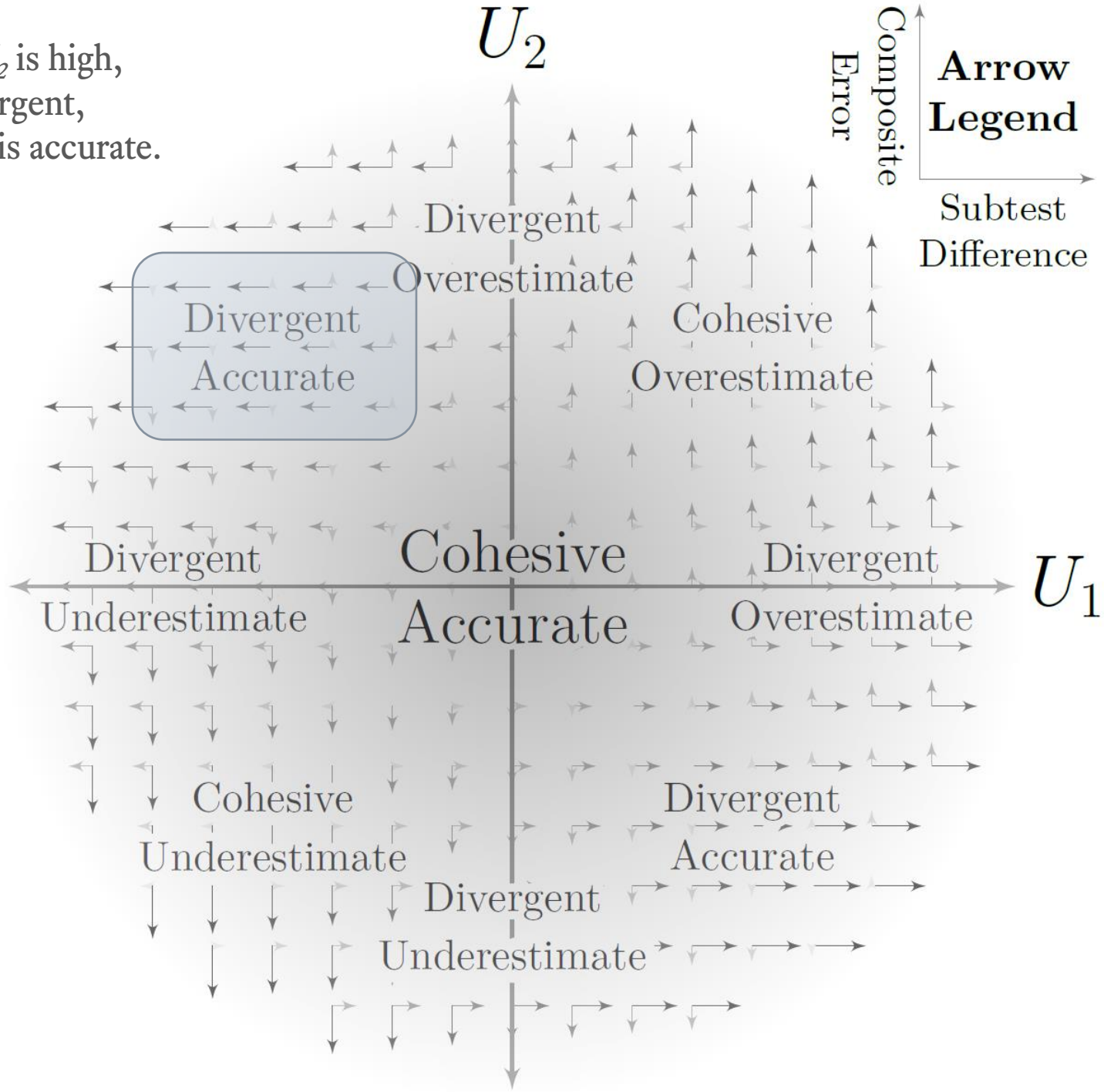
If U_1 is high, and U_2 is low,
X_1 and X_2 are divergent,
but the composite is accurate.



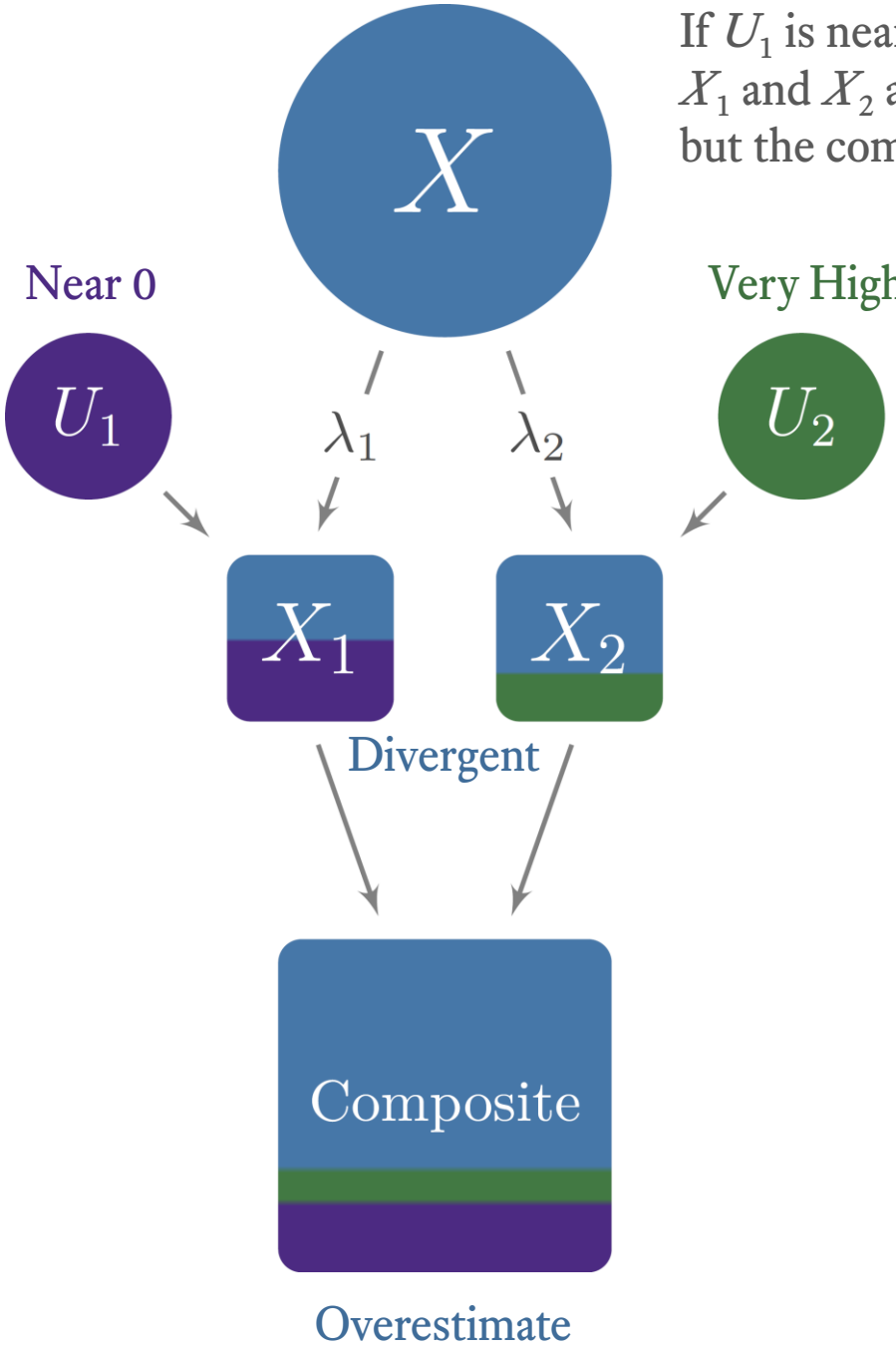


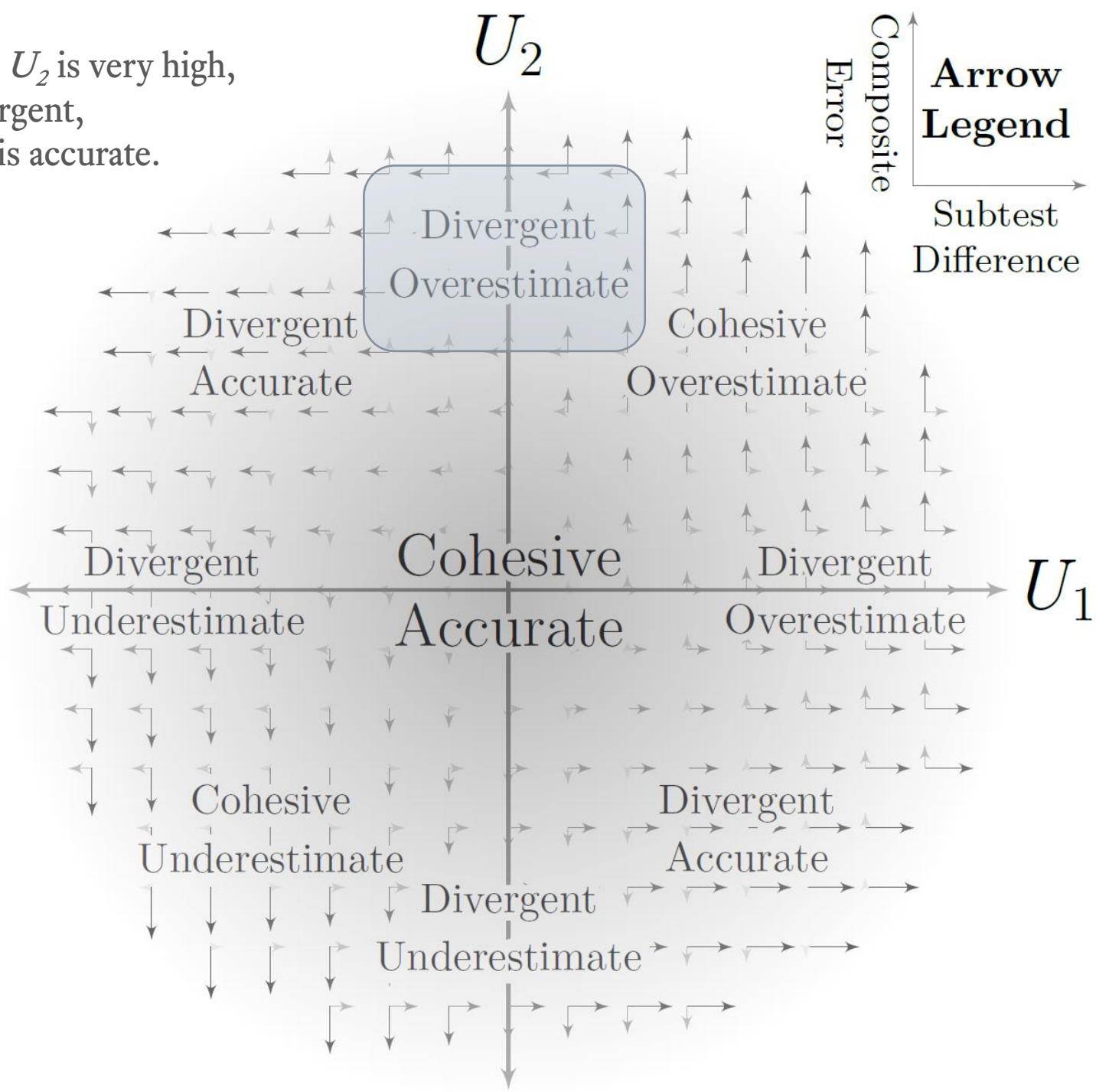
If U_1 is low, and U_2 is high,
X_1 and X_2 are divergent,
but the composite is accurate.



