How intelligence research can guide interventions to reduce error rates in health self-management

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Presented in the symposium, *"Causal models that integrate literacy, g, and health outcomes: A practical guide to more effective disease prevention and health promotion?"*
International Society for Intelligence Research, Decatur, GA
December 12, 2008

Or, “Levers for Change”

g theory* reveals:

- High-use levers are weak—but improvable
- High-promise levers go unrecognized
- Alluring blind alleys to avoid

**g* = Also called “Spearman’s *g*,” it is the general mental ability factor discovered using factor analysis, confirmed by Carroll (1993) as the core of all specific mental abilities, and shown to be correlated both phenotypically and genetically with a wide array of brain attributes (Deary, 2000; Jensen, 1998; Jung & Haier, 2007). “*g* theory” refers to the set of generalizations gleaned from a century of research on the nature, origins, and educational, employment, health, and other consequences of population dispersion along the *g* continuum (e.g., Batty et al., 2007; Gottfredson, 1998, 2002; Kuncel et al., 2004; Lubinski, 2004).

The view from *g* theory

- New guys on the block in 1990s, big players by 2000s
  - Health literacy
  - Cognitive epidemiology
- Overlapping concerns & constructs
  - Reading/literacy-health relation
  - IQ/*g*-health relation
- Common methods
  - Atheoretical
  - Throwing a wide net (measures, outcomes)
  - Searching for incremental predictive validity (e.g., net of SES)
- Common results
  - Pervasive connections (knowledge, behavior, morbidity, mortality)
  - Inconsistent findings, unclear patterns

Repeating past mistakes, such as:

The best definitions of health literacy will recognize that:

- It is an extremely complex construct — "Definitions" fallacy*
- It is not an attribute of the individual, but the intersection of individuals and environments — Confuses ability and achievement

The best measures of health literacy will:

- Be specific to health, not general — False "specificity theory"
- Cover all relevant knowledge and skills — "Marbles" fallacy

The best interventions for low health literacy will:

- Create a more health-literate population — But little generalization
- Reduce group disparities — But SD expands when mean rises

The best estimates of its effects control for SES — Sociologists' fallacy

* See Gottfredson (2009) for common misconceptions & logical fallacies about cognitive abilities.

What *g* research & theory can offer

Large body of evidence on:

- Core construct (*g*: learning/reasoning ability)
- Predictor domain
- Task domain
- Criterion domain
- Causal relations among them
- Past mistakes & persisting fallacies

Clear patterns
"Deep generalizations"

Key sources:

- Research literatures in psychometrics, job analysis, school & job performance, status attainment, behavior genetics, neuroscience (all represented in this room today)

Yet untapped, especially in health literacy

- A tremendous opportunity cost for patients and providers

Health literacy—
its heritage lost?

Cognitive epidemiology next?

Work literacy: Military research in 1970s

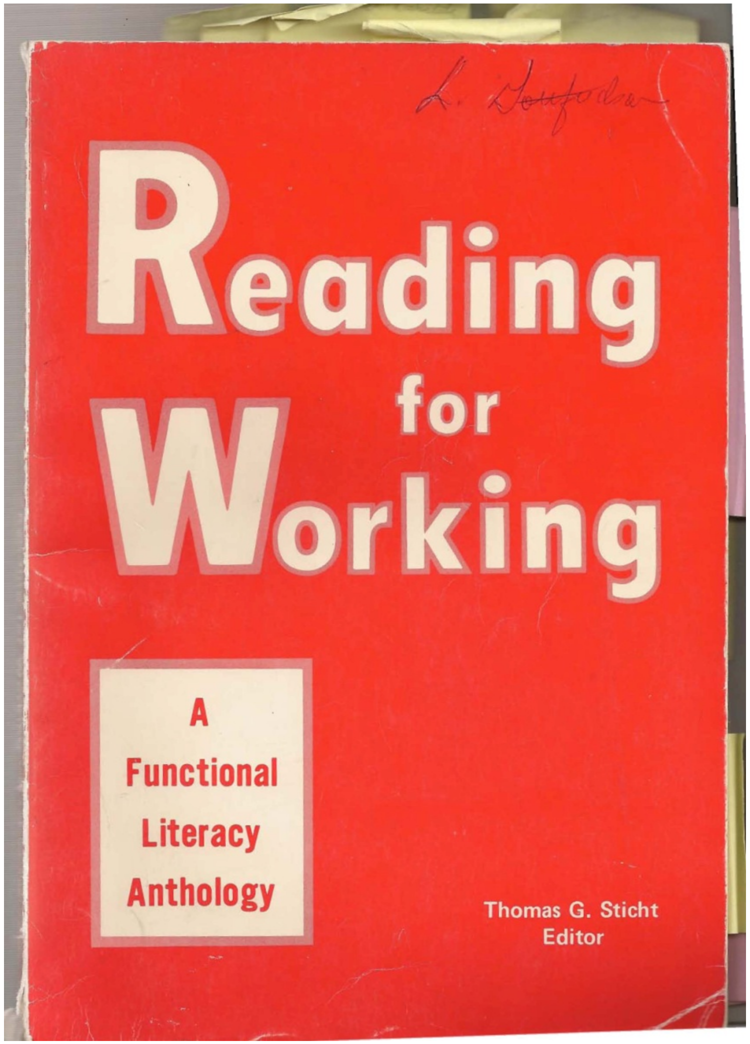


Table 22

Intercorrelations of Predictor and Selected Background Variables Summed for Four Jobs

Variable	1	2	3	4	5	6	7
1. Reading	–	.69	.65	.54	.30	–.04	–.27
2. Arithmetic	.69	–	.61	.43	.34	–.10	–.22
3. AFQT	.65	.61	–	.47	.26	.01	–.30
4. Listening	.54	.43	.47	–	.12	.00	–.22
5. Education	.30	.34	.26	.12	–	.01	.12
6. Age	–.04	–.10	.01	.00	.01	–	.11
7. Race[a]	–.27	–.22	–.30	–.22	.12	.11	–

[a]For computing the correlations with race, Caucasian was assigned the code number of 0, and Negro the code number of 1.

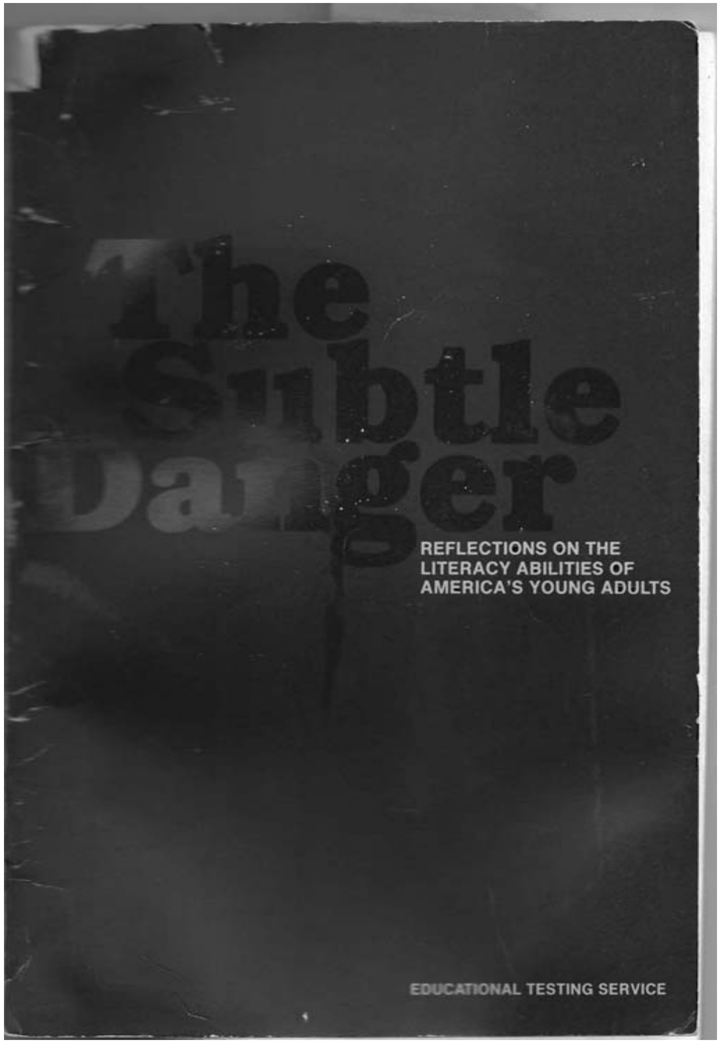
"Literacy" is general

- not reading per se , but comprehension
- not content specific
- not modality specific

"Literacy" ≈ "trainability" = AFQT

- Can teach specific knowledge & skills
- Cannot teach "literacy"

US Department of Education (NAEP)—1980s



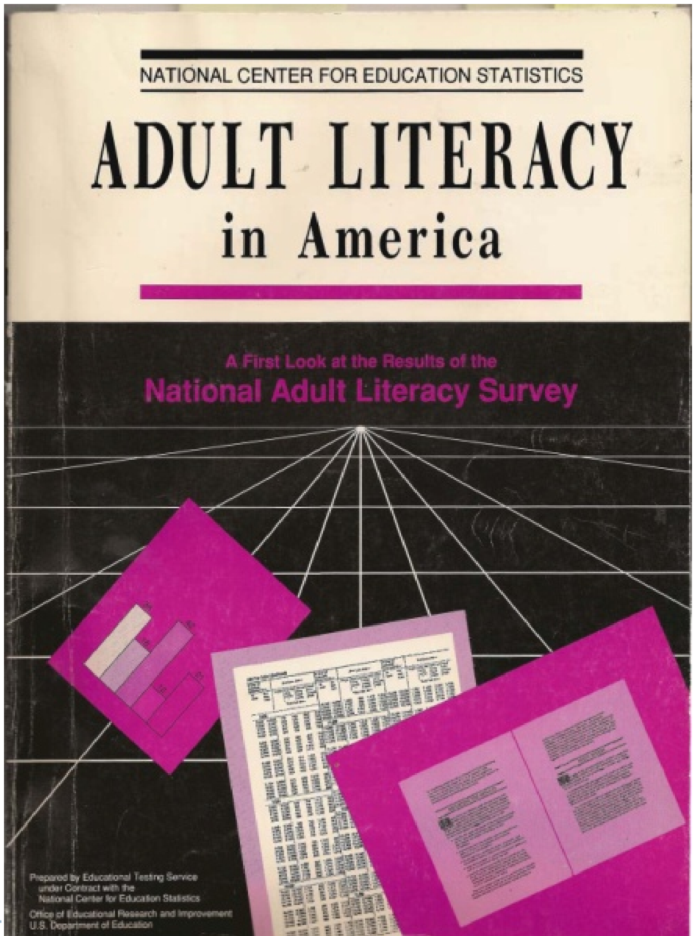
On "literacy":

"Children and young adults have adequate abilities for basic tasks, *but are poor problem solvers*….Skills can be applied in isolation but not in combination" (p. 28).

