Everyday Life and Health as an Intelligence Test—Throughout Evolution

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How can that be?

- Isn't IQ just a narrow academic ability?
  - *No: IQ captures a very general, very practical ability*
- Aren't there multiple intelligences?
  - *No: many abilities but only one broad intelligence*
- Don't other things matter in life—motivation, social advantages?
  - *Yes, of course: but higher IQ boosts odds throughout*

Tiny odds yield huge effects over time—in tests, life, & evolution

Life's Long Test Battery

- Many "subtests"
  - Varied, evolving, inescapable
- Surprising similarity to IQ tests
  - Wellspring of "cognitive barriers"
- Crucial difference
  - Options for lowering "cognitive barriers"

For example:
- Patient-provider communication
- Complexity of treatment regimens

Most Crucial Ability in 4 Life Realms

1. Judgment and reasoning	1st factor in job analyses (major distinction in what jobs require) Jobs
2. Problem solving and complex information processing	Functional literacy Daily self-maintenance
3. Problem-solving abilities; ability to acquire new information and complete complex cognitive tasks	Health literacy Health self-care
4. Problem solving capacity; abstract thinking or reasoning; capacity to acquire knowledge	Experts rate these 3 as most important elements of intelligence Intelligence test

A superficial similarity, but…

- How can such different “tests” measure the same ability?
  1. What is intelligence *(g)?*
  2. What makes a task/test “*g* loaded”?

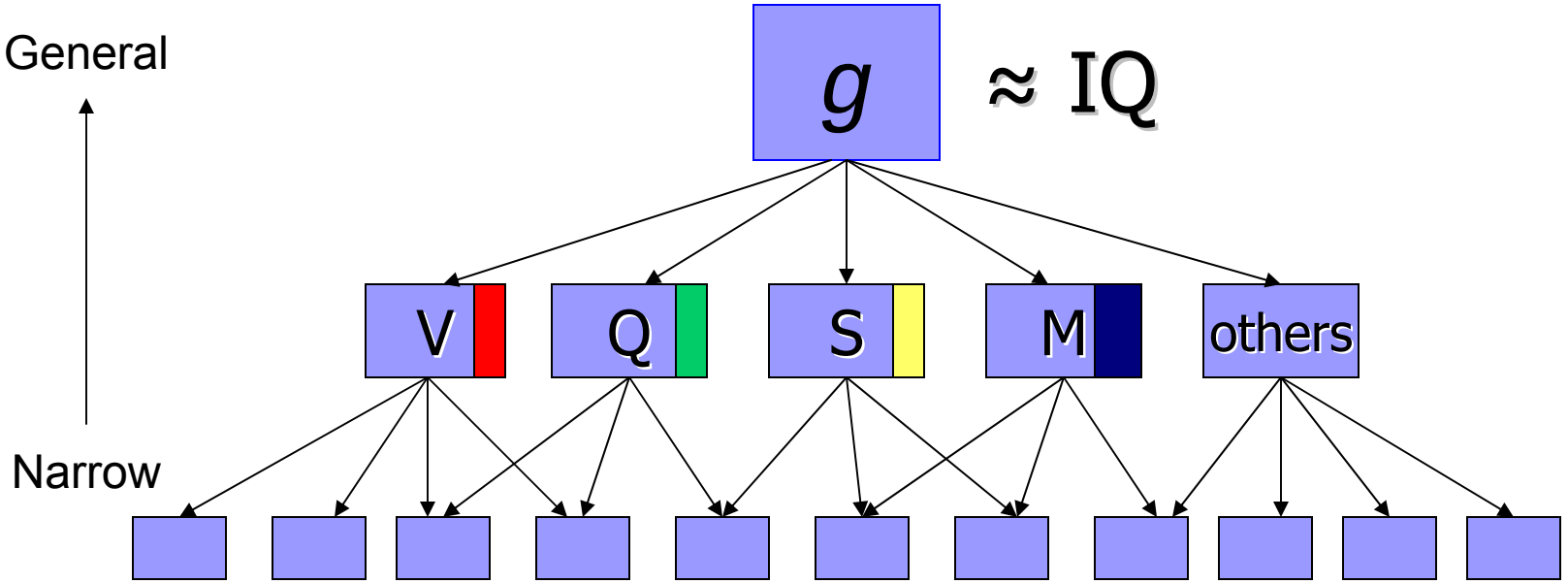
“Intelligence”