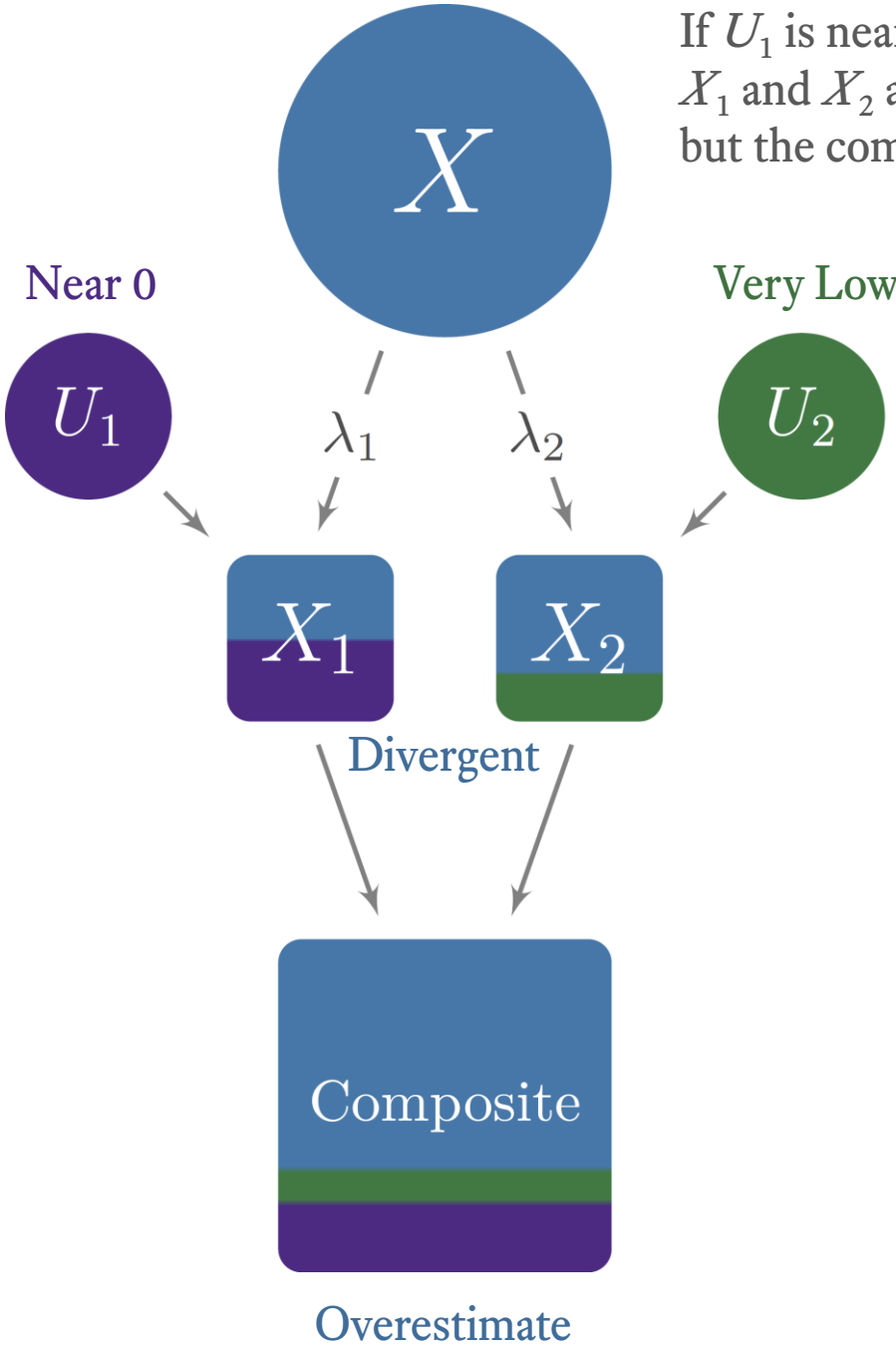


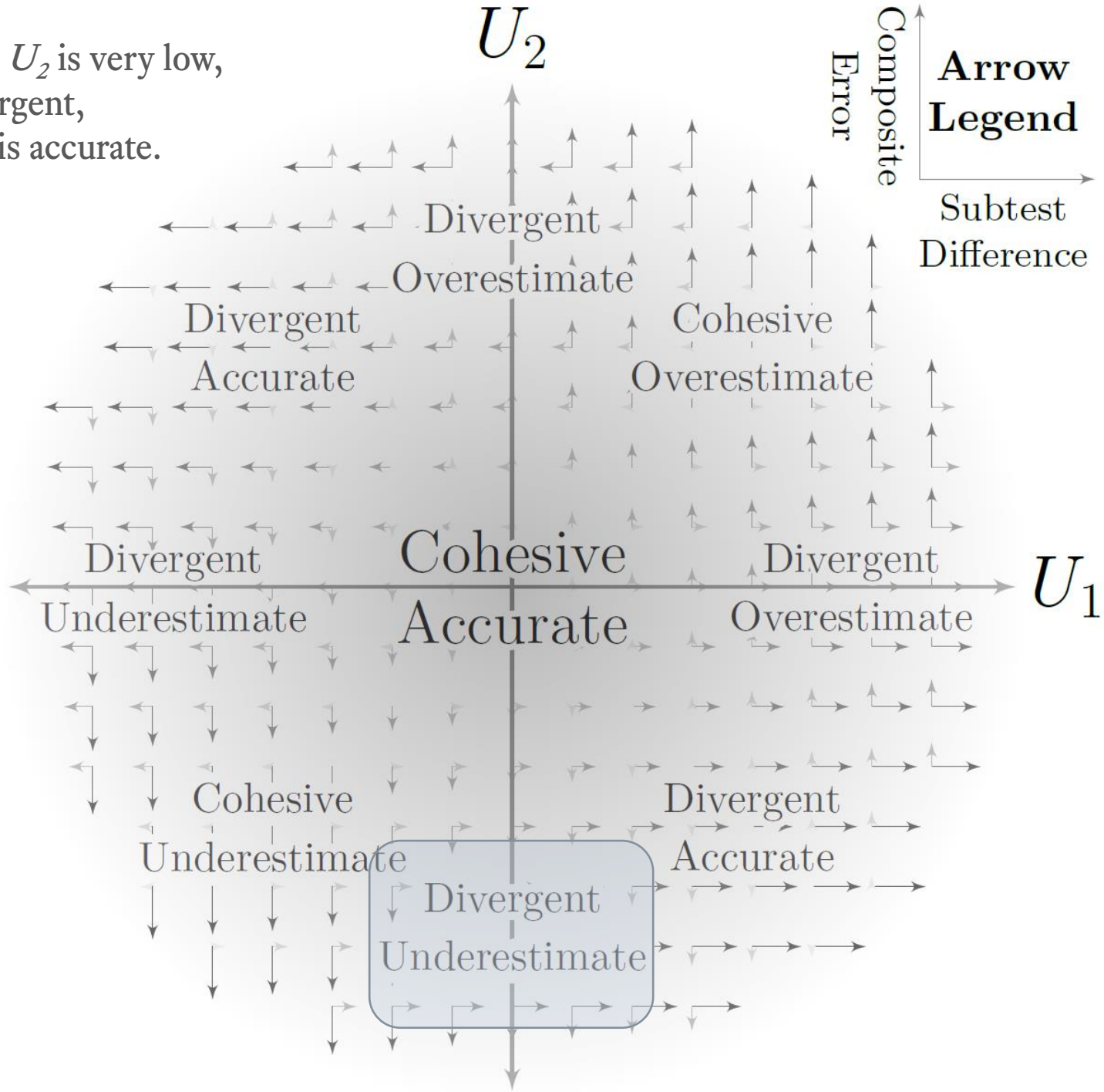
If U_1 is near 0, and U_2 is very high,
X_1 and X_2 are divergent,
but the composite is accurate.

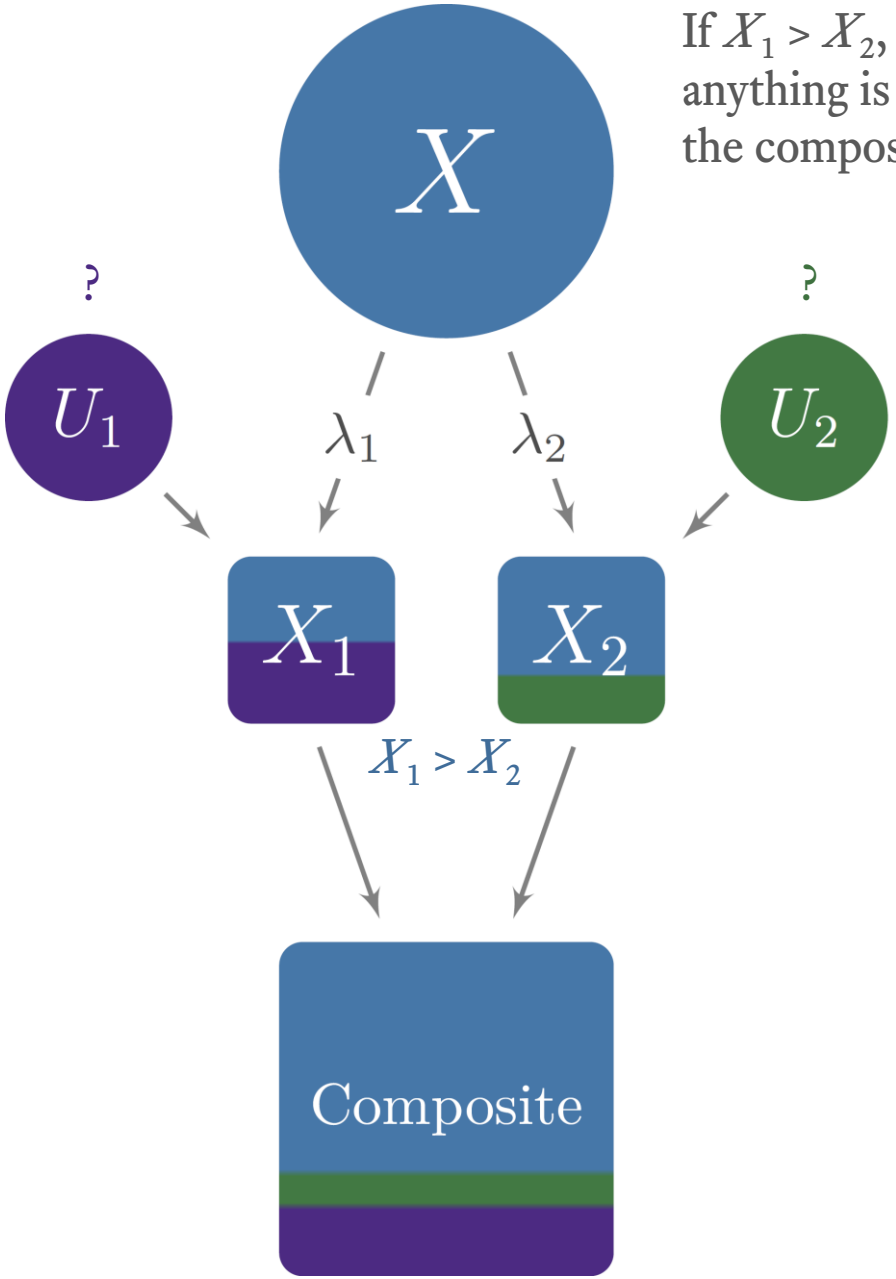




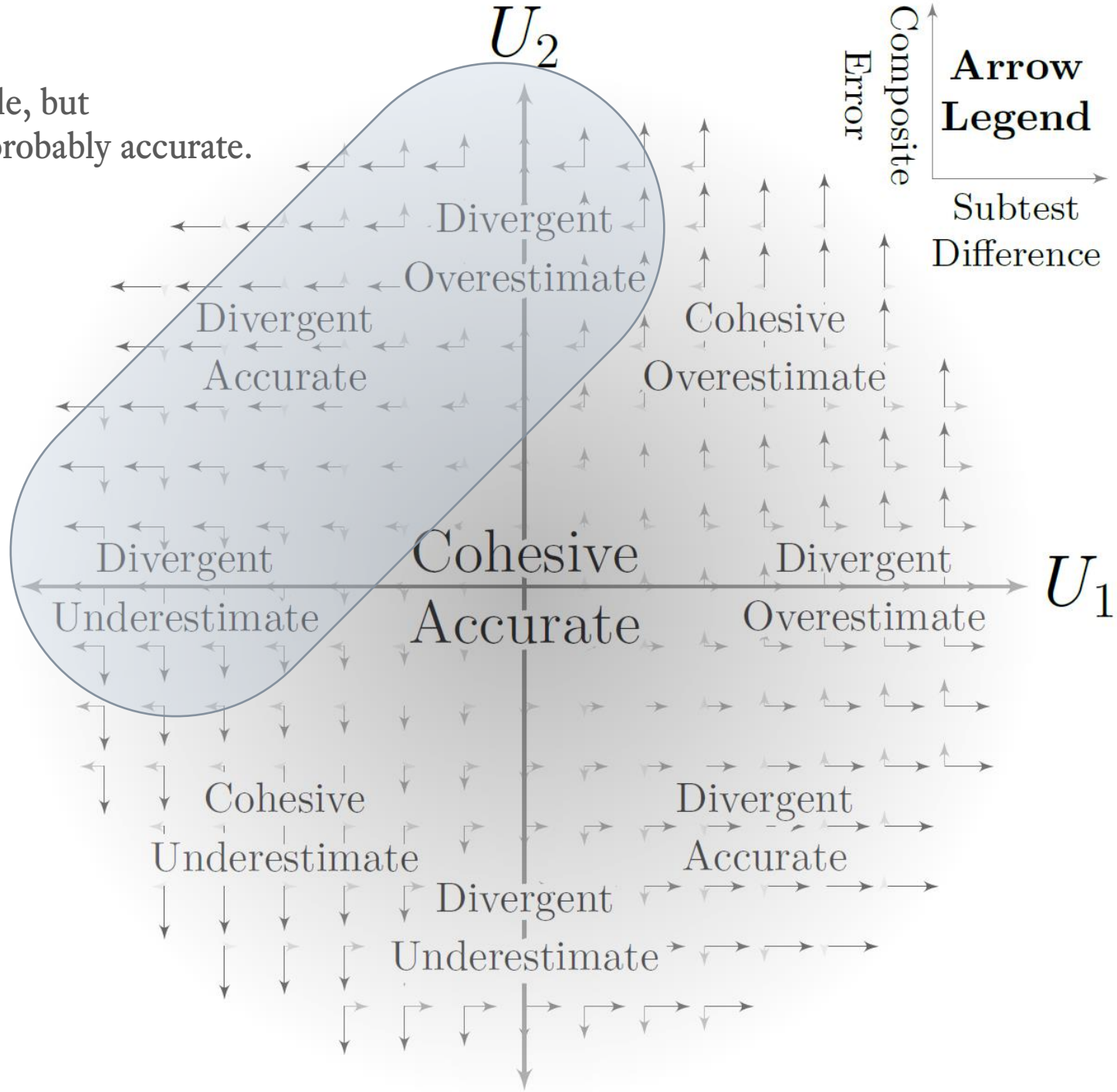
If U_1 is near 0, and U_2 is very low,
X_1 and X_2 are divergent,
but the composite is accurate.