National Adult Literacy Survey (NALS)—1990s

Subset of items = Health Adult Literacy Survey (HALS)

See also: Test of Functional Health Literacy in Adults (TOFHLA)



Literacy is not content specific:

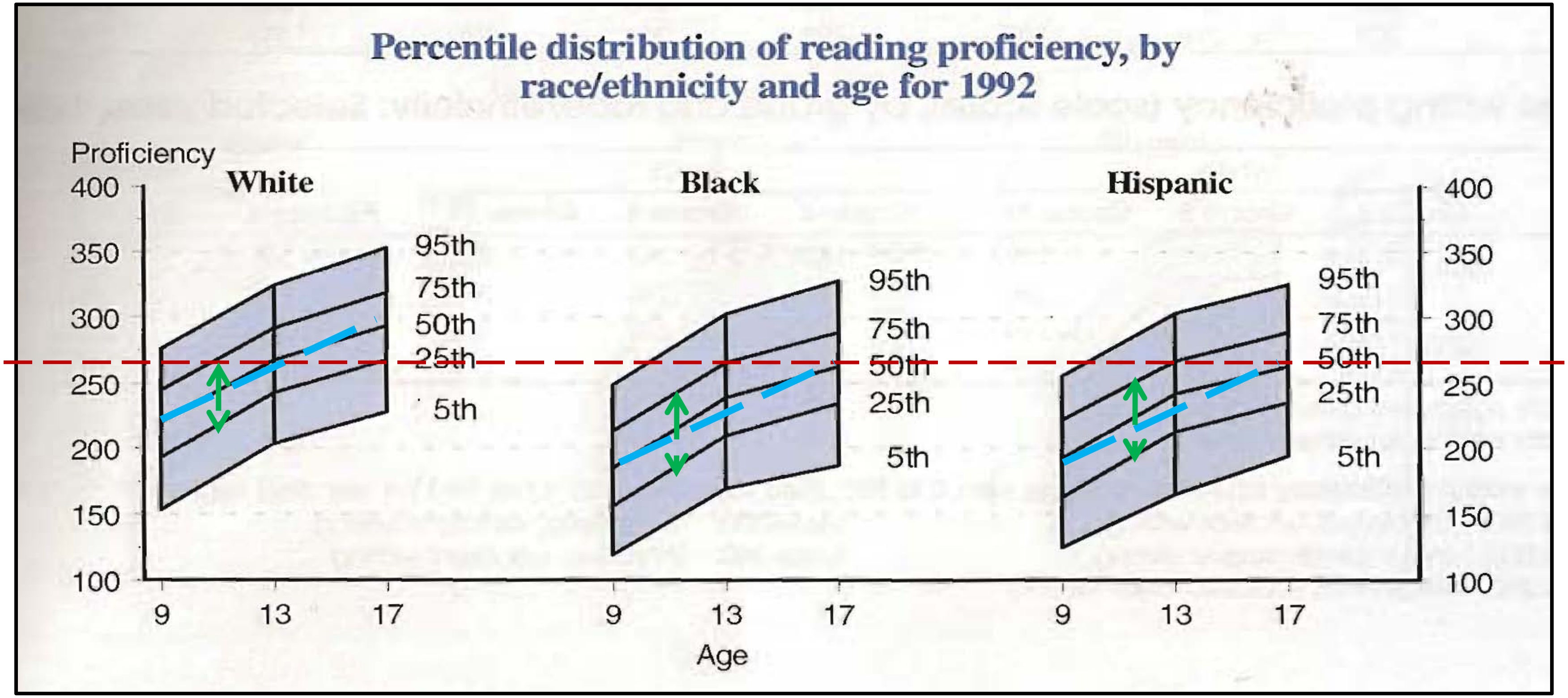
• prose, quantitative, & document scales show same results—as if "in triplicate"

Literacy is a general ability:

- "complex information processing skills"
- "verbal comprehension & reasoning"
- "ability to understand, analyze, evaluate"

Literacy sometimes equated with reading ability, but reading ability develops *slowly* (NAEP)

Growth: 8 years older ≈ 80-point gain
Variation within age: Interquartile range ≈ 54
Achievement gap: White-Black ≈ 34
White-Hispanic ≈ 27



Heuristic

Health self-care as a job

Diabetes: Patients' "job description"

- **Learn about diabetes in general (At "entry')**
  - Physiological process
  - Interdependence of diet, exercise, meds
  - Symptoms & corrective action
  - Consequences of poor control
- **Apply knowledge to own case (Daily, Hourly)**
  - Implement appropriate regimen
  - Continuously monitor physical signs
  - Diagnose problems in timely manner
  - Adjust food, exercise, meds in timely and appropriate manner
- **Coordinate with relevant parties (Frequently)**
  - Negotiate changes in activities with family, friends, job
  - Enlist/capitalize on social support
  - Communicate status and needs to HCPs
- **Update knowledge & adjust regimen (Occasionally)**
  - When other chronic conditions or disabilities develop
  - When new treatments available
  - When life circumstances change

Good performance requires good judgment*

- **IT IS NOT** mechanically following a recipe
- **IT IS** keeping a complex system under control in often unpredictable circumstances
  - Coordinate a regimen having multiple interacting elements
  - Adjust parts as needed to maintain good control of system buffeted by many other factors
  - Anticipate lag time between (in)action and system response
  - Monitor advance "hidden" indicators (blood glucose) to prevent system veering badly out of control
  - Decide appropriate type and timing of corrective action if system veering off-track
  - Monitor/control other shocks to system (infection, emotional stress)
  - Coordinate regimen with other daily activities
  - Plan ahead (meals, meds, etc.)
    - For the expected
    - For the unexpected and unpredictable
  - Prioritize conflicting demands on time and behavior

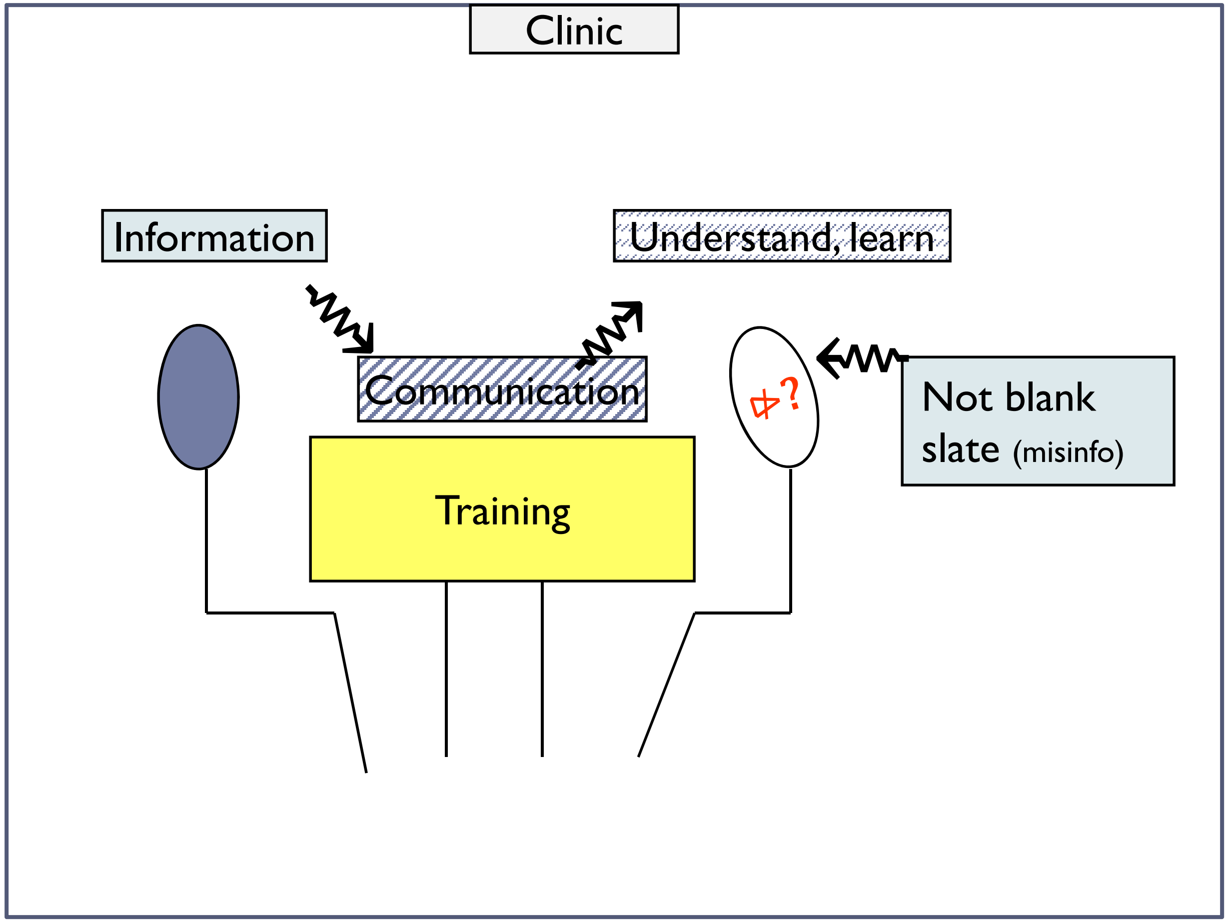
* See Gottfredson (1997, 2006)

But little training or supervision

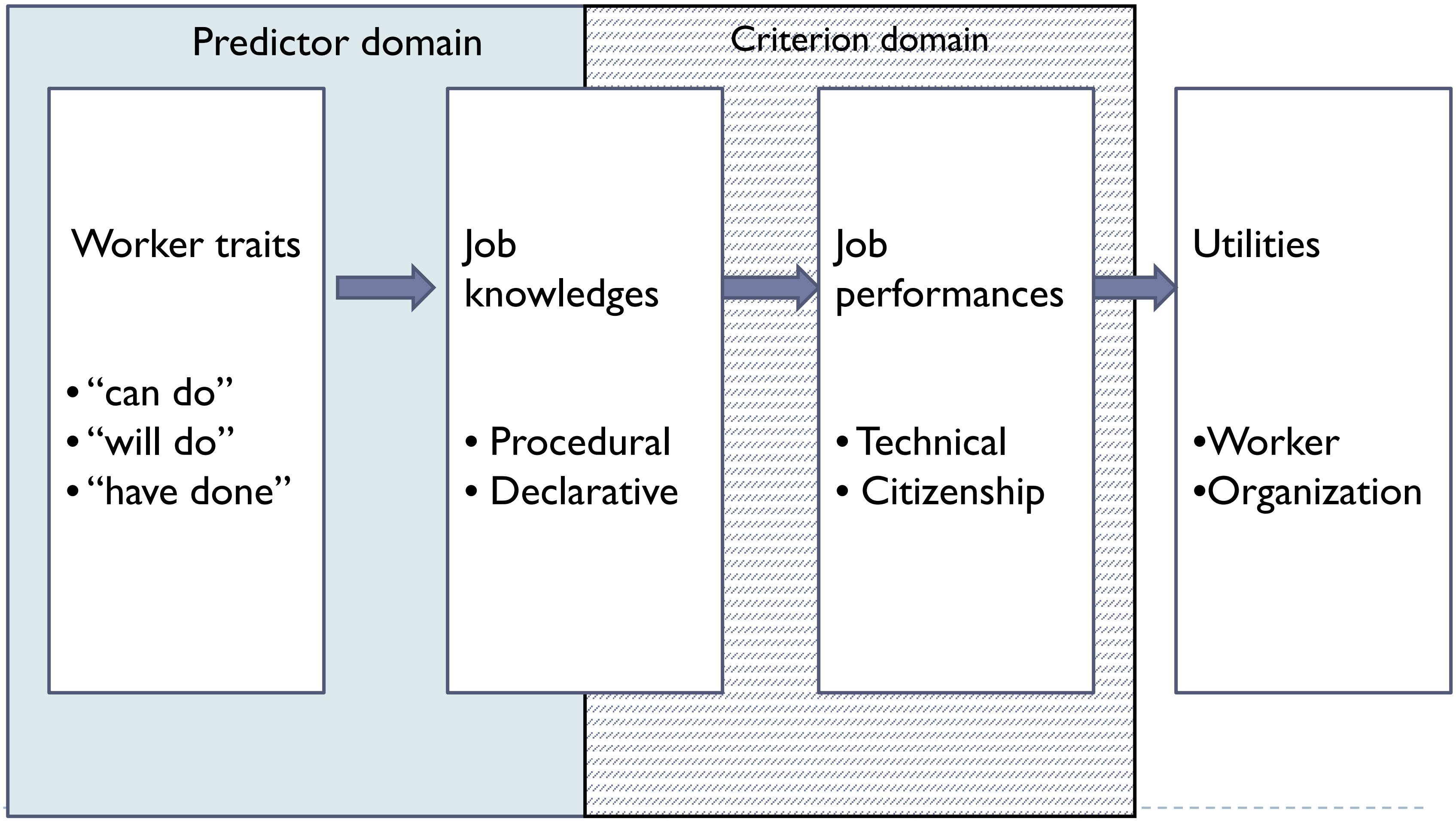
Apply "on the job"