General mental ability factor (*g*)

(century of research)

Many abilities, but only one general intelligence

- All mental tests measure mostly the same ability: *g*
- *g* is ~content independent
- *g* carries the freight of prediction



Sample IQ Items

(individually administered)

	Easy	**Moderate**	**Hard**
Fill in the next two numbers	3, 5, 7, 9,__, __	3, 5, 6, 8, 9, __, __	10, 9, 8, 9, 8, 7, __, __
Name one similarity	orange—banana (93%)	table-chair (55%)	Praise-punishment (25%)
Define the word			

Infer the rule

More abstract

Complexity is the active ingredient:
More complex tasks are more "*g* loaded"

% = % of 16-65 year-olds getting at least partial credit for answer, WAIS, 1955

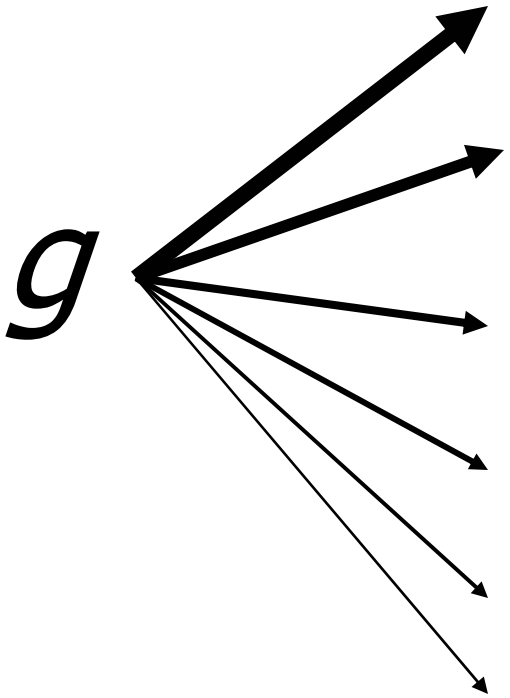
Psychometric Secret
(Spearman-Brown Reliability Formula)

Many weak items

.2	.2	.2	.3	.1	.1	.2
.2	.1	.2	.1	.3	.2	.1
.1	.2	.1	.2	.1	.1	.3
.2	.1	.3	.3	.1	.2	.1
.2	.2	.2	.3	.1	.1	.2
.2	.1	.2	.1	.3	.2	.1
.1	.2	.1	.2	.1	.1	.3
.2	.1	.3	.3	.1	.2	.1

Strong test

Life's subtests differ in *g* loading



	r
Standardized academic achievement	.8
Job performance—complex jobs	
Years of education	.6
Occupational level	
Job performance—middle-level jobs	.4-.5
Income	.3-.4
Delinquency	-.25
Job performance—simple jobs	.2

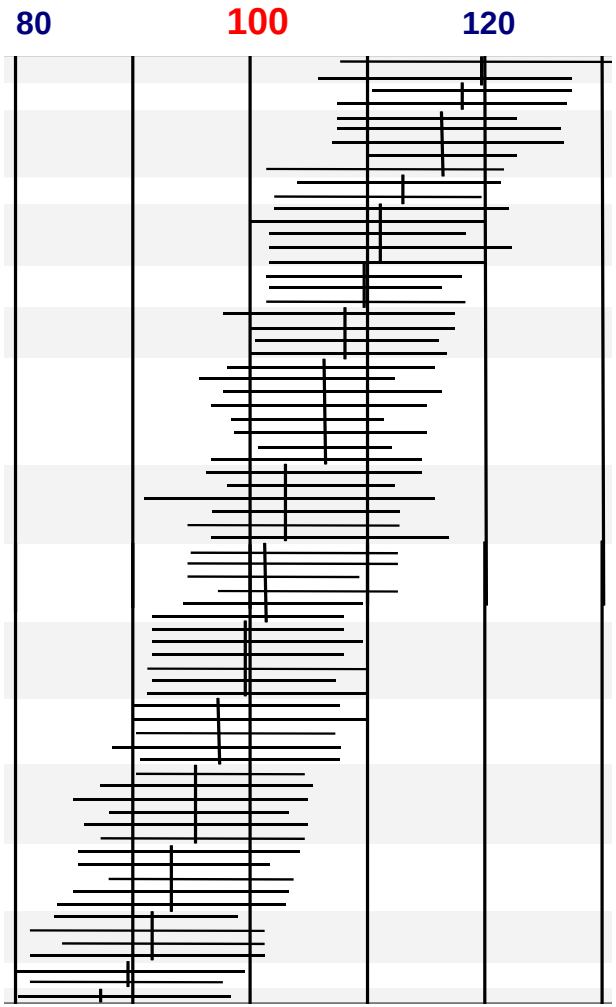
“Jobs”