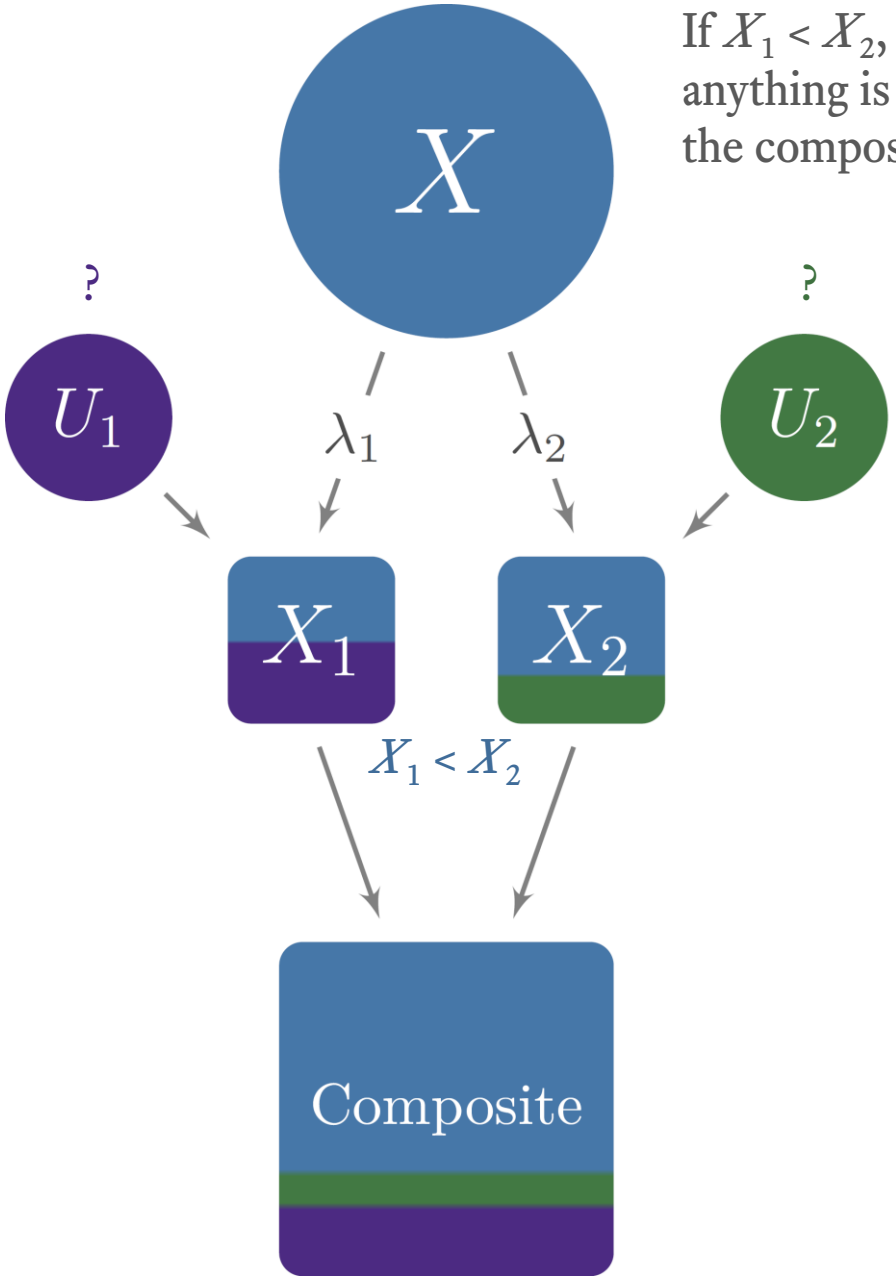




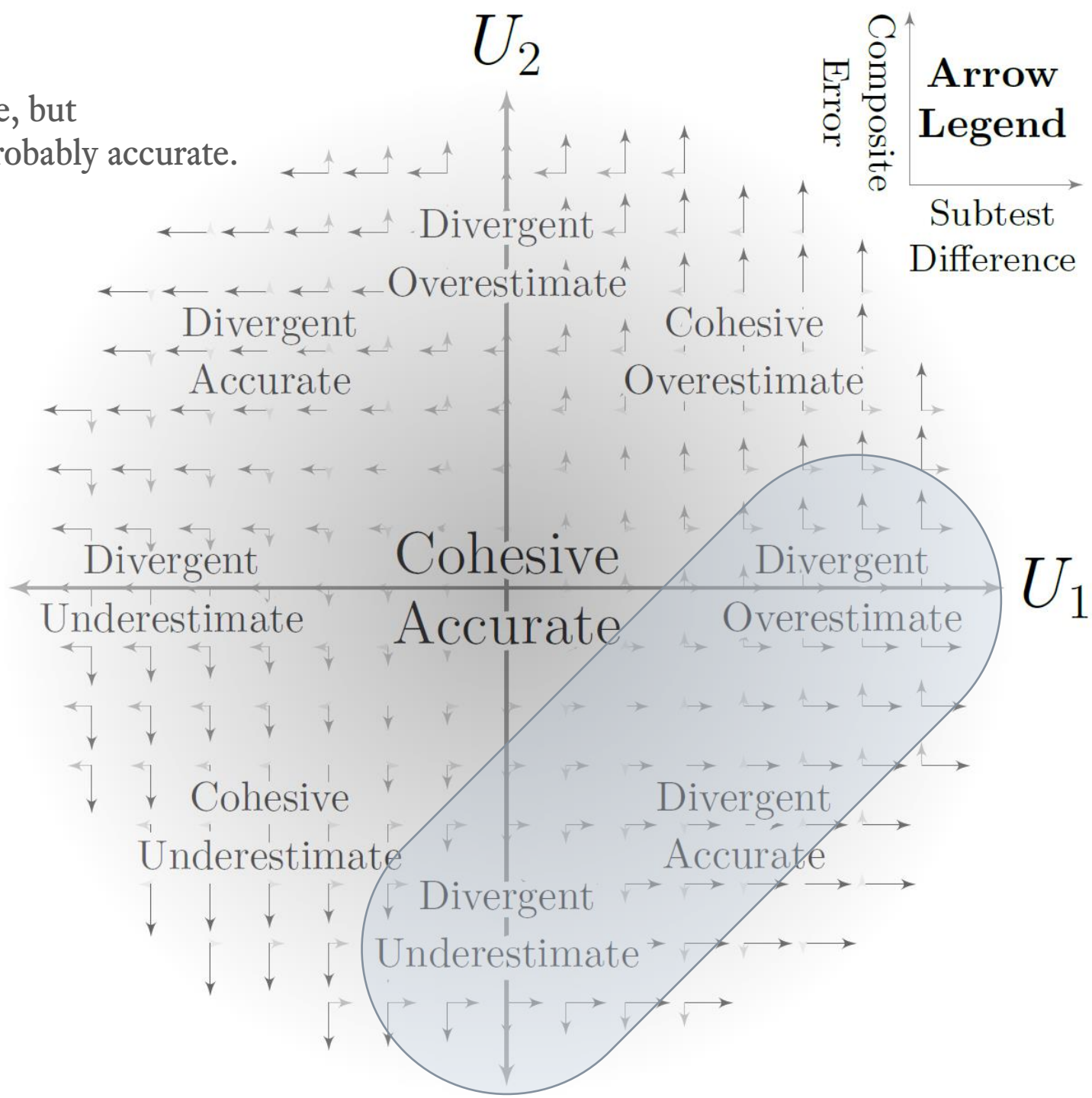


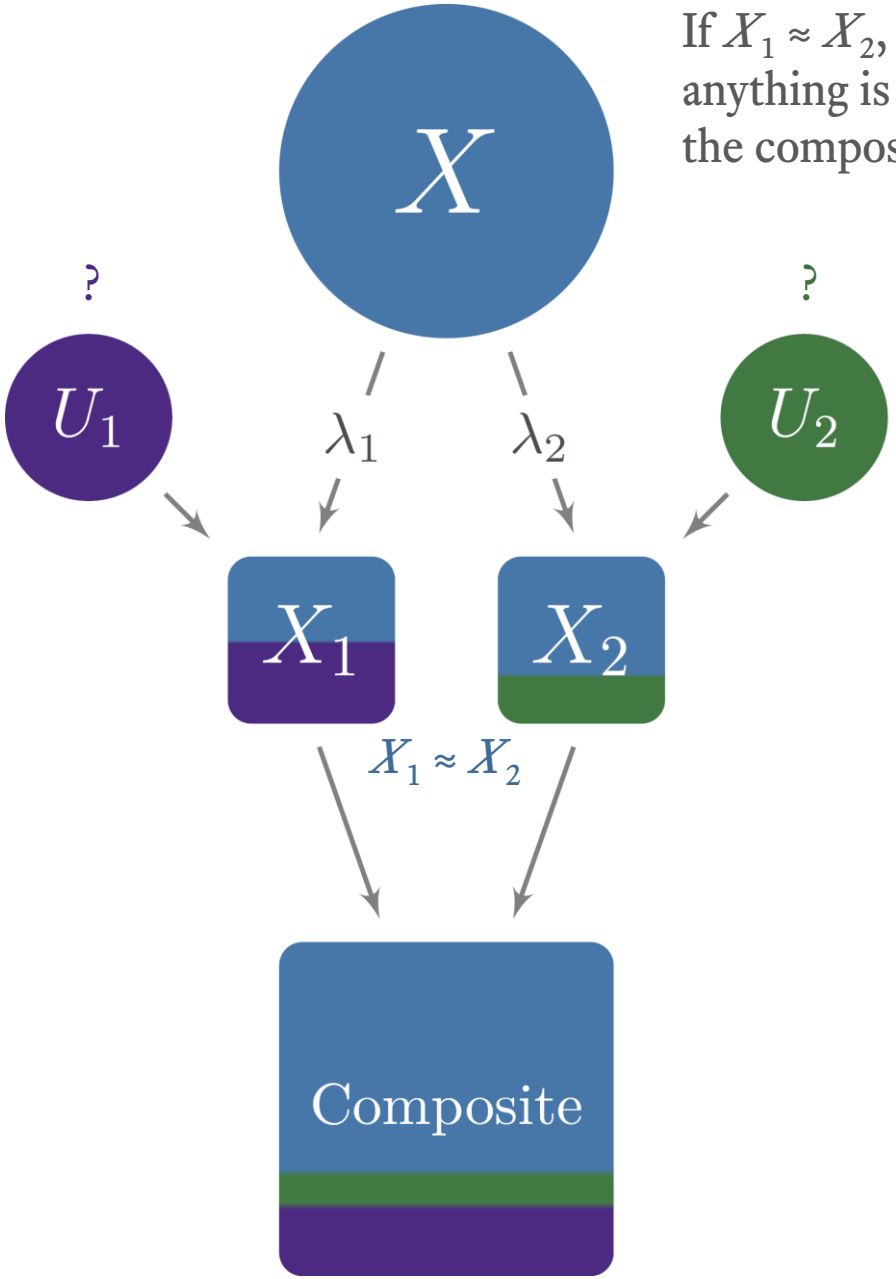
If $X_1 > X_2$,
anything is possible, but
the composite is probably accurate.