- 24 hours/day
- 7 days/week

Adherence
Self-management



Construct domains in job performance research



IQ-job performance gradients*

Five "Deep Generalizations"

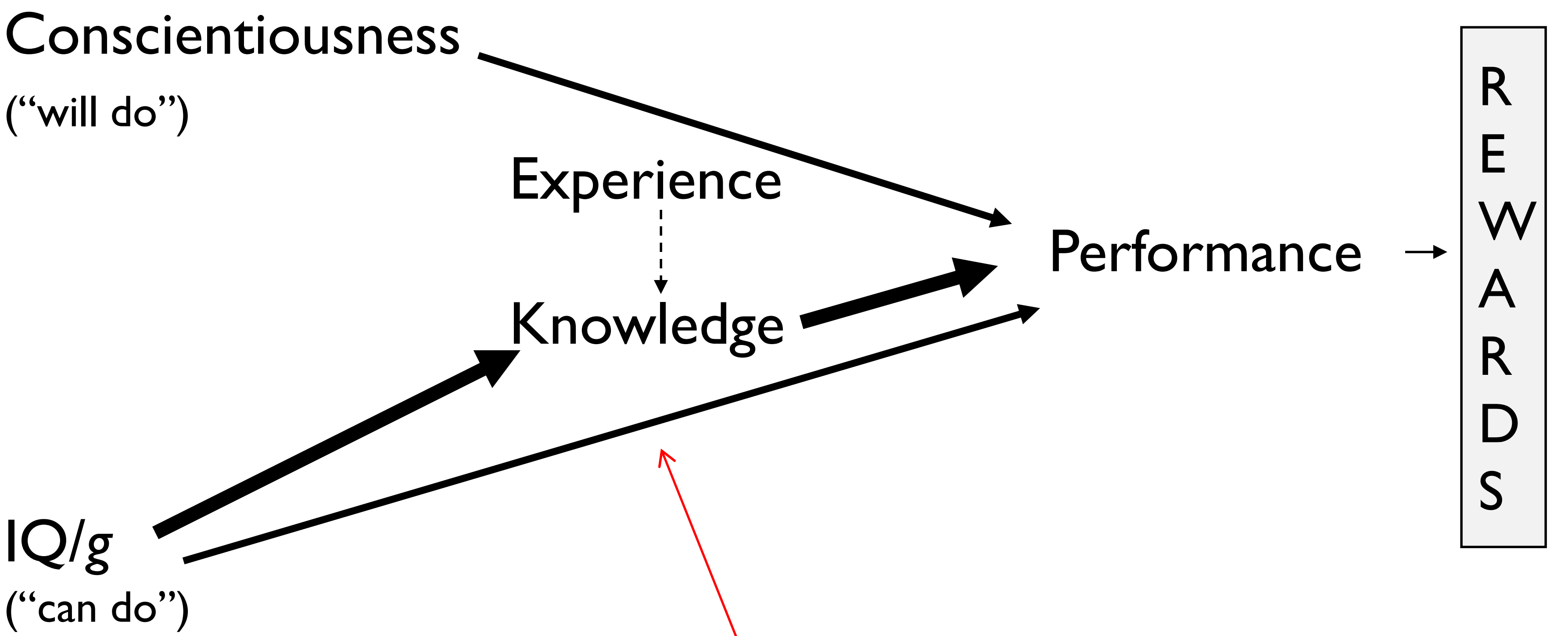
- IQ/g enhances performance in <u>all</u> jobs
- 4 moderators

Two "Muddlers"

- 2 statistical artifacts

*Based on 90 years of personnel selection research (e.g., Schmidt & Hunter, 1998, 2004)

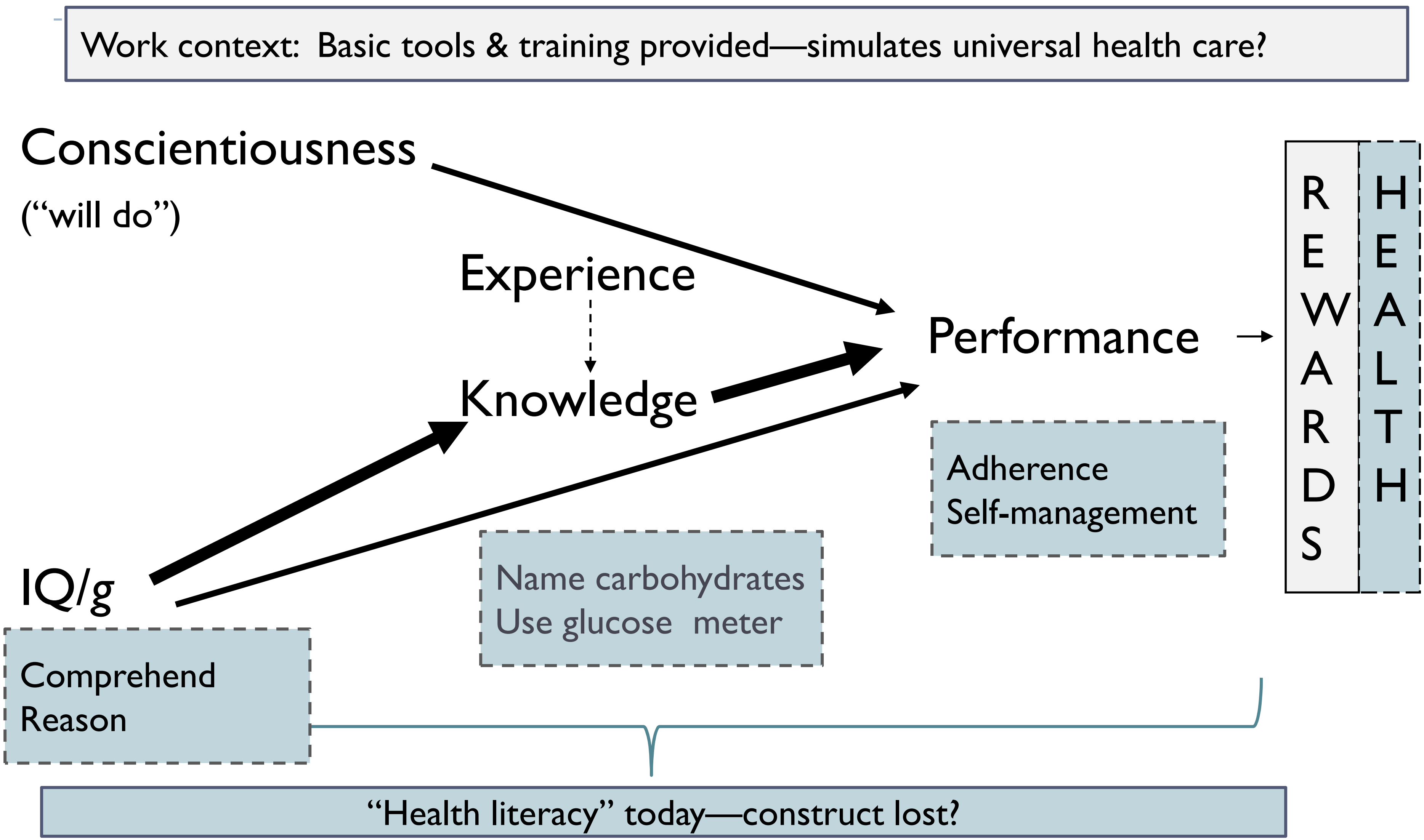
Causal model of job performance (typical job)*



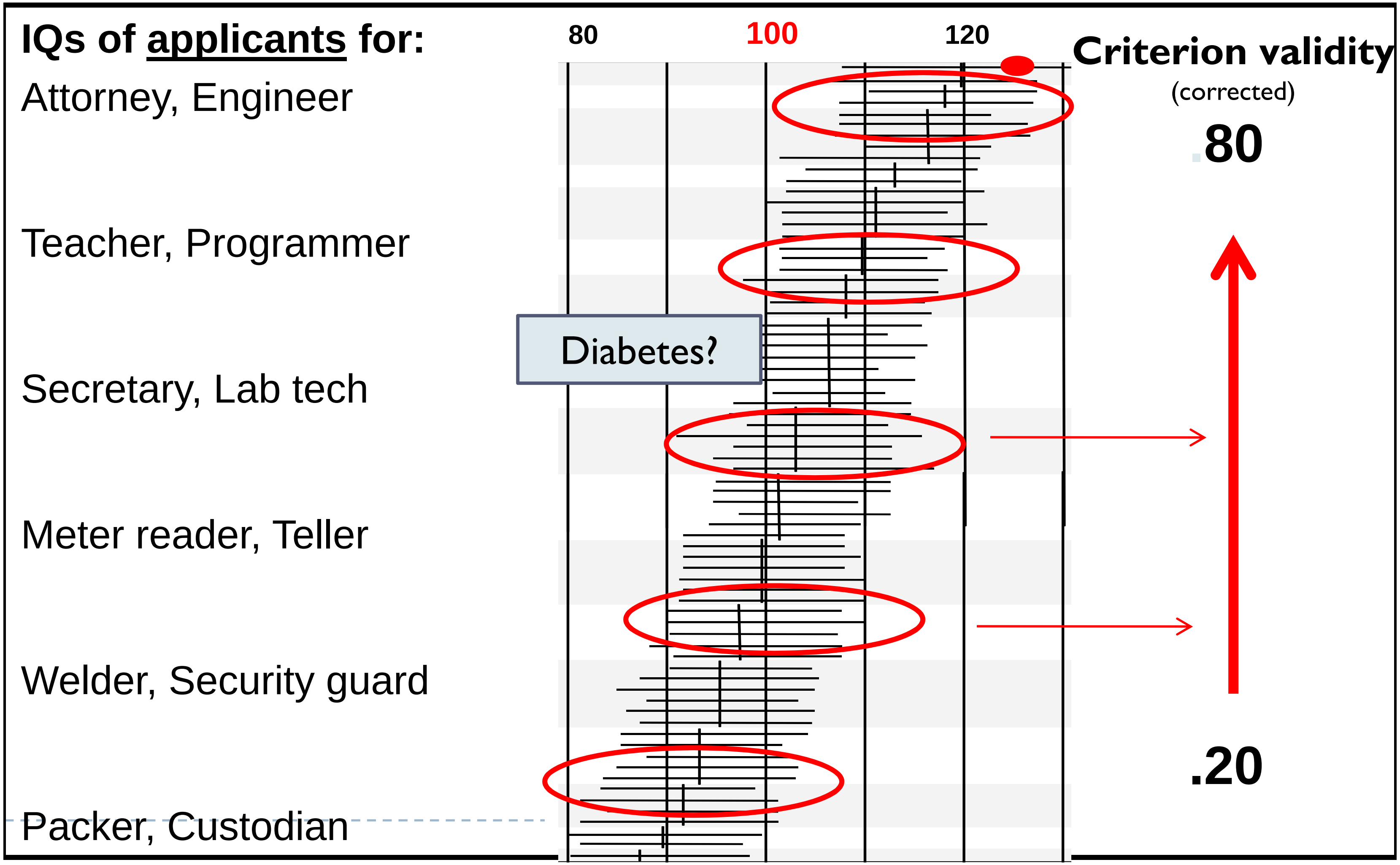
Generalization: Validity generalization of IQ/g ($r_{g/performance} > 0$)

*For example, see Hunter (1986), Schmidt & Hunter (1998)