Status level & on-the-job performance

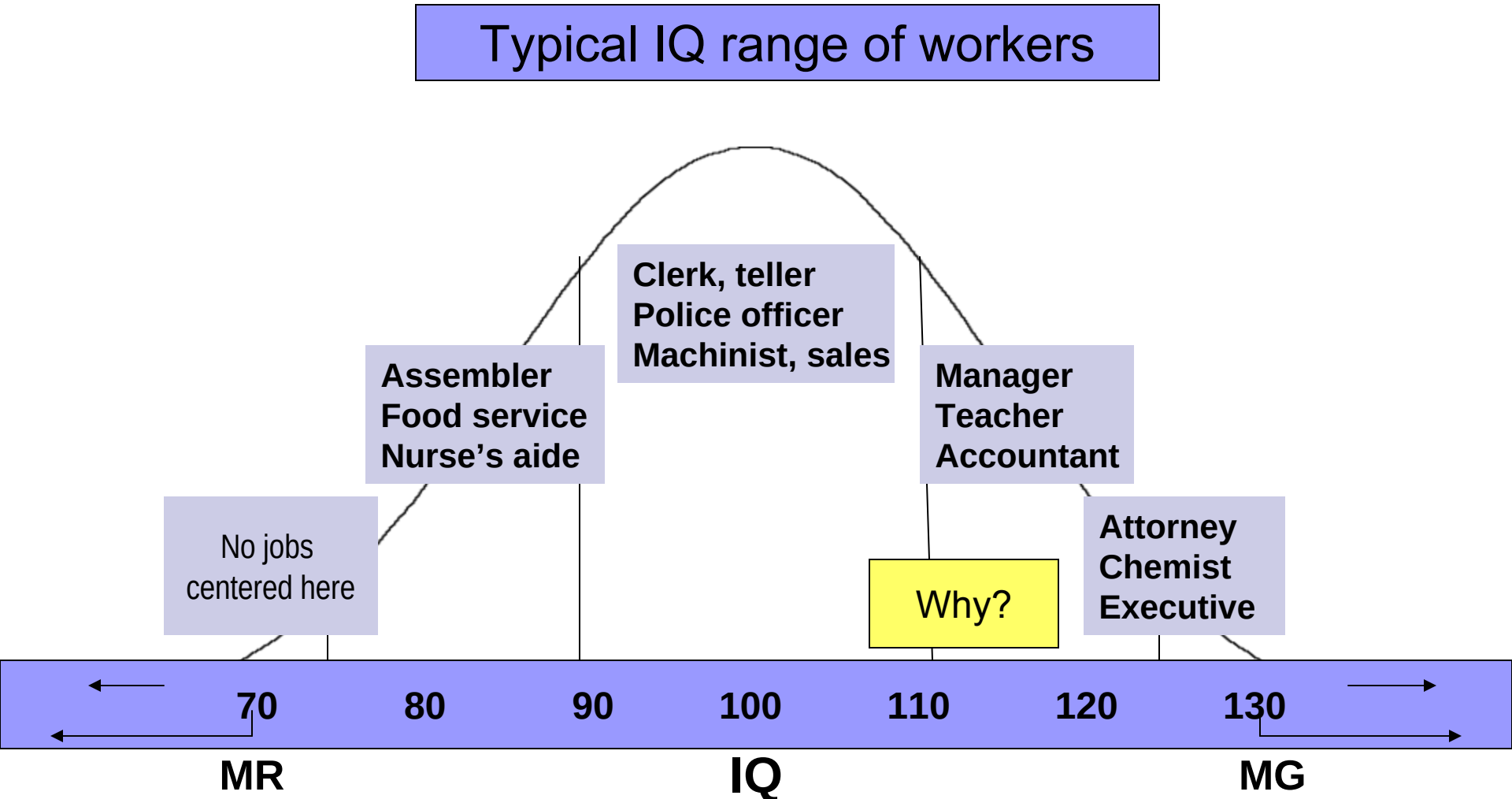
(century of research)