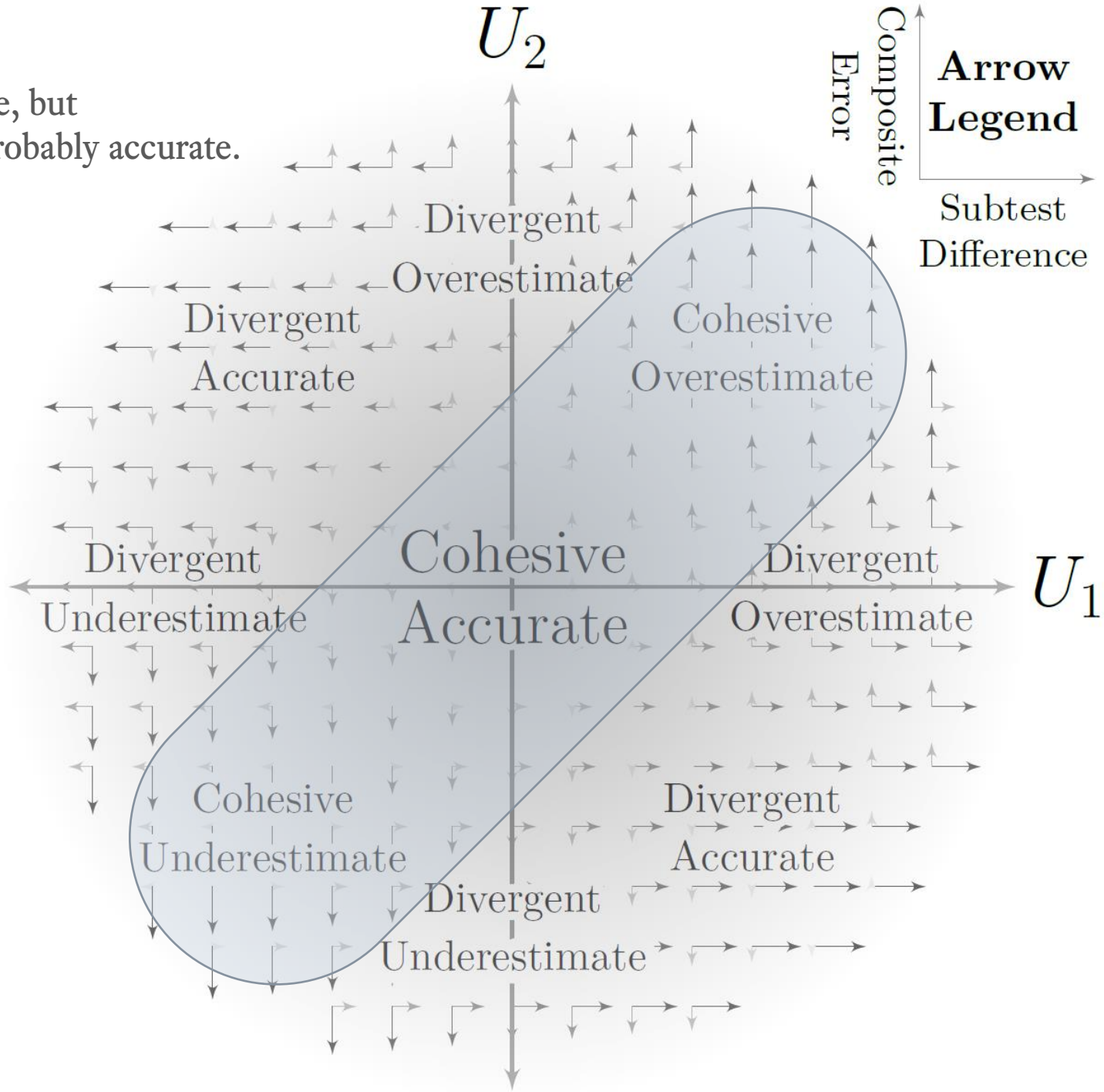


If $X_1 < X_2$,
anything is possible, but
the composite is probably accurate.





If $X_1 \approx X_2$,
anything is possible, but
the composite is probably accurate.

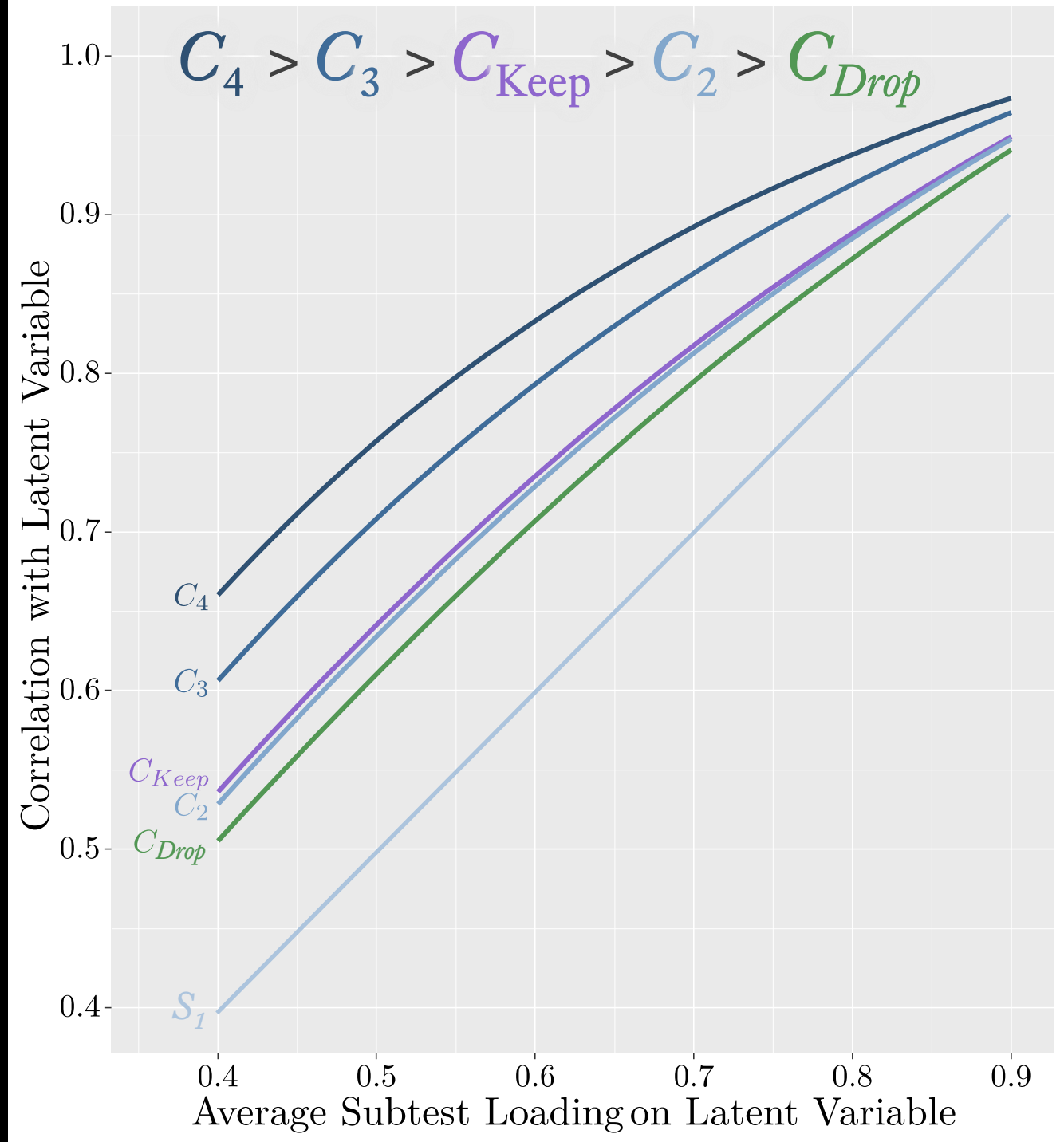


Assuming Multivariate Normality,

Dropping Divergent Scores Lowers the Validity of the Estimate

Composite Scores

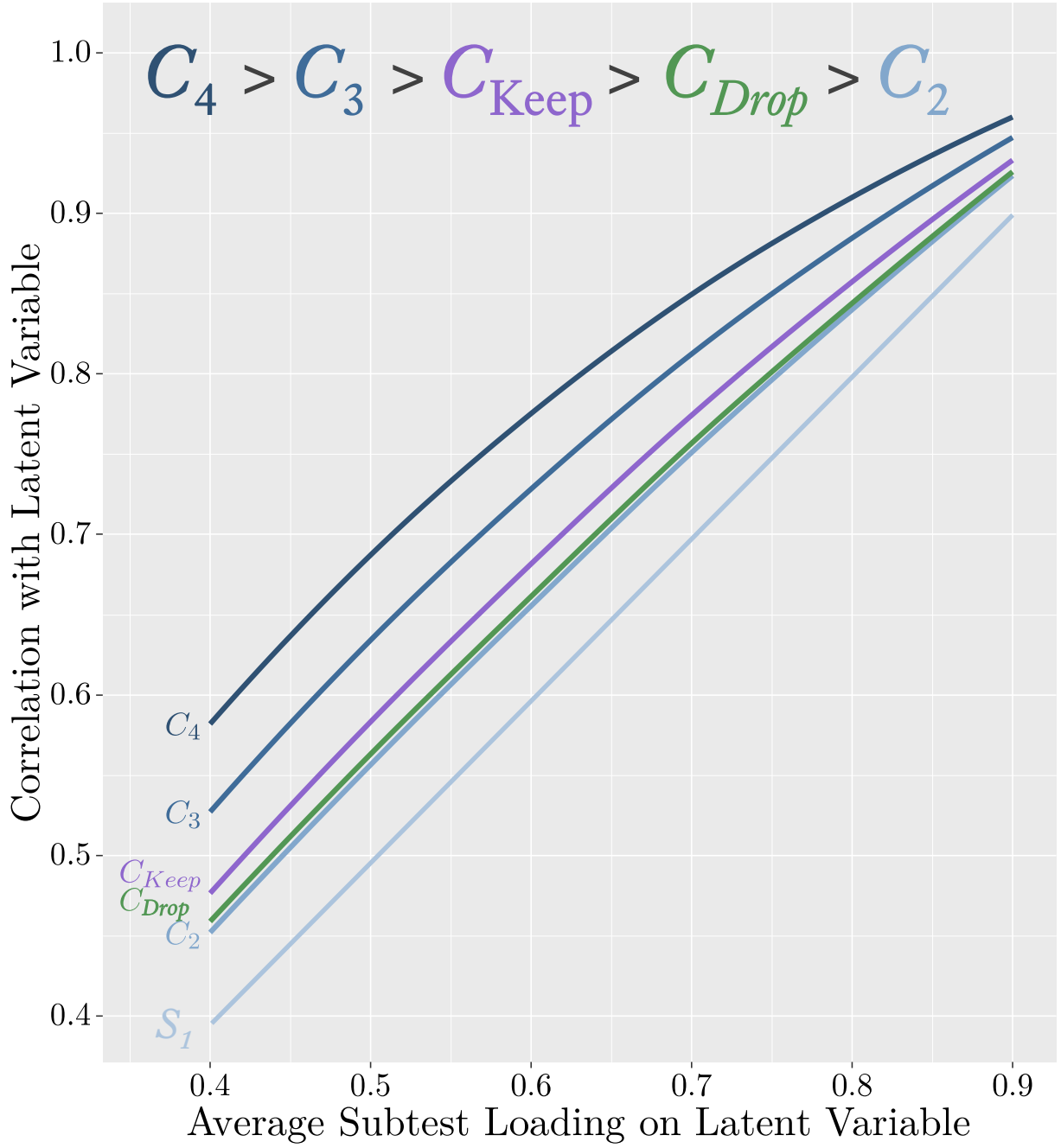
S_1 = Always give 1 test
C_2 = Always give 2 tests
C_3 = Always give 3 tests
C_4 = Always give 4 tests
C_{Drop} = Give more tests if divergent, drop divergent scores
C_{Keep} = Give more tests if divergent, keep divergent scores

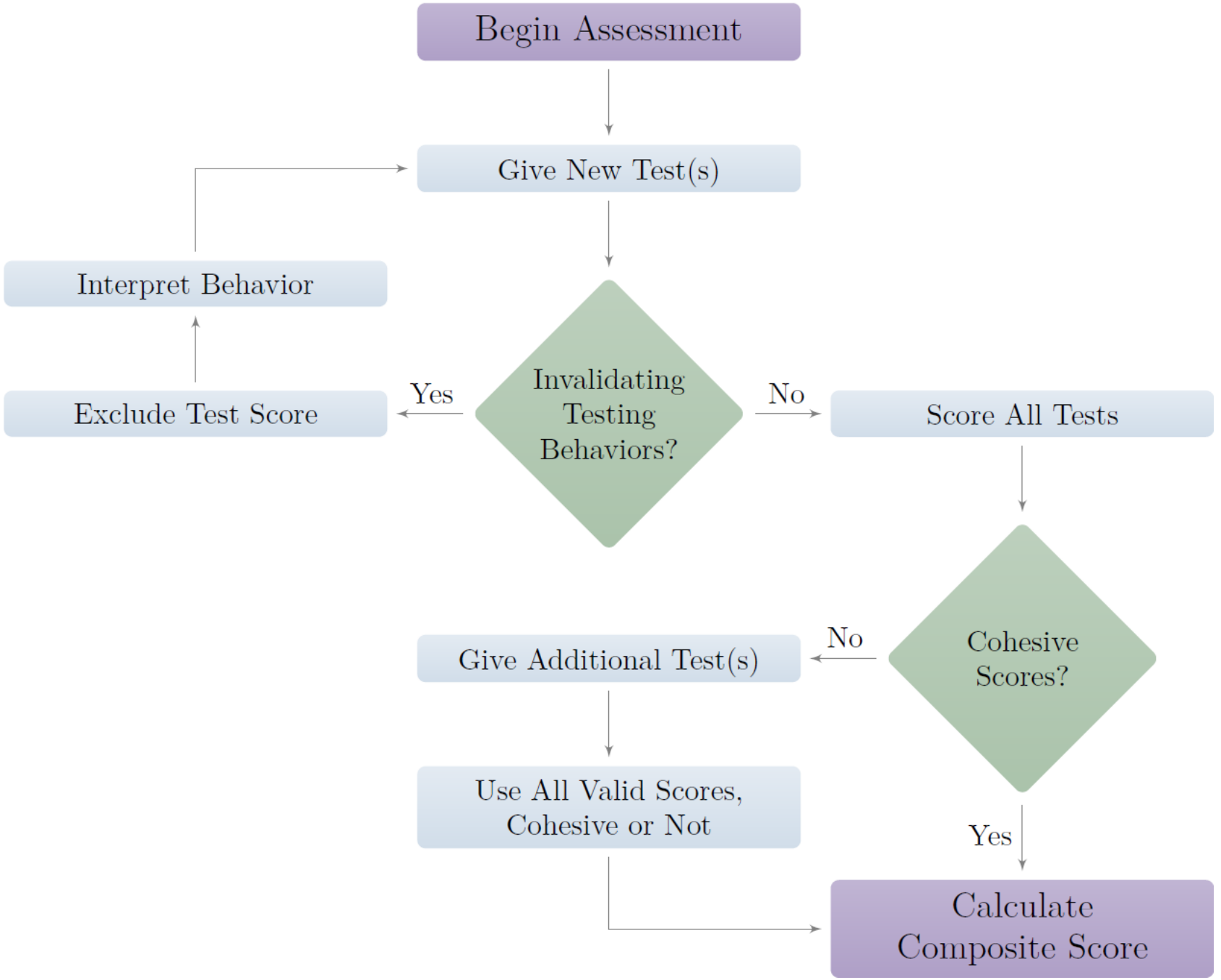


Assuming Non-Normal Errors,
Dropping Divergent Scores
Still Lowers the Validity
of the Estimate

Composite Scores

C_2 = Always give 2 tests
C_3 = Always give 3 tests
C_4 = Always give 4 tests
C_{Drop} = Give more tests if divergent, drop divergent scores
C_{Keep} = Give more tests if divergent, keep divergent scores





Large Differences Can Prompt Further Testing, But Use All Valid Scores, Cohesive or Not.