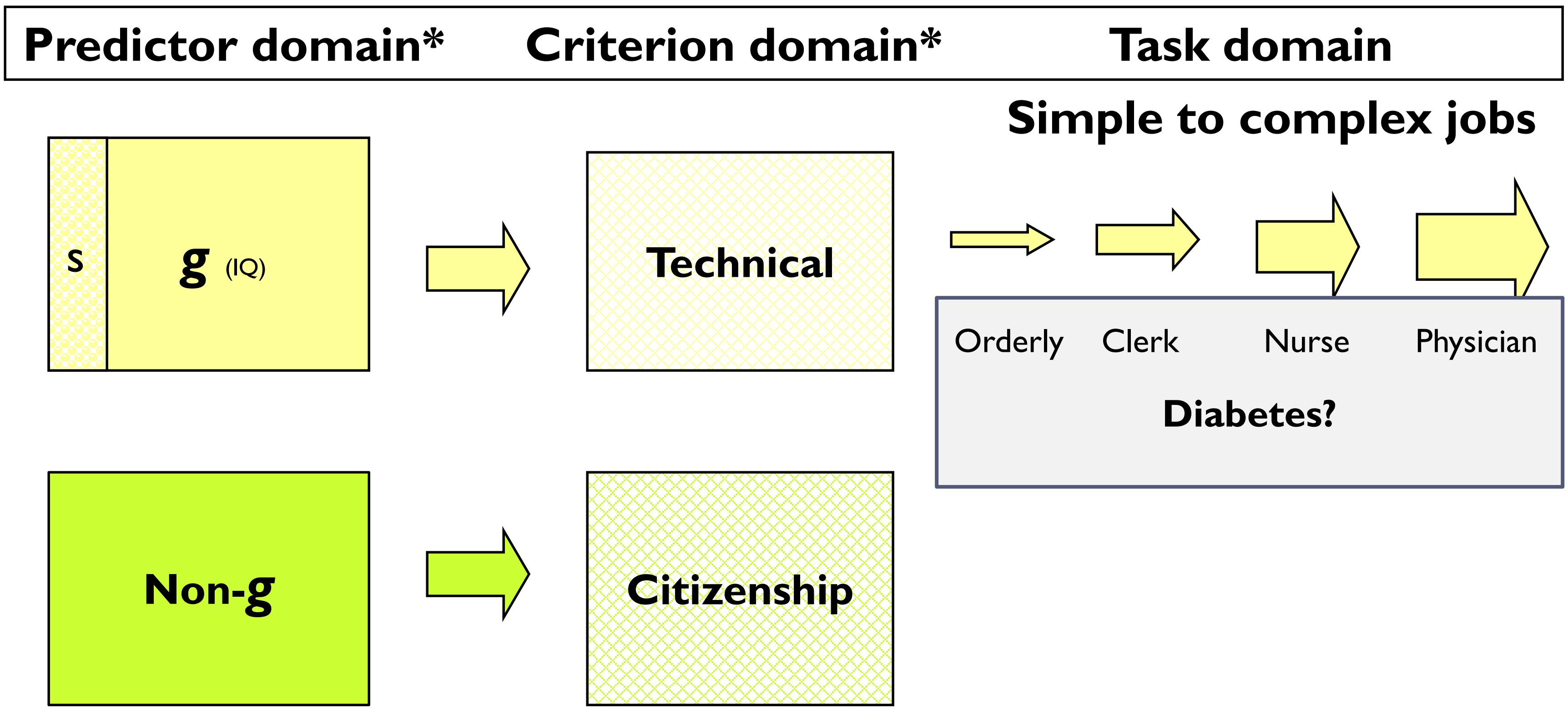
Causal model of job performance (typical job)



IQ predicts performance in all jobs—but especially higher up

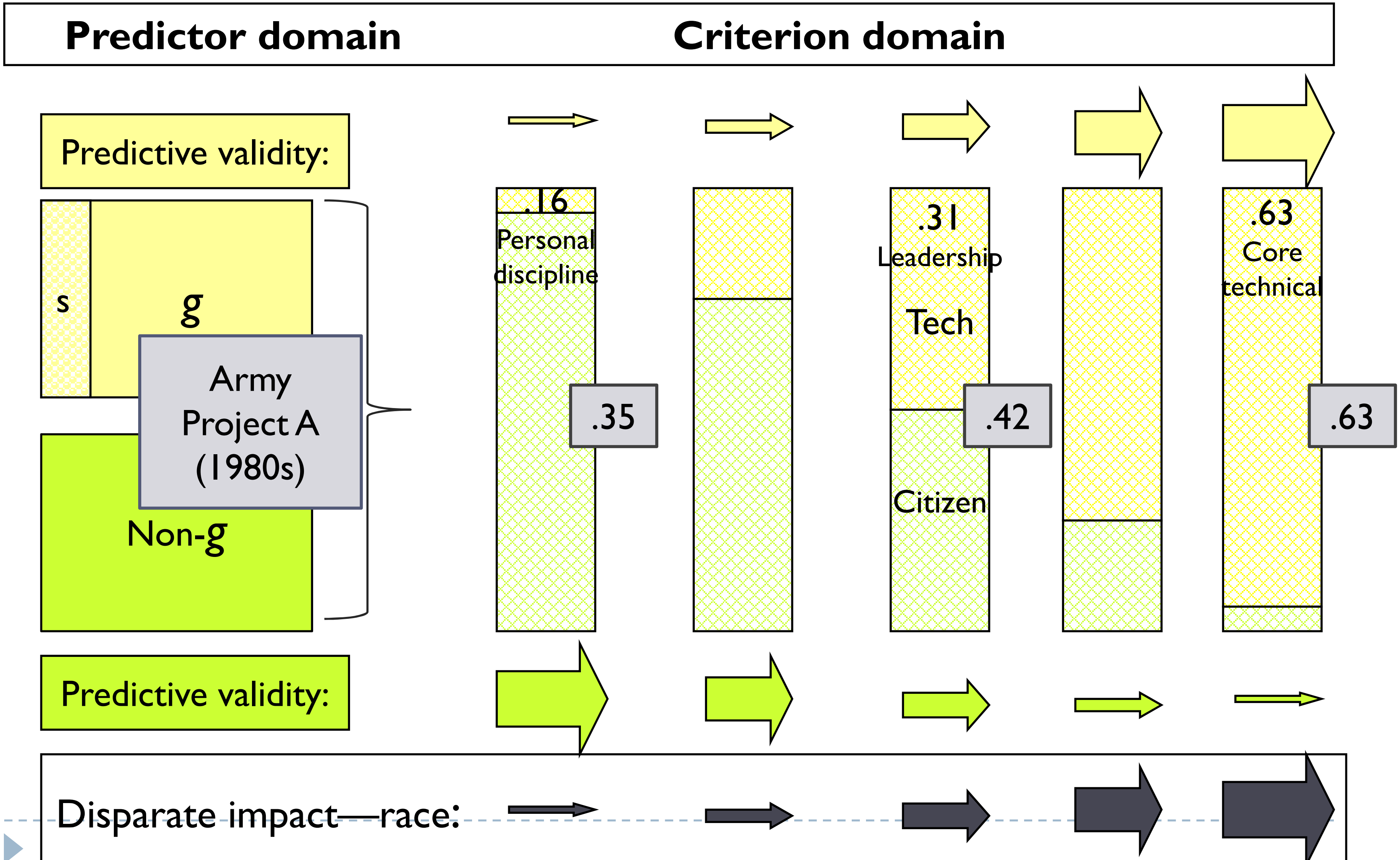


Two moderators: (1) criterion type and (2) task complexity



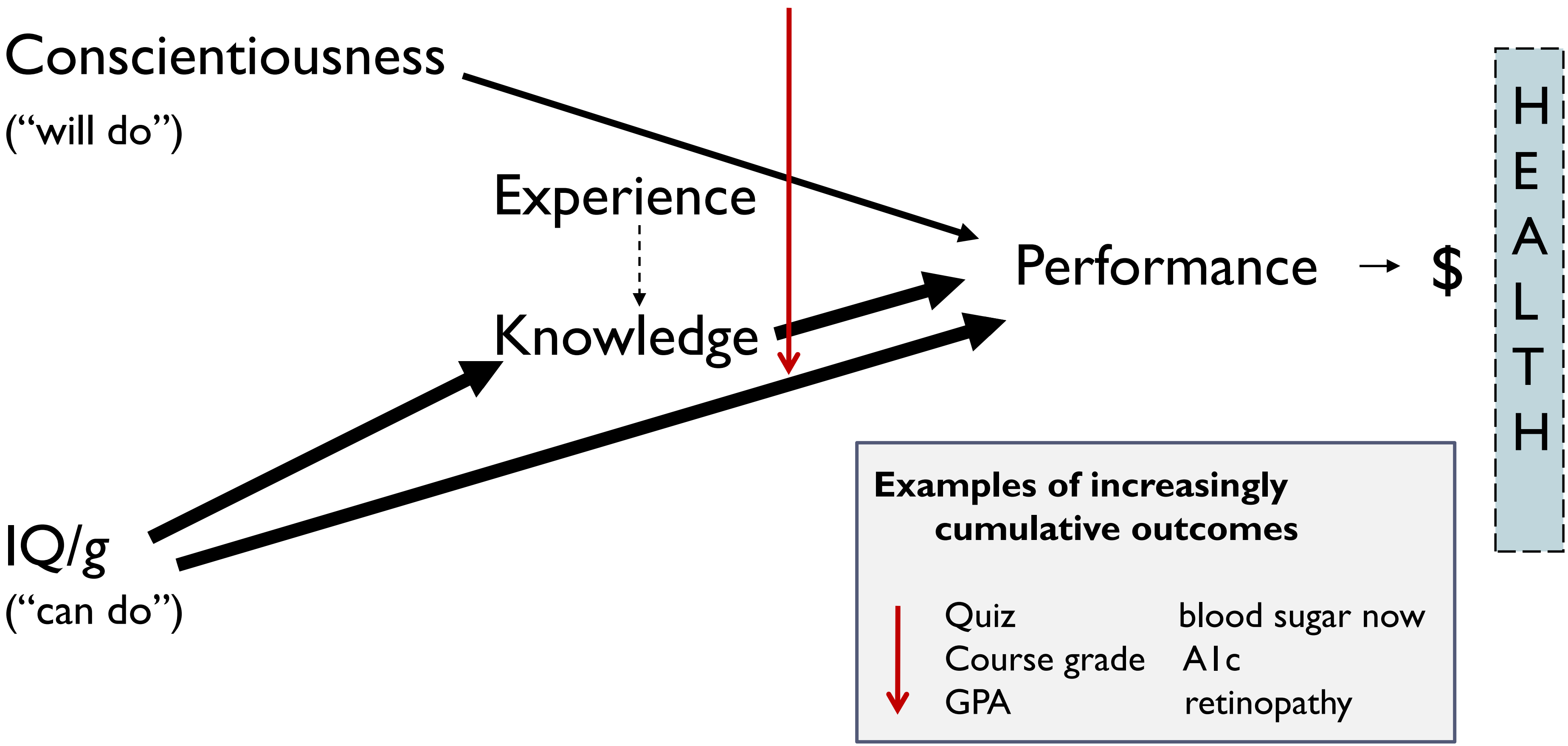
*On structure of predictor & criterion domains, see Campbell (1990), Campbell & Knapp (2001)

Resulting clockwork-like patterns



Two more moderators: (1) worker discretion allowed and (2) performance cumulative*

IQ-performance correlation rises when individuals work more independently and outcomes are more cumulative in nature



*Hunter (1986), Schmidt & Hunter (1992)

Two muddlers—Statistical artifacts (VG research)

- Test unreliability → "specificity theory"*
- Sample restriction in range ↗

(predictors are highly sensitive to differences in context, task)

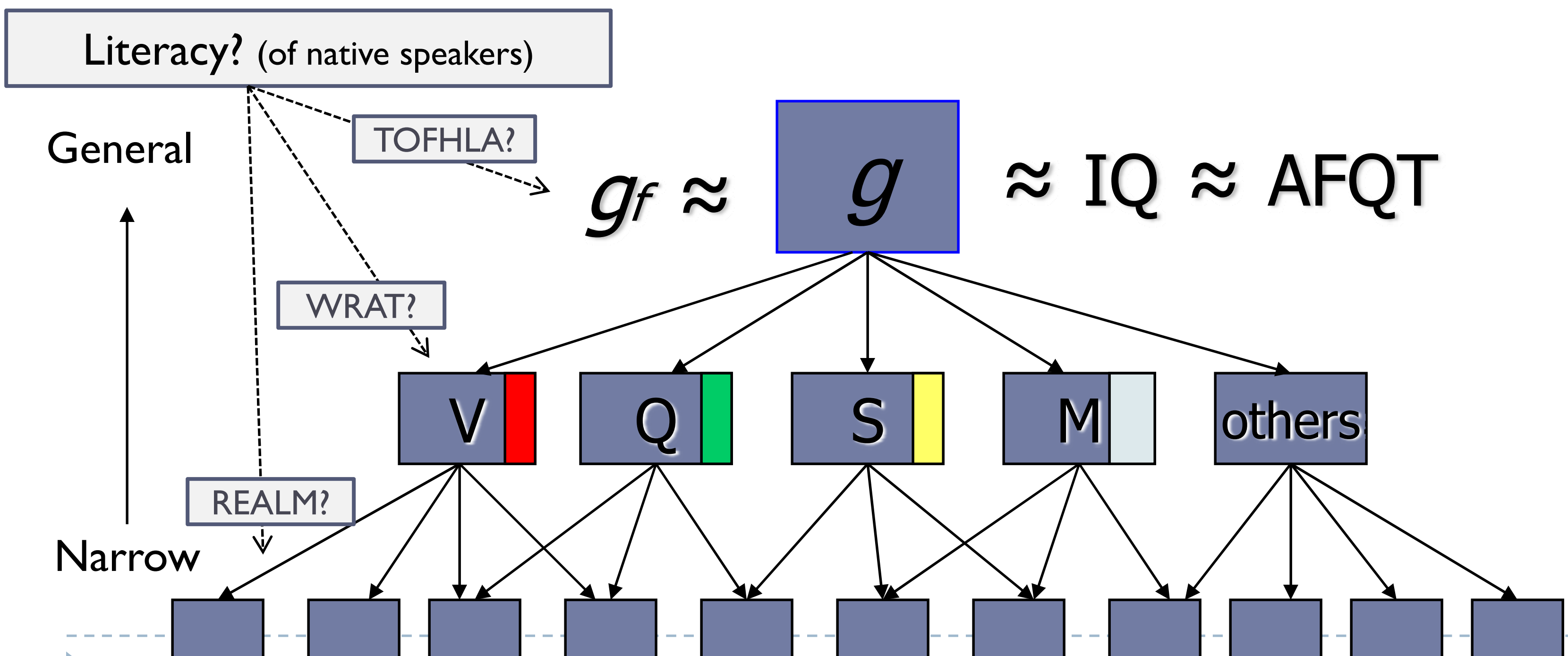
- *Tests' range of discriminability (e.g., ceilings, floors)* ⟹ *Attenuates prediction*

e.g., Mini Mental Status Exam

*The once-reigning theory in both intelligence and job performance fields that was disproved ~1970s by research using new factor-analytic & meta-analytic techniques (e.g., Schmidt & Hunter, 1998).

Structure of "intelligence"—and "literacy"?

- All mental tests measure mostly the same ability: *g* (it is their common core)
- *g* is ~content independent
- *g* carries the freight of prediction
- More general abilities are more heritable & less manipulable



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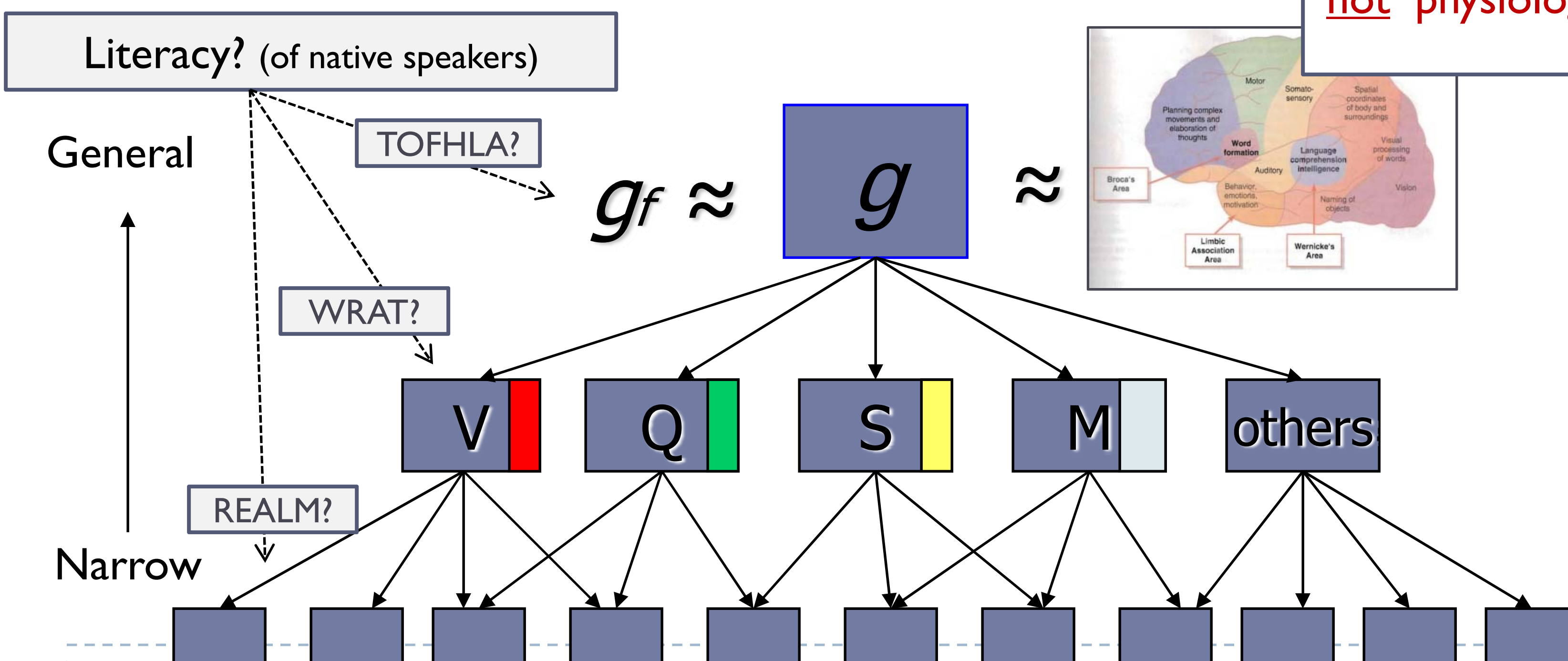
NOTE: *g* is unitary as a *behavioral* phenotype, but <u>not</u> physiologically



Recommendations for intervention I: Avoid past mistakes

The best **definitions** of healt… …teracy will recognize that:

- It is an extremely c… …struct
- It is not an at… …e individual, but the intersection of individuals … …onments

Think general

"Definitions" fallacy

Confuses ability and achievement

The best **measures** of hea… …acy will:

- Be specific to h… …general
- Cover all re… …knowledge and skills

Think simple (NVS, UD)

False "specificity theory"

"Marbles" fallacy

The best **interventions** for lo… …ealth literacy will:

- Create a more heal… …population
- Reduce grou… …es

Think error reduction

But little generalization

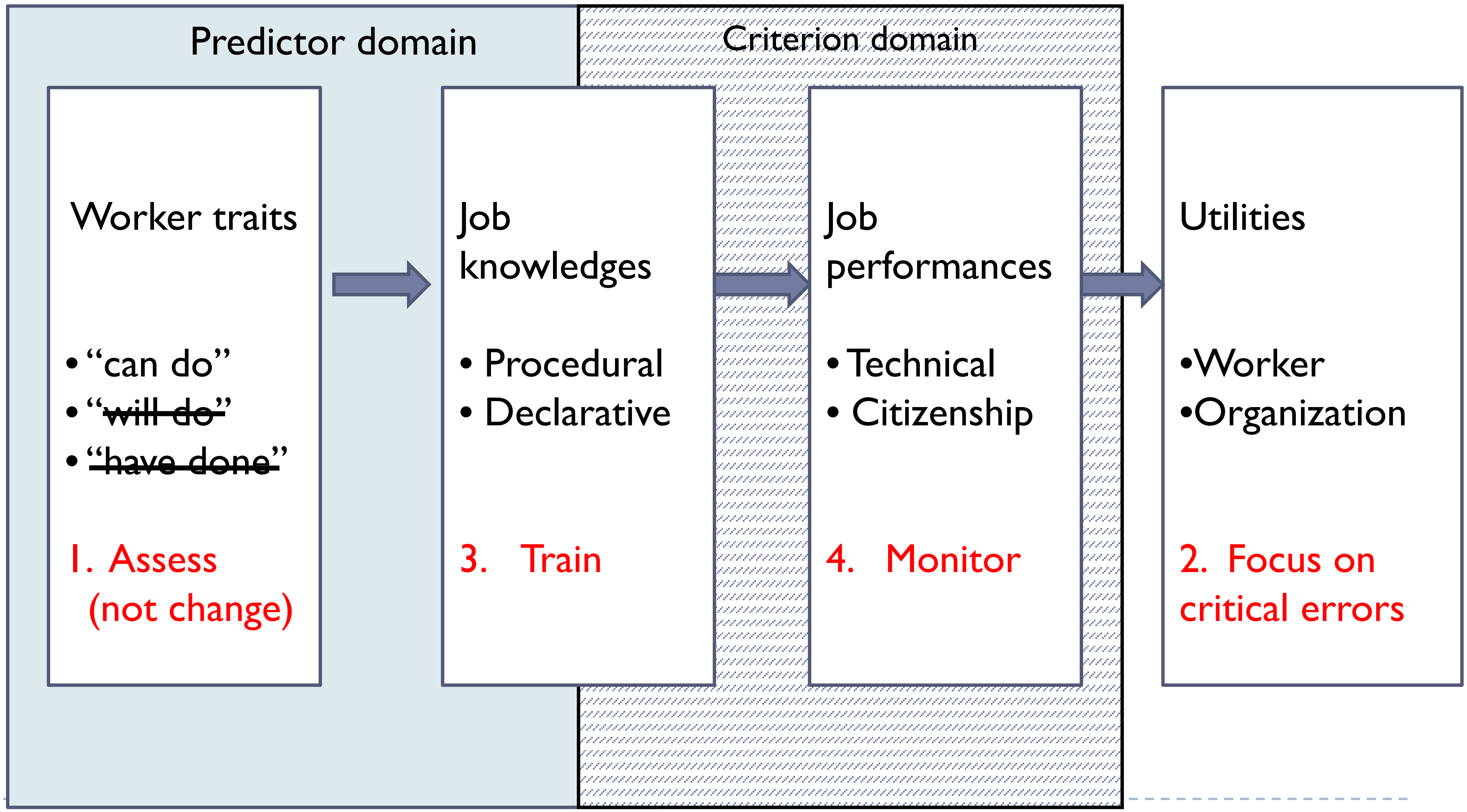
But SD expands when mean rises

Recommendations for interventions II: Identify & reduce sources of patient error

Can't change *g* level, but can use *g* theory to manipulate worker-job interface to reduce rates of patient error:

1. Worker side—import tools
   - Train providers in individual differences
   - Train patients using learning principles (educ psych)
2. Job side—develop tools (explained shortly)

Points of leverage for error reduction



Error model (human factors approach)

Error

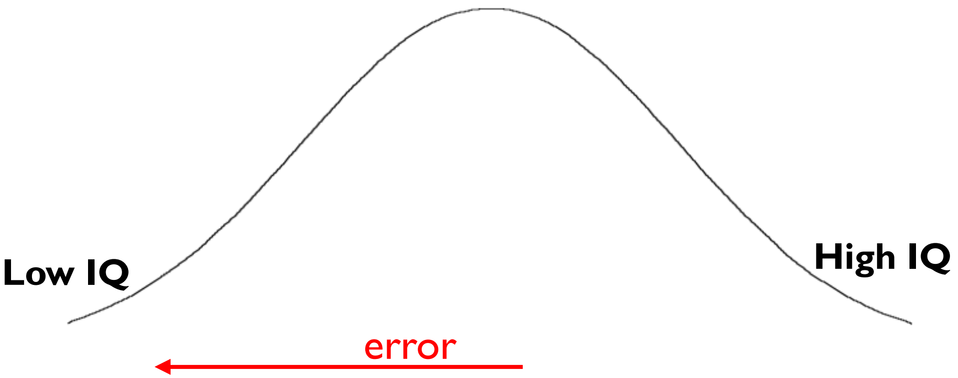
- A cognitive mistake (á la psychometric)
- Commission or omission
- "We all make mistakes"

Ask: What increases error rates in patients' self-care?