Misconception

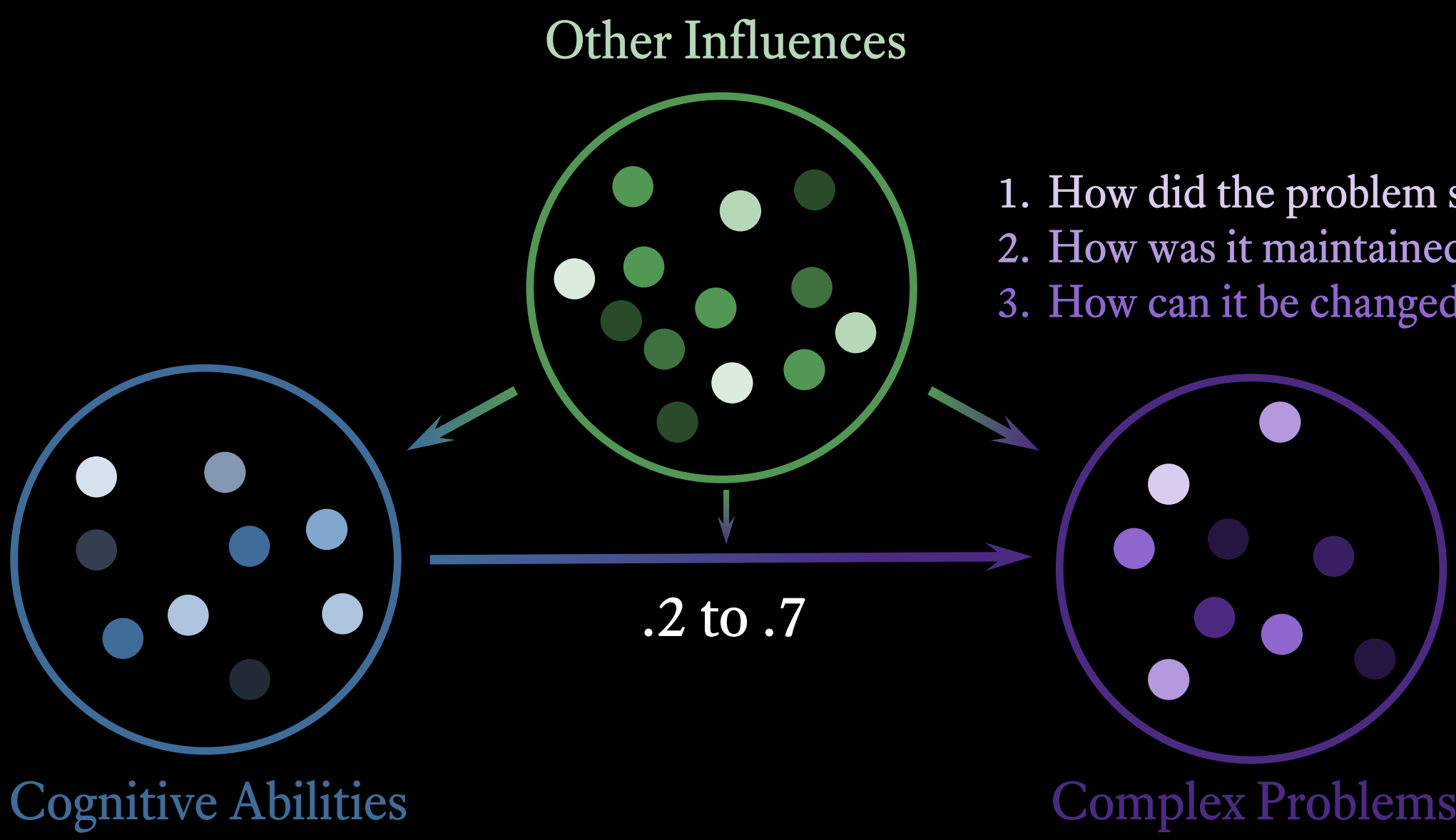
Divergent Scores Invalidate Composite Scores

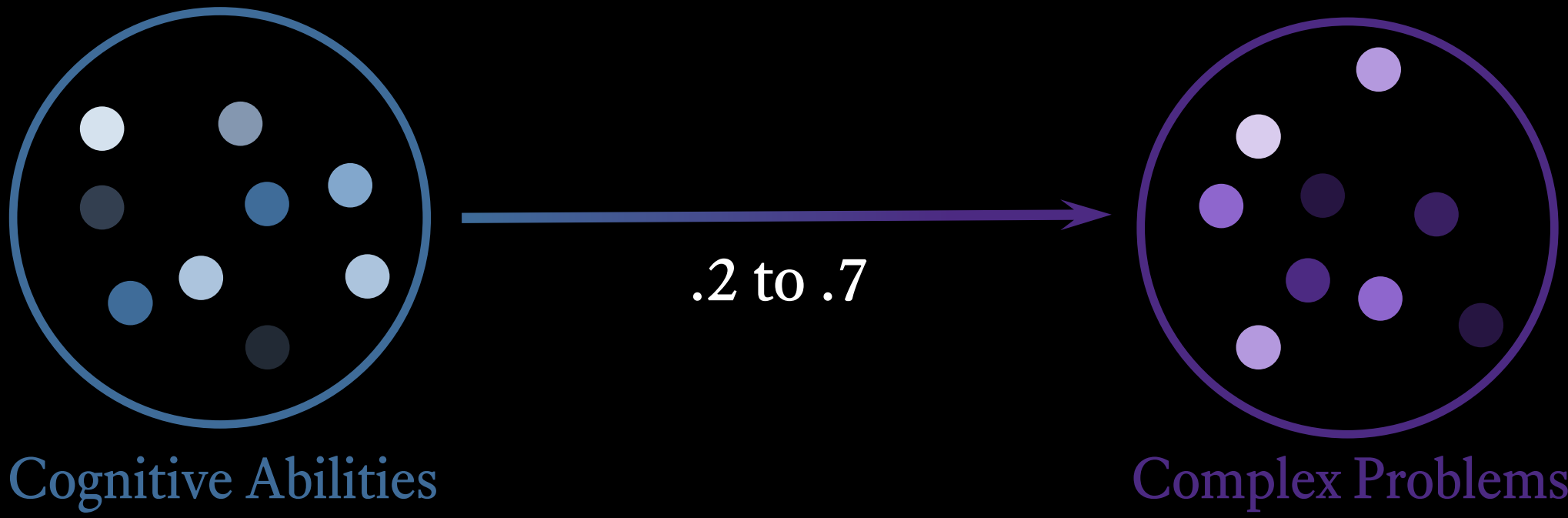
Reality

Excluding Outliers Will Bias the Composite Score

Responsible Use of Cognitive Ability Assessment Data

- Humility
- Prudence
- Empathy


Other Influences
1. How did the problem start?
2. How was it maintained?
3. How can it be changed?
.2 to .7
Cognitive Abilities
Complex Problems


.2 to .7
Cognitive Abilities
Complex Problems

Explanation 1

On a test in which Judy had to repeat words and segment them into individual phonemes, Judy earned a standard score of 78, which is in the Borderline Range. Only 7 percent of children performed at Judy's level or lower on this test. This test is a good predictor of the ability to read single words isolated from contextual cues. On a test that measures this ability, Judy scored an 83, which is in the 13th percentile and is considered to be in the Low Average Range.

Explanation 1

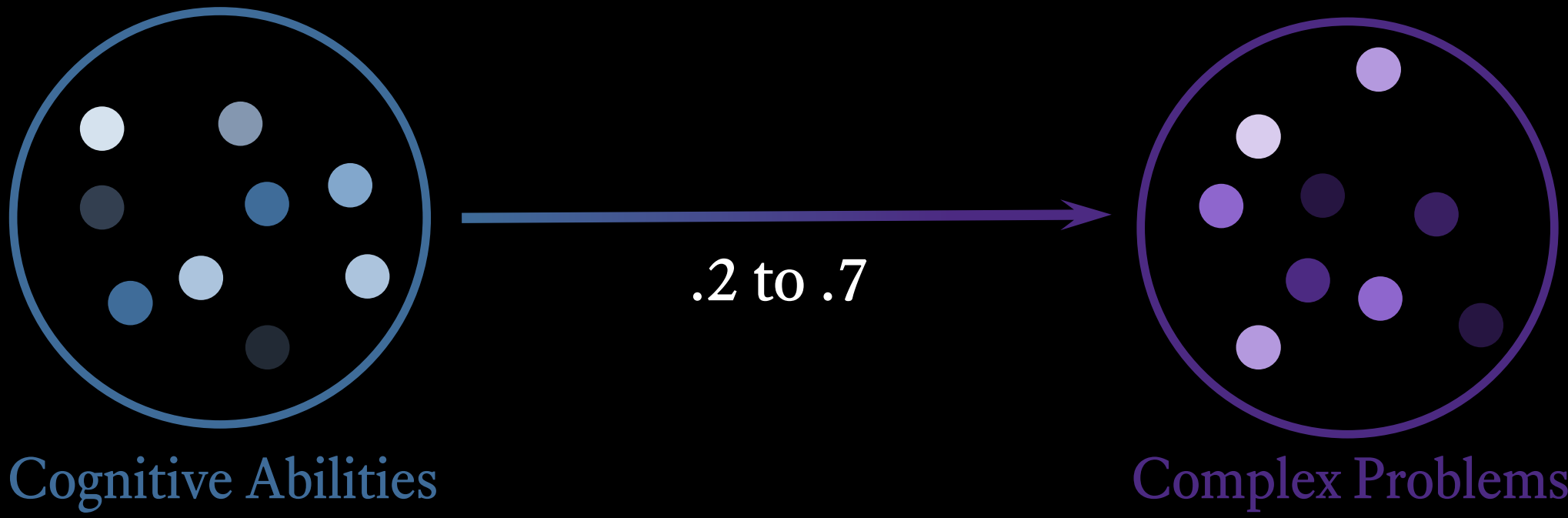
Reading single words is necessary to understand sentences and paragraphs. On a test that requires the evaluee to read a paragraph and then answer questions that test the evaluee's understanding of the text, Judy scored an 84, which is in the 14th percentile and in the Low Average Range.