- Patient side
  - **Weaker g**
  - Weaker KSAs (knowledge, skills & abilities)
  - Impaired deployment of KSAs (e.g., stress, illness)
- Task demand side
  - **More complex**

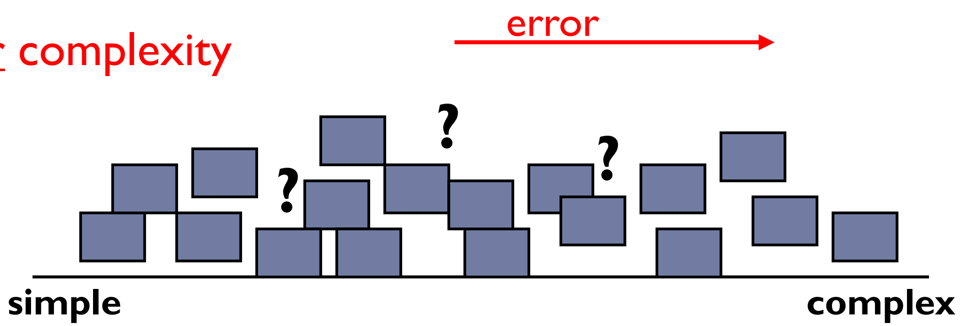
Need epidemiology of patient error

1. Cognitive susceptibility (patient's g level)

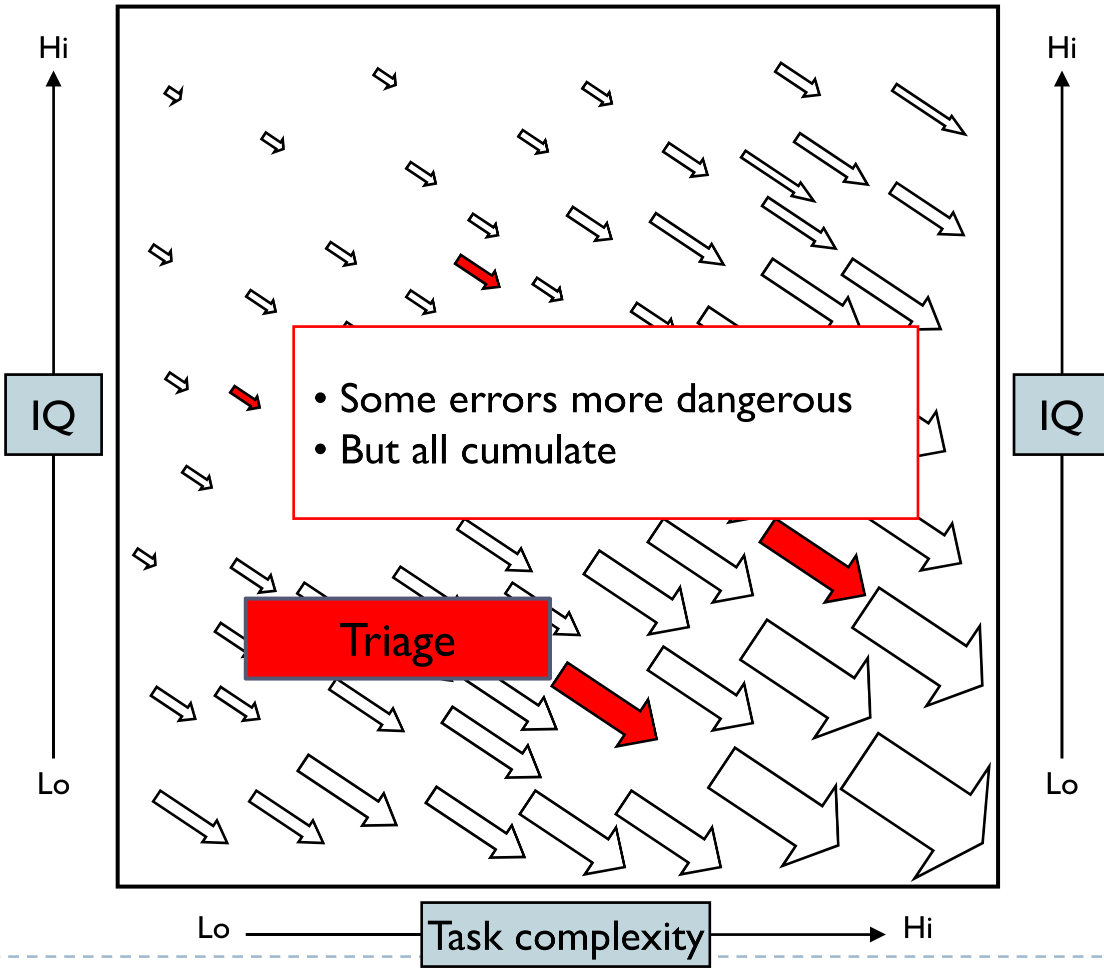


3. Error rates
(non-adherence)
- rise at lower IQ
- rise with greater complexity

2. Cognitive hazards
(task's g loading)



Matrix of cognitive risk
(patient error rates on tasks)



<u>Can predict error rates if we know:</u>

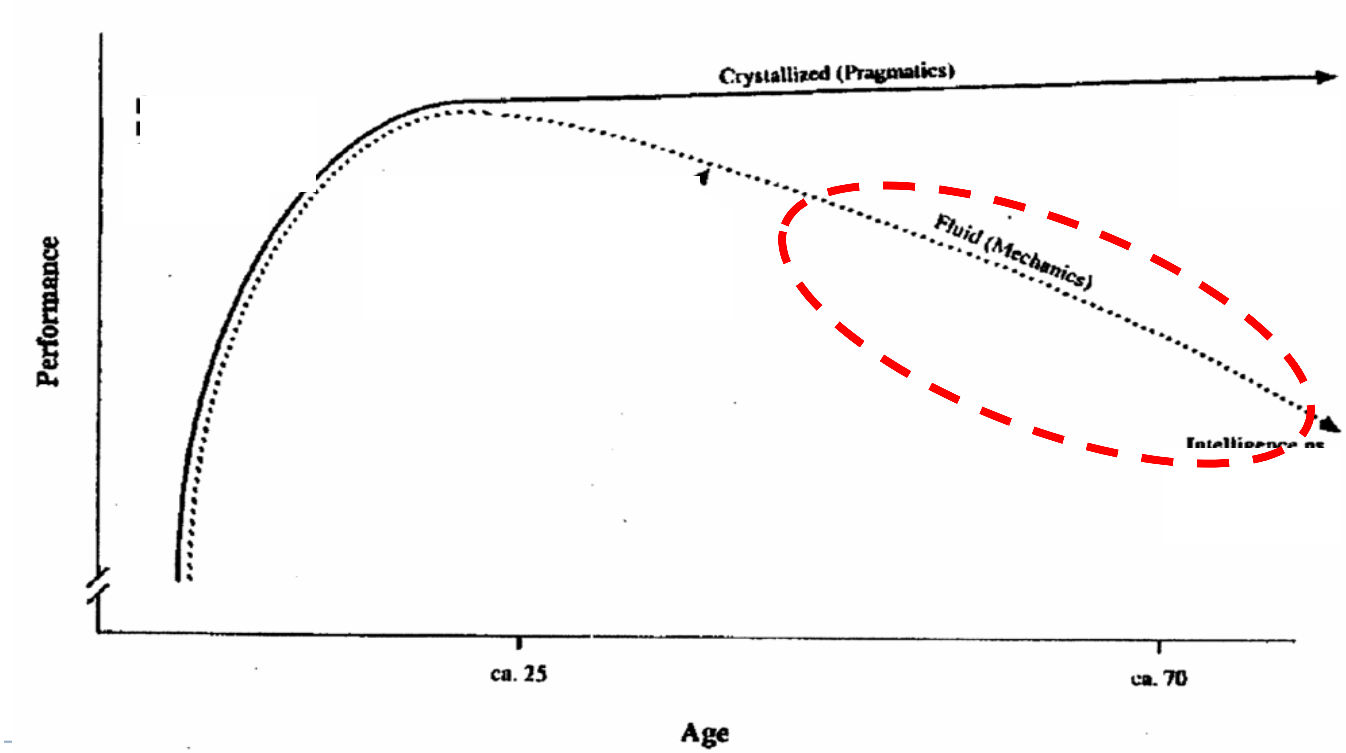
Distribution of *g* in groups of patients:
- race
- age
- locale

Distribution of *g* loadings in sets of tasks:
- preventive care
- chronic diseases

Error rates increase with age

- fluid *g* down
- "jobs" more complex (morbidity up)

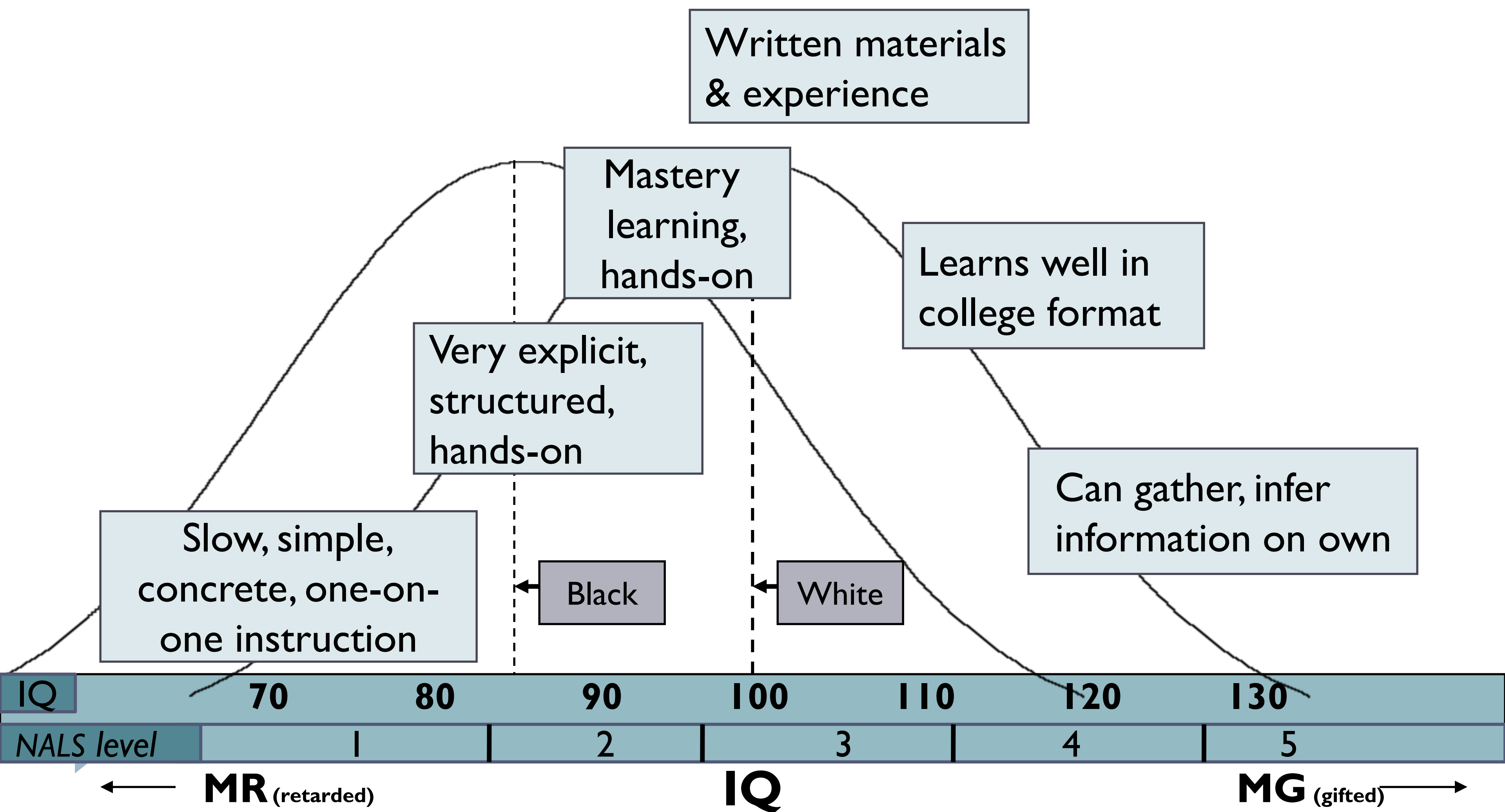
Average profile only



Basic cultural knowledge (G_C)

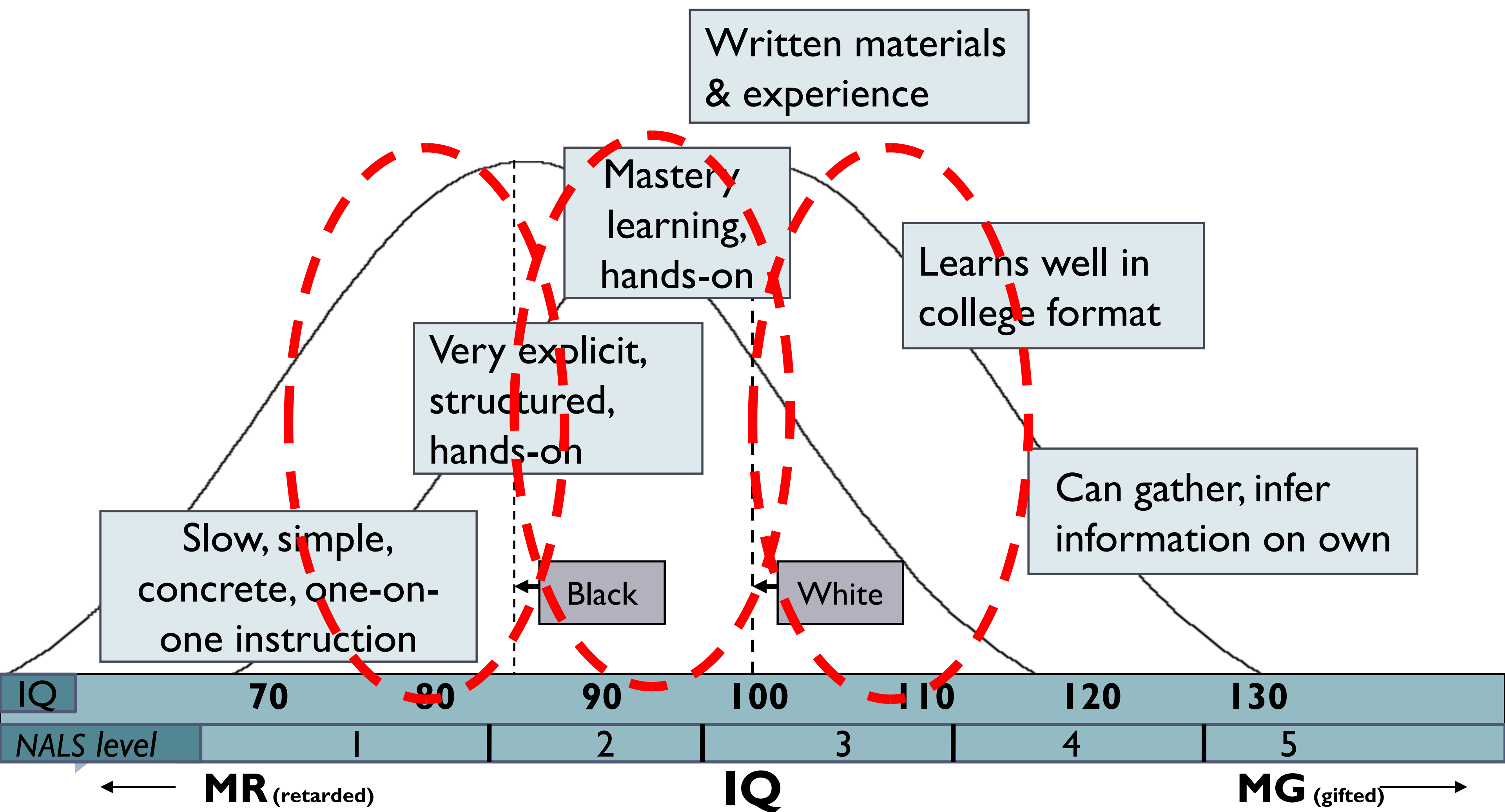
Basic information processing (G_F)

Instructional needs differ by IQ level (adults)



Distribution of your clinic population?

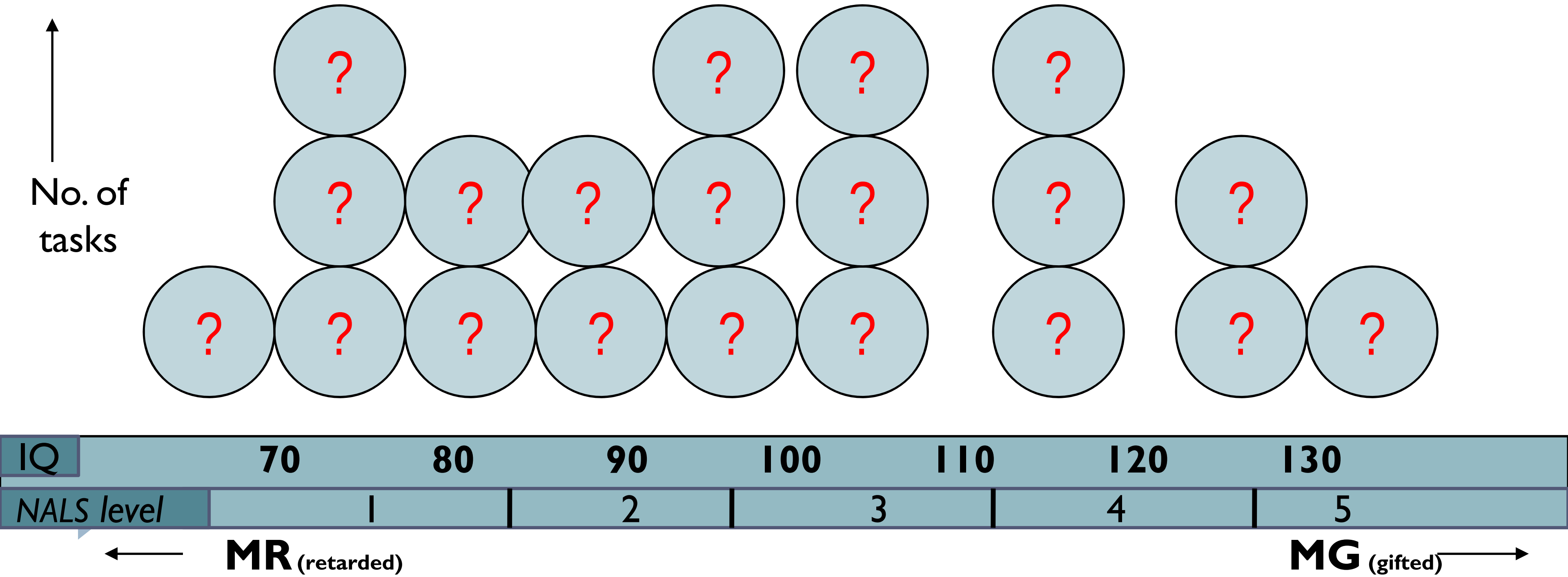
Instructional needs differ by IQ level (adults)



Distribution of cognitive hazards?

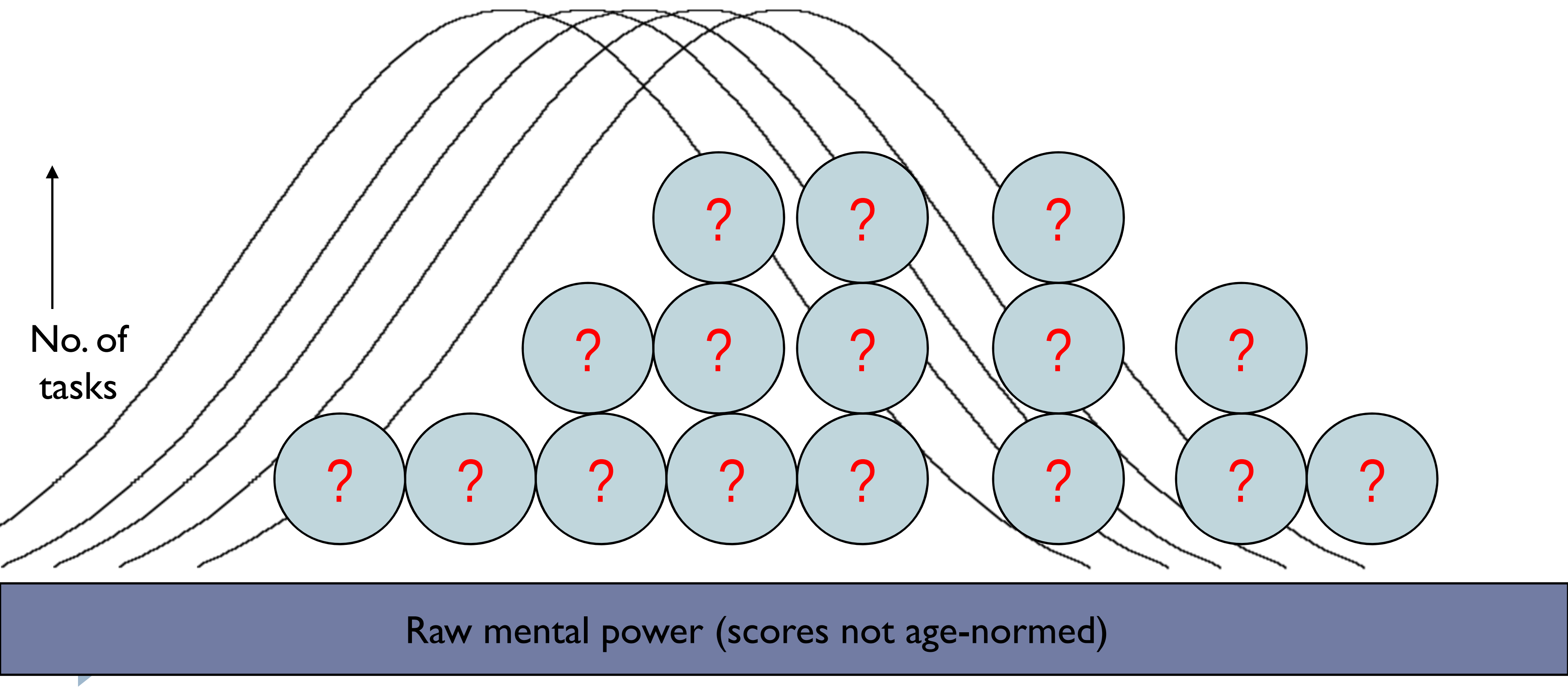
Easy is unlikely—broad range is more likely