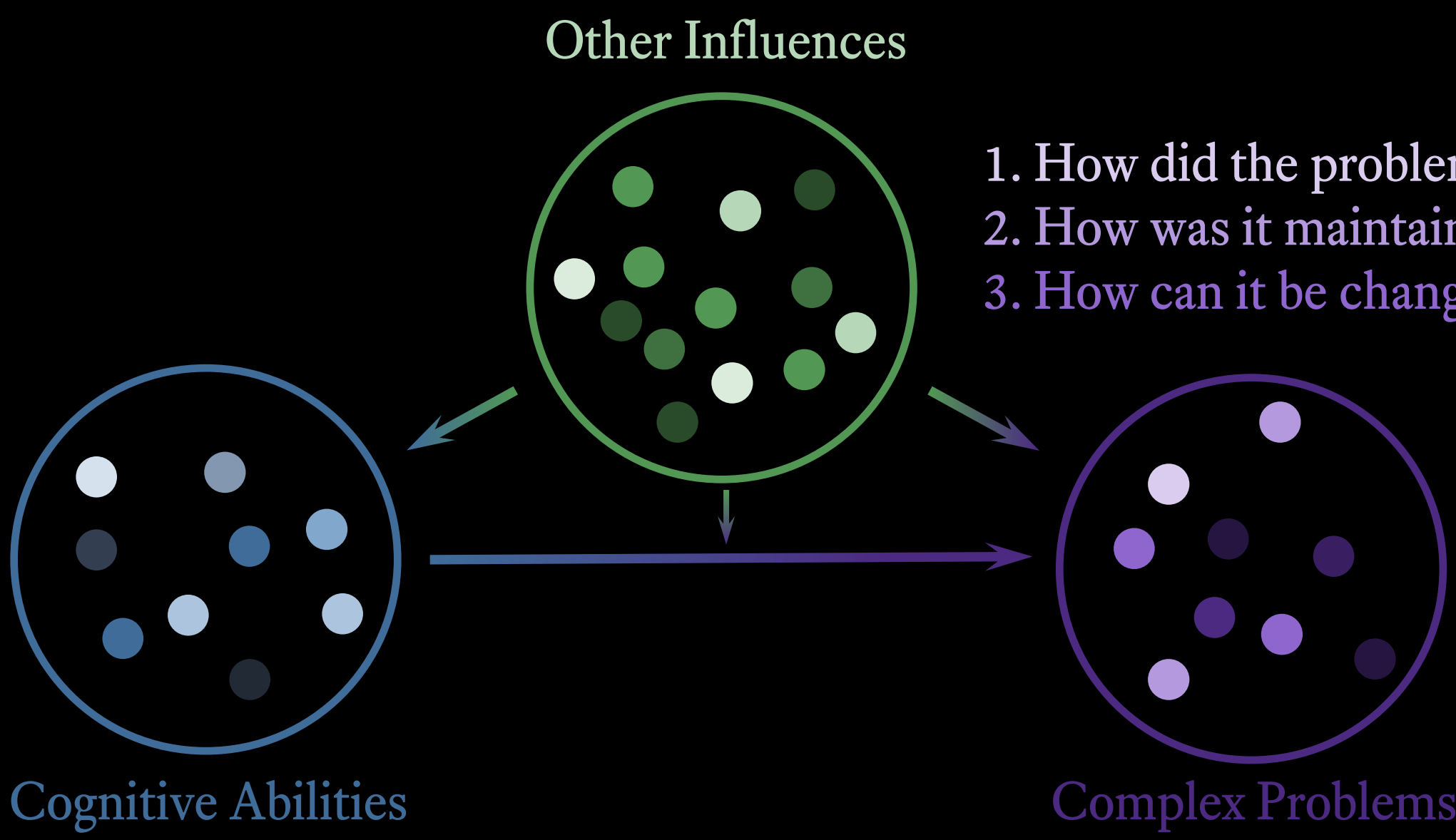
Explanation 1

An 84 in Reading Comprehension is 24 points lower than her Full Scale IQ of 110 (75th percentile, High Average Range). This is significant at the .01 level and only 3% of children in Judy's age range have a 24-point discrepancy or larger between Reading Comprehension and Full Scale IQ.

Explanation 1

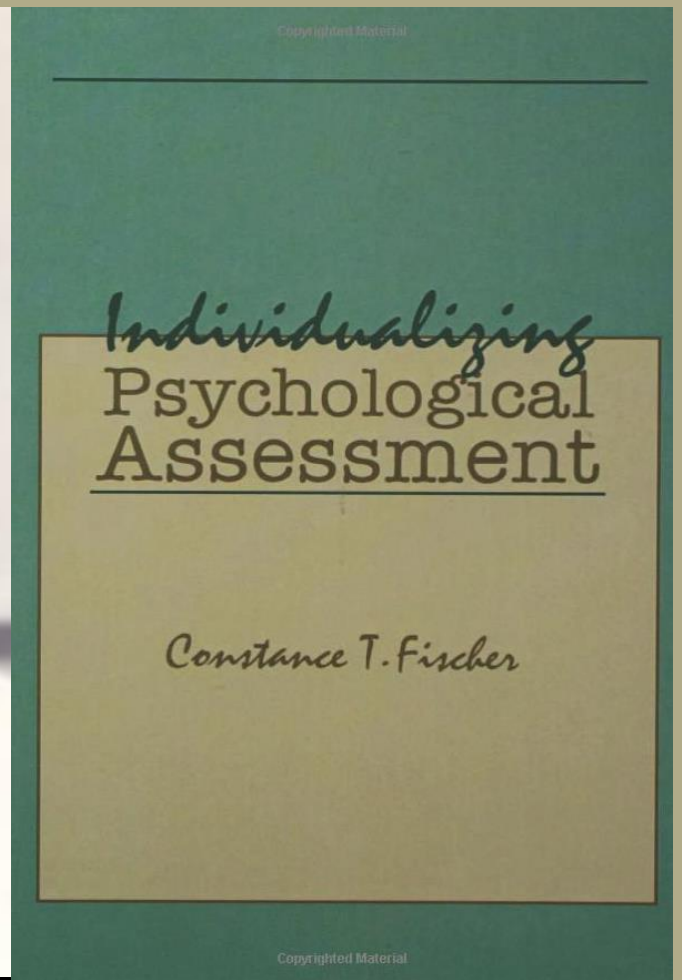
Thus, Judy meets criteria for Reading Disorder. More specifically, Judy appears to have phonological dyslexia. Phonological dyslexia refers to difficulties in reading single words because of the inability to hear individual phonemes distinctly. This difficulty in decoding single words makes reading narrative text difficult because the reading process is slow and error prone. Intensive remediation in phonics skills followed by reading fluency training is recommended.


.2 to .7
Cognitive Abilities
Complex Problems


Other Influences
1. How did the problem start?
2. How was it maintained?
3. How can it be changed?
Cognitive Abilities
Complex Problems

Constance T. Fischer

Collaborative Assessment



"Finally, it helps to remember that *reports are for the readers*, not the for the author. Reports are for communicating key findings, along with illustrative support, to readers. The report is not a repository of everything the assessor did and noticed; or a place for the assessor to wander around and finally discover the outcome; or a laboratory report of esoteric, scientific indicators; or an arena for the assessor to demonstrate personal clinical prowess, superiority of insights, technological wizardry, and so on; or a place to test the elasticity and comprehensiveness of the assessor's theory; or the occasion to demonstrate the author's literary potential. To repeat, reports *are for readers*." (p. 115)

Write About People

Not About Tests

Tell the story of the person being assessed, not the story of the assessment of the person.

Explanation 2

For most 12-year-olds as bright as Judy is, reading is a skill that is so well developed and smooth that it becomes a pleasure. For Judy, however, reading is chore. It takes sustained mental effort for her to read each word one by one. It then requires further concentration for her to go back and figure out what these individual words mean when they are strung together in complete sentences, paragraphs, and stories. Reading is a slow, laborious process that is often unpleasant for Judy.

Explanation 2

Why did Judy, a bright and delightfully creative girl, fail to learn to read fluently? The problem that most likely first caused Judy to fall behind her peers is that she does not hear speech sounds as clearly as most people do. It is as if she needs glasses for her ears: The sounds are blurry.

Explanation 2

For example, although she can hear the whole word *cat* perfectly well, she might not recognize as easily as most children do that the word consists of three distinct sounds: /k/, /a/, and /t/. For this reason, she has to work harder to remember that these three sounds correspond to three separate letters: /k/= c, /a/ = a, and /t/ = t.

Explanation 2

With simple words like *cat*, Judy's natural ability is more than sufficient to help her remember what the letters mean. However, learning to recognize and remember larger words, uncommonly used words, or words with irregular spellings is much more difficult for Judy than it is for most children.

Explanation 2

Many children with the same difficulty in hearing speech sounds distinctly eventually learn to work around the problem and come to read reasonably well. However, Judy is a perceptive and sensitive student who was acutely aware, from very early on, that she did not read as well as her classmates.

Explanation 2

She clearly remembers that her friends and classmates giggled when she made reading errors that were, to them, inexplicable. For example, for a while she earned the nickname "Tornado Girl" when she was reading aloud in class and misread *volcano* as *tornado*. She came to dread reading aloud in class and felt growing levels of shame even when she read silently to herself.

Explanation 2

She began to avoid reading at all costs. She did not read for pleasure, even when the texts were easy enough for her to read because she felt, in her words, “dumb, dumb, and dumb.” Over the next several years, she fell further behind her peers. By avoiding reading, she never developed the smooth, automatic reading skills that are necessary to make reading a pleasurable and self-sustaining activity.

Explanation 2

Although Judy's ability to hear speech sounds distinctly is still low compared to her 12-year-old peers, this weakness is not what is holding her back now. Indeed, her current ability to hear speech sounds distinctly is actually better than that of average 6 and 7-year-olds, most of whom learn to read without difficulty.

Explanation 2

With extra help, Judy can learn to decode words phonetically. However, for her to develop her reading fluency and reading comprehension skills to the level that she is capable, she will need to engage in sustained practice reading texts that are both interesting for Judy and are at the correct level of difficulty.

Explanation 2

She is likely to be willing to read only if she is helped to manage the sense of shame she feels when she attempts to read a book. This may require the collaboration of a reading specialist and a behavior specialist with expertise in the cognitive-behavioral treatment of anxiety-related problems.