Medical advances increase complexity



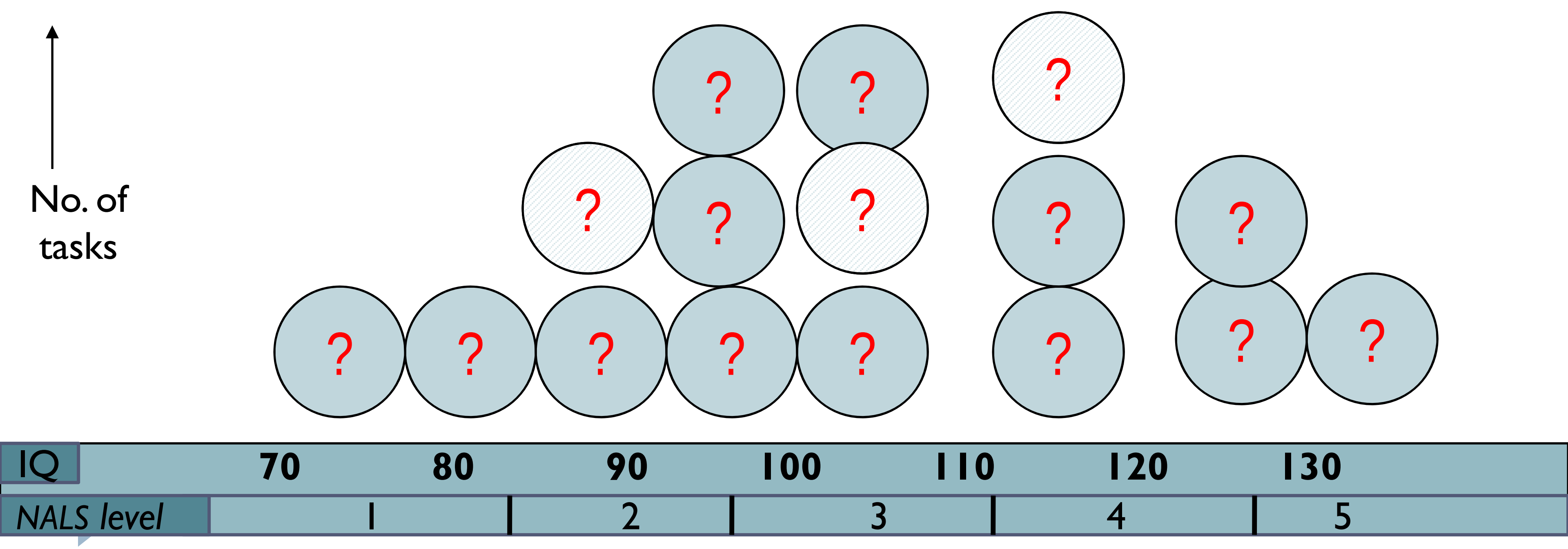
Distribution of cognitive hazards?

Aging lowers our ability to deal with them



Distribution of cognitive hurdles?

Some complexity unnecessary, but much inherent



Interventions in job complexity: Develop tools

Audit complexity

1. Identify distribution of cognitive hurdles
   - Identify/classify building blocks of complexity
     - Elements of tasks (cognitive task analysis—*functional* level)
     - Constellations of tasks (cognitive job analysis—SMEs, focus groups)
     - Scoring system
   - Estimate expected error rates/task (human factors analysis)
   - Estimate error criticalities (critical incidents analysis, SMEs, focus groups)

Common building blocks of job complexity?

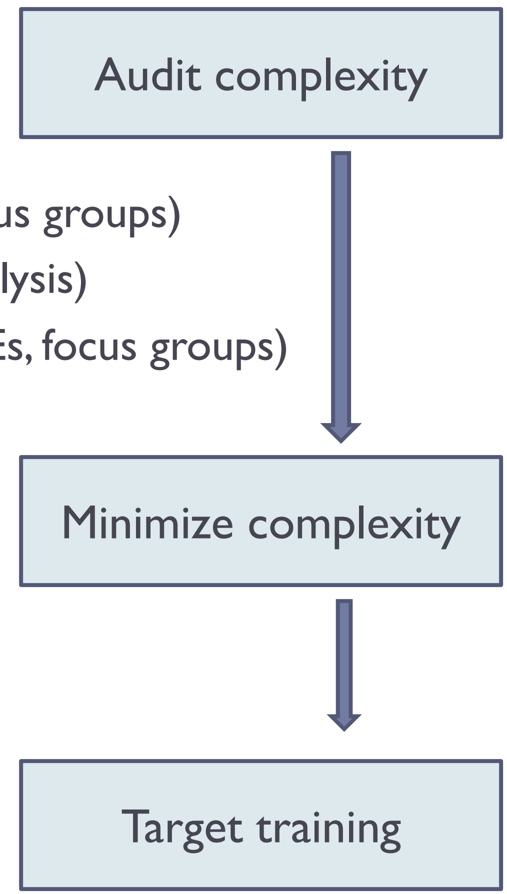
- Individual tasks
  - Abstract, unseen processes; cause-effect relations
  - Incomplete or conflicting information; much information to integrate; relevance unclear
  - Inferences required; operations not specified
  - Ambiguous, uncertain, unpredictable conditions
  - Distracting information or events
  - Problem not obvious, feedback ambiguous, standards change
- Task constellation (Often neglected, even in job analyses)
  - Multi-tasking, prioritizing
  - Sequencing, timing, coordinating
  - Evolving mix of tasks
  - Little supervision; need for independent judgment

Interventions in job complexity: Develop tools

1. Identify distribution of cognitive hurdles
   - Identify/classify building blocks of complexity
     - Elements of tasks (cognitive task analysis—*functional* level)
     - Constellations of tasks (cognitive job analysis—MSEs, focus groups)
   - Estimate expected error rates/task (human factors analysis)
   - Estimate error criticalities (critical incidents analysis, SMEs, focus groups)

2. Where possible, eliminate/lower hurdles
   - Focus on essentials
   - Then simplify

3. Train, <u>contingent</u> on g stratum of patients:
   - Narrow task domain (triage, job stripping)
   - Individualize training (more scaffolding)
   - Increase supervision (monitoring, feedback)



Complexity of self-management: The neglected lever in health care

Patient error rates (non-adherence) increase when:

- Tasks are more complex
- Constellations of tasks (e.g., the "job" of diabetes) are large, diverse, ambiguous, poorly organized, unsupervised, etc.

Patient error increases morbidity, mortality, & costs

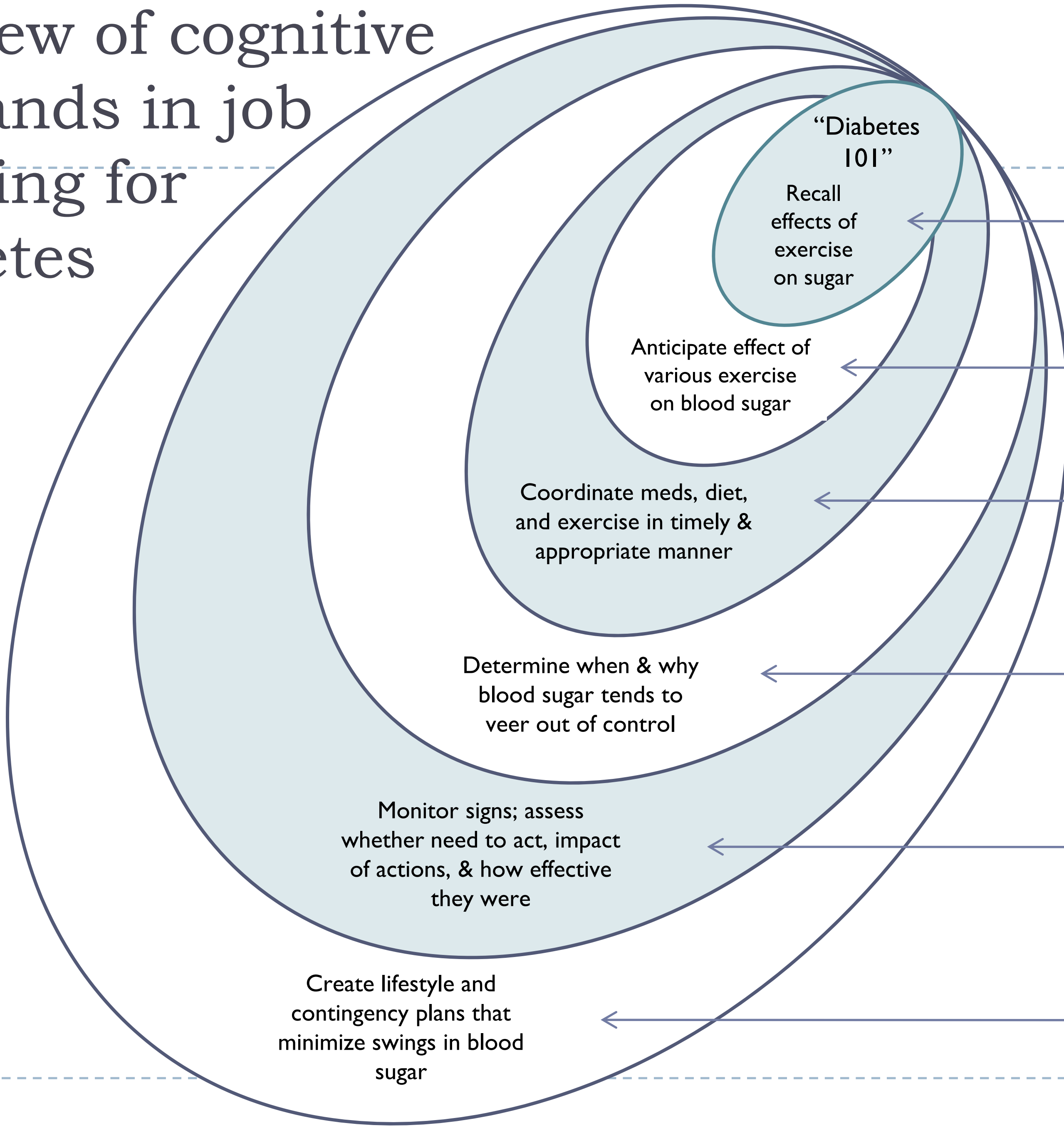
But we know virtually nothing about <u>task</u>-based patterns of cognitive error

- How much, and why, do self-care tasks differ in complexity level (cognitive risk)?
- How are these risks are sequenced across days, weeks, years?
  - In preventing illness & injury
  - In managing illness & injury
- What are the likely points of *preventable* cognitive overload & critical error?

Cognitive analyses of self-care "jobs" could yield large returns via

- Better "job" design
- Better "job" training
- Better supervision

Preview of cognitive demands in job training for diabetes



<u>Bloom's taxonomy of educational objectives (cognitive domain)</u>

Simplest tasks

1. Remember
   recognize, recall, Identify, retrieve
2. Understand
   paraphrase, summarize, compare, predict, infer,
3. Apply
   execute familiar task,, apply procedure to unfamiliar task
4. Analyze
   distinguish, focus, select, integrate, coordinate
5. Evaluate
   check, monitor, detect inconsistencies, judge effectiveness
6. Create
   hypothesize, plan, invent, devise, design

Most complex tasks

Citations

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Thank you.

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