Details with no purpose

Lots of jargon

Details paint a picture

Written in classic style

Explanation 1

Explanation 2

Context-free present focus

Describes tests & data

Integrates past with present problems

Tells Judy's story

Narratives Are the Beginning

Interview

Empathize

Listen to People

Investigate

Clarify

Gather data

Do the math

Learn from Data

Interpret the data

Forget the math

Induce empathy

Explain problems

Retell the Story

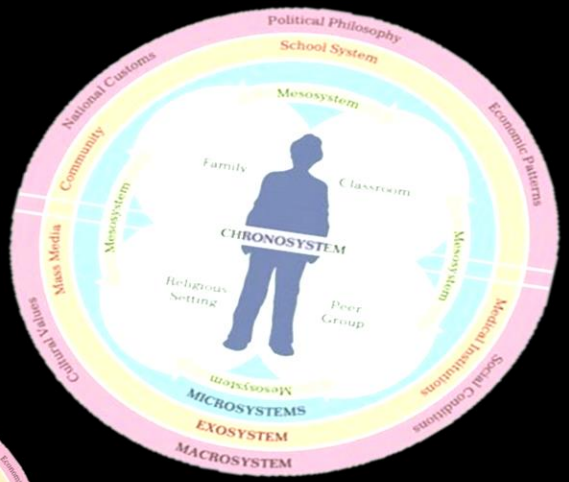
Restore hope

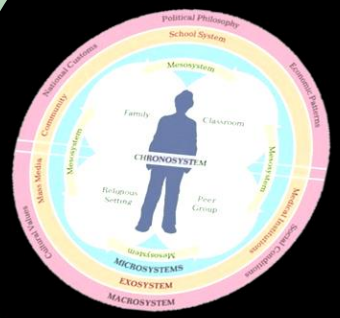
Inspire change

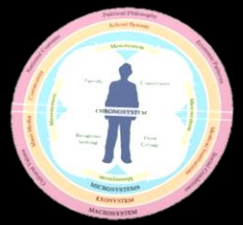
and Ending of Assessment

Current Context

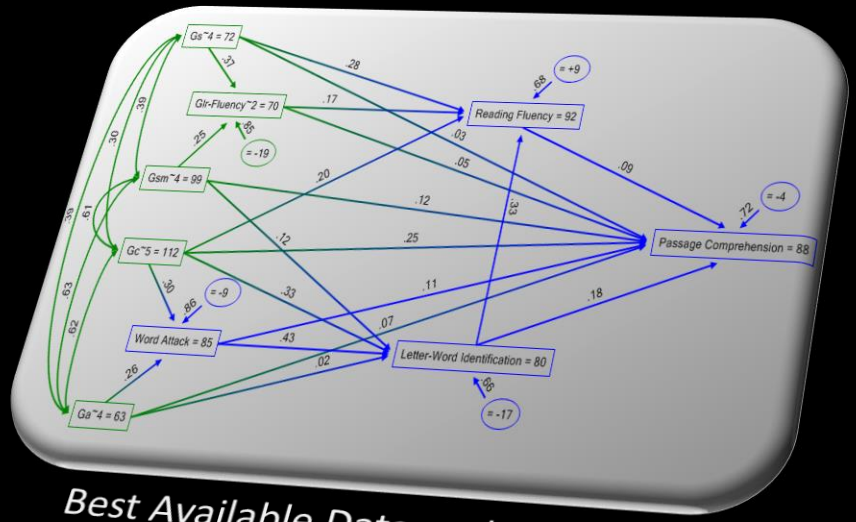
Development & Learning History







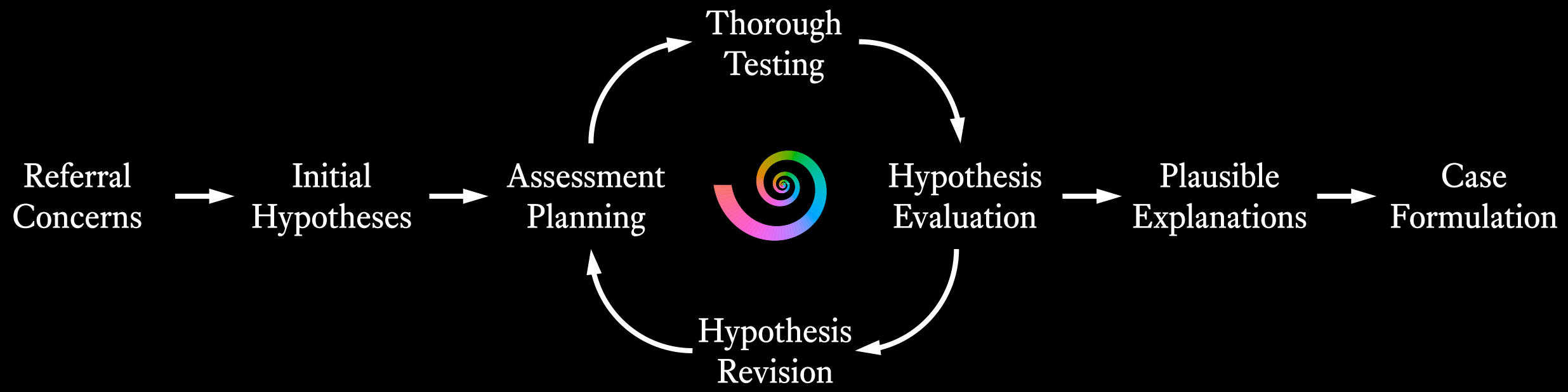
Narrative ↔ Test Scores

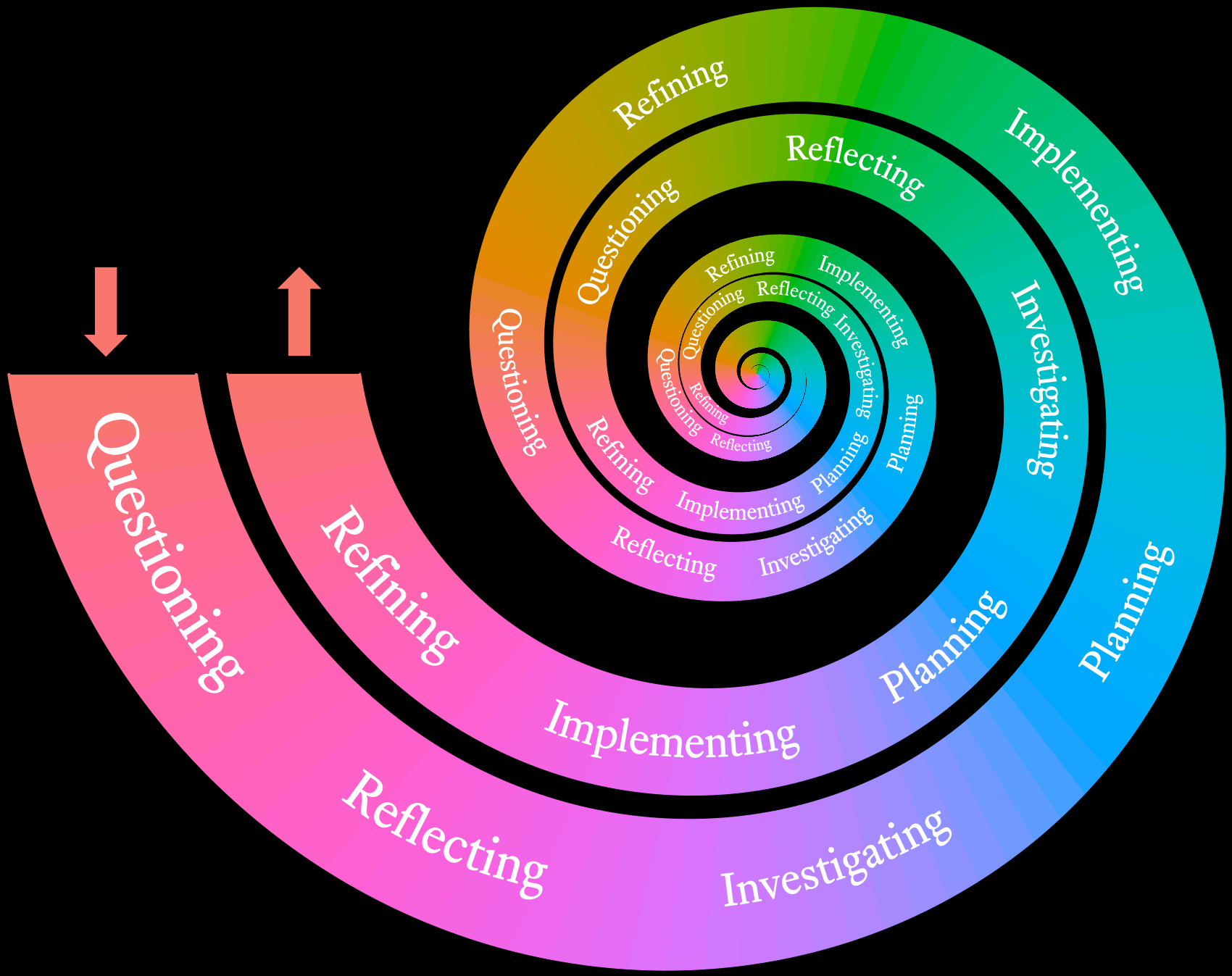


Best Available Data and Models

Theory-Centric Assessment

The Scientific Method Applied to Individuals

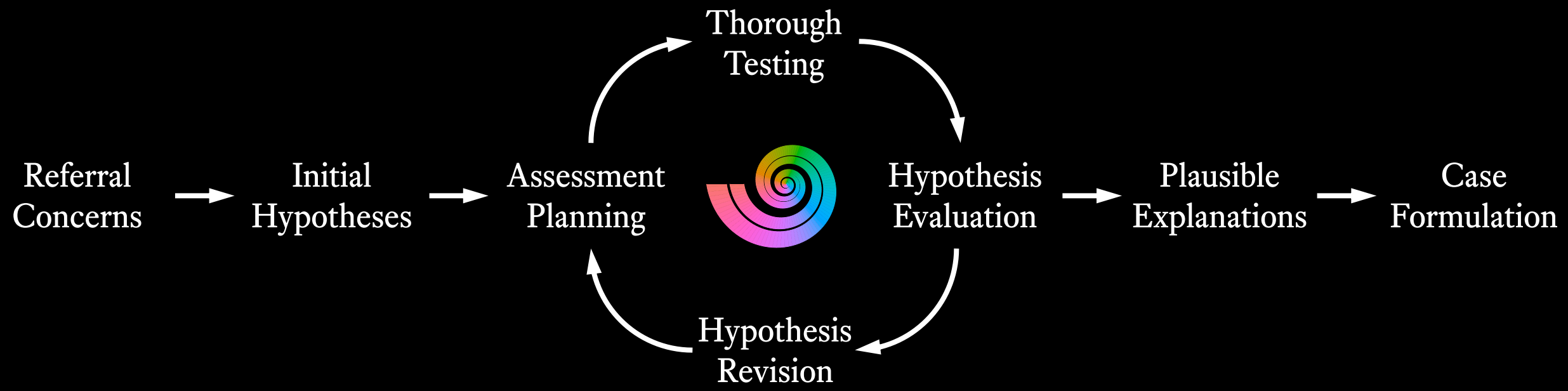




McIntyre (2008, p. 7)

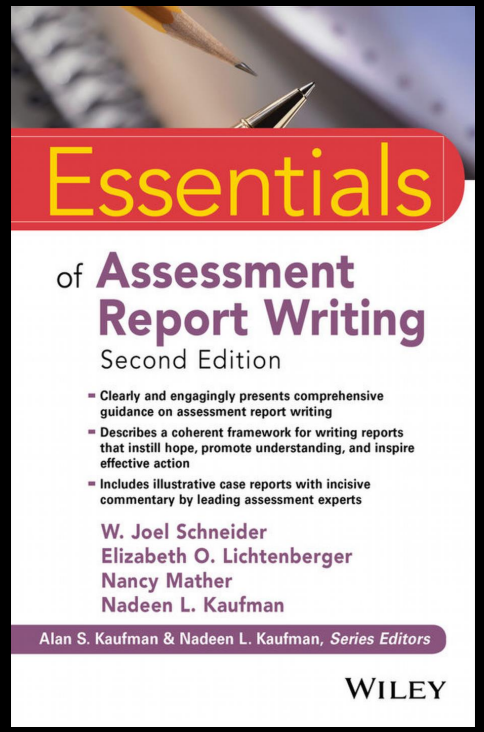
Theory-Centric Assessment

The Scientific Method Applied to Individuals



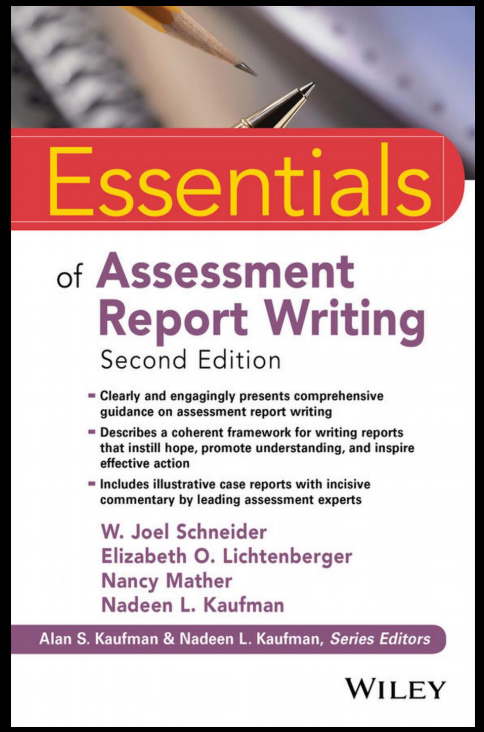
We Have Much to Learn from Qualitative Researchers

Jaden



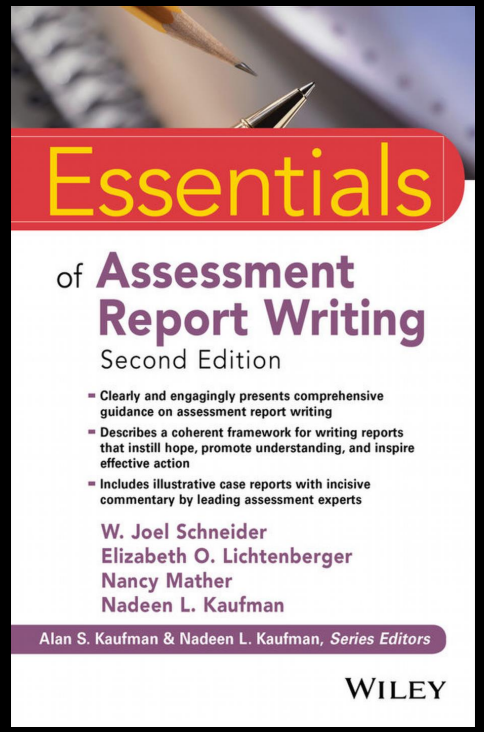
Jaden has nonverbal skills that are as far ahead of most children as his language skills are behind. **Visual-spatial ability** refers to how well a person can solve practical problems by imagining how objects would look as they are moved and rotated. For example, some people can "see" in advance how to move large pieces of furniture though narrow doors and around hallway corners rather than trying to figure it out by trial and error. They can look at complex machinery and intuit how it moves and how it works. They can detect, remember, and recreate complex visual patterns. Jaden has this talent in abundance. He is able to perform better than about 95 percent of children his age on tests of visual-spatial ability.

Jaden



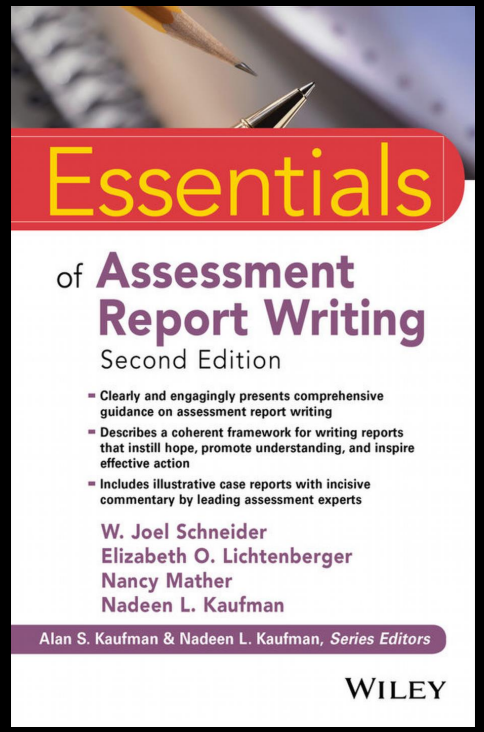
Jaden's visual-spatial talent is not just evident in his test scores, but in many aspects of his life. For example, although other children at Jaden's preschool also enjoy construction toys, Jaden's creations display a mechanical sophistication unmatched by those of his peers. With Tinker Toys and Lego Bricks, he creates buildings and vehicles with working levers, gears, pulleys, elevators, and hinged doors—which often interact in a coordinated system. To illustrate, I observed him construct a high-walled castle with towers, battlements, slit-windows, and flying buttresses. Jaden worked quickly and without hesitation, as if he were reproducing a model he could already see in his head.

Jaden



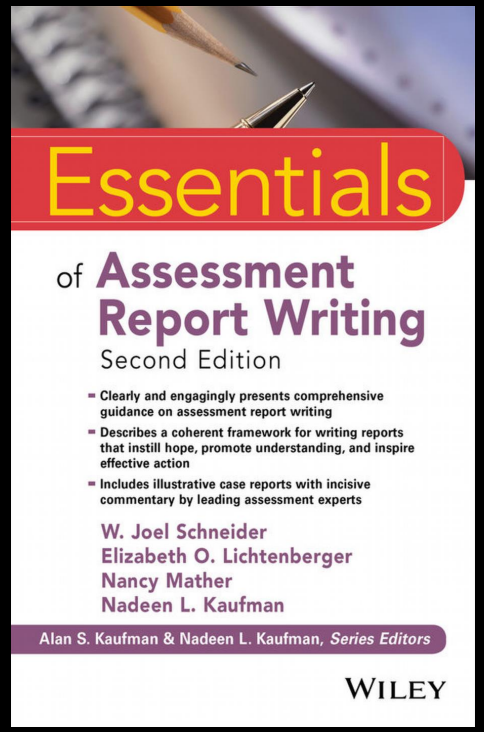
Whereas Jaden's peers mostly used whatever colors were convenient, Jaden paid careful attention to both color and texture, alternating the sequence of colors to create a bright, checkered appearance applied with both consistency and pleasing variations. The castle had a working drawbridge that could be raised and lowered with a wheel and string. On the central tower, he installed a spiral staircase, down which a large marble could roll. At the bottom of the staircase, the marble opened a latch for a trap door in the floor, through which fell a heavy brick which triggered a spring-loaded catapult aimed at figurines Jaden informed me were "bad guys."

Jaden



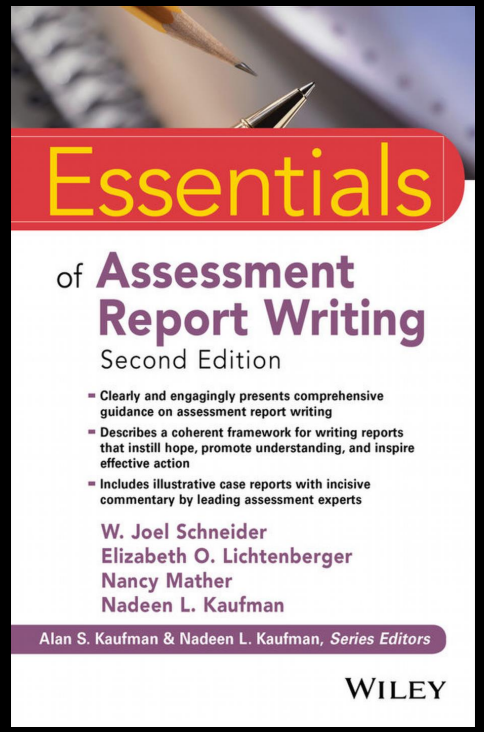
Jaden's ability to make impressively creative structures is not just a matter of talent, but also of interest and encouragement. That is, Jaden has strong visual-spatial skills and excellent mechanical reasoning ability, which allows him to visualize how things will work before he makes them. He also has a designer's eye for making his creations pop with color. Jaden is not just good at building, but passionate and persistent at learning the craft. Jaden is unusually focused on objects and not particularly interested in people (in part because of his difficulty with verbal communication). Thus, he spends his time focused on that which is he is good at and enjoys: building. Fortunately for Jaden, he is in an environment which allows him the time, materials, and emotional support for developing his creative talent for construction.

Finn



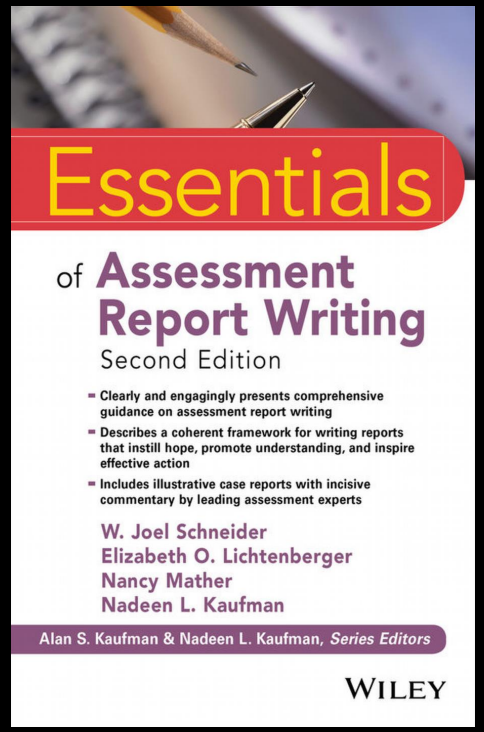
Visual-spatial processing refers to abilities such as being able to visualize how objects should look from different angles and to visualize how to put objects together so that they fit snugly. Finn's visual-spatial abilities are in the high range, scoring better than 91 percent of people his age. This is one of Finn's main cognitive strengths, and he uses it to his advantage, often in creative ways. For example, when he solves math problems in his head, he often "thinks with his hands," imagining numbers as common objects of varying lengths which he can "move" with his hands as he visualizes the solutions. Although most people do not solve math problems this way, Finn has found his talent for visualizing to be useful for quick and accurate mental calculations. He is a little self-conscious about how he looks when he concentrates on manipulating imaginary objects, but it works for him.

ARACELI



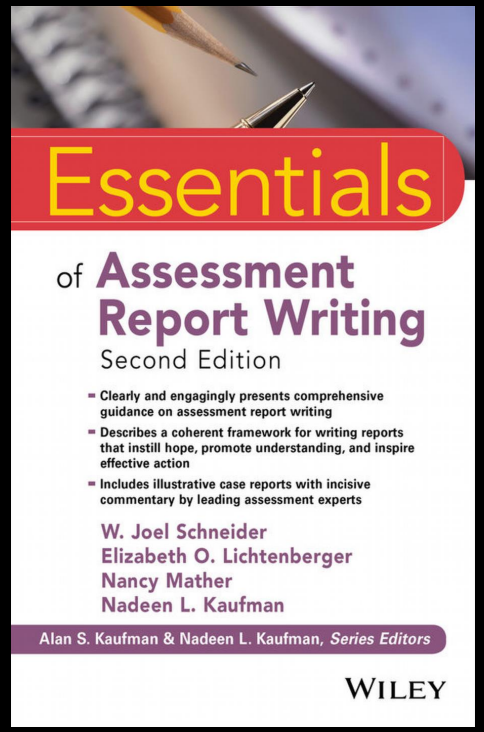
Araceli's low working memory capacity puts her at a disadvantage in many aspects of her life. Let me illustrate with an observation from the classroom. Because Araceli had said that she struggled to take good notes, I observed her during a lecture in her biology class. Araceli paid close attention to her instructor and conscientiously took notes, even when giggling classmates engaged in distracting side conversations. However, even when her classmates were quiet, it was clear that Araceli was either able to listen to the instructor or to take lecture notes but was unable to do both at the same time.

Araceli



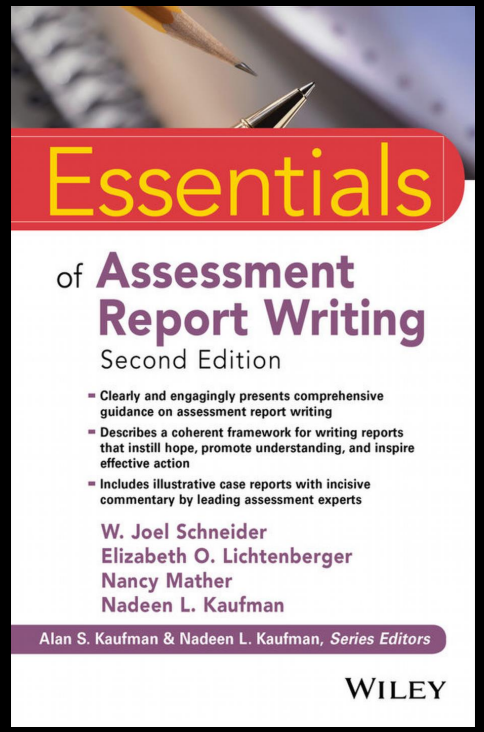
For example, at a pivotal point in the lecture, the instructor wrote the definition of respiration on the board. While Araceli was busy copying the definition, the instructor gave an effective example of how it worked, making the concept memorable with some light humor. Although the rest of the class laughed, Araceli was so absorbed in the act of copying the definition, she did not even crack a smile. She did not hear the joke…or the example.

ARACELI



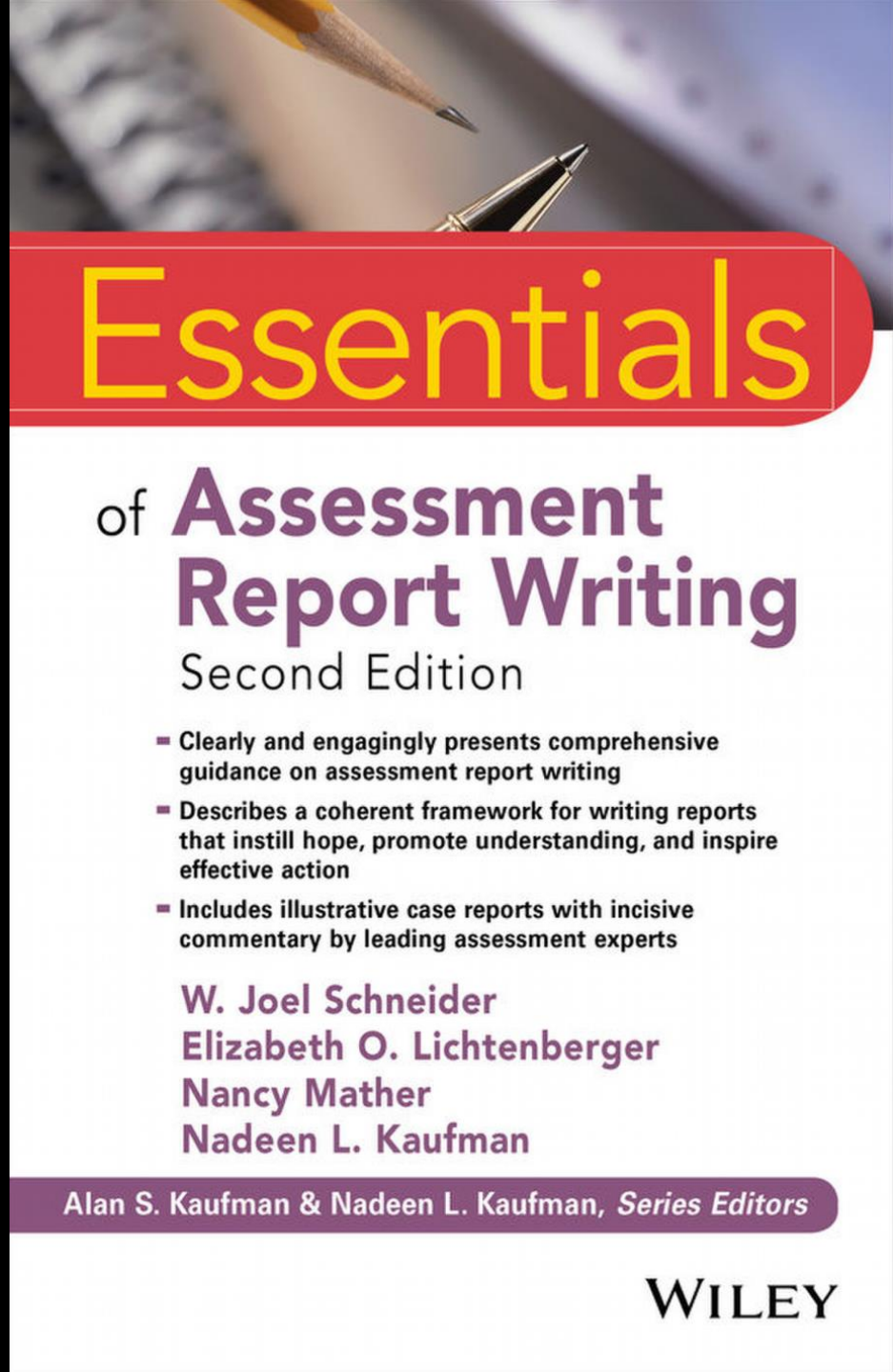
The instructor highlighted that example with humor for a reason: It appeared on the next exam. When I compared Araceli's notes with mine I saw that, sure enough, the definition was copied word for word but she had no summary of the instructor's example. I asked her if she remembered the example, but she had only a vague recollection of it. More importantly, she did not yet understand how respiration worked. People with strong working memory can store and process information simultaneously. In this case, Araceli could either store information (listen to the lecture) or process information (write summaries of concepts in her notes), but she was less able than her classmates to do both simultaneously.

ARACELI



This is just one example of what is likely happening many times each lecture: Her limited working memory capacity makes it difficult for her to direct her attention flexibly between the lecture and her notes, and she is missing far more lecture content than she realizes. Worse, low working memory capacity does not only cause her to miss information in the classroom, but also on the soccer field, at her part-time job, and in conversations with peers.

Greater Detail and Depth Found Here



Questions