Higher-status jobs ⟹ higher-IQ workers

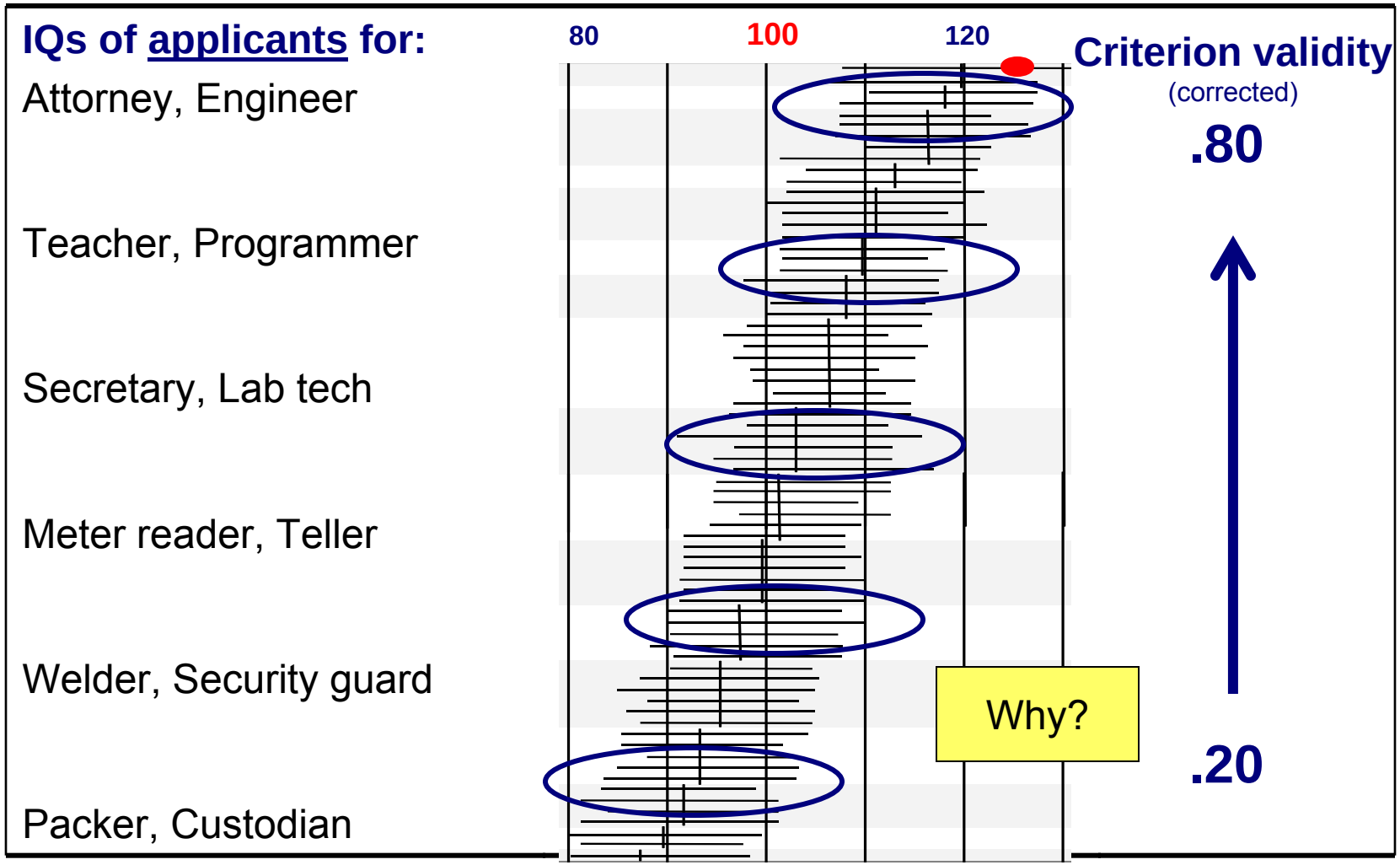
IQs of applicants for:	IQs: Middle 50%
Attorney, Engineer	108-128
Teacher, Programmer	100-120
Secretary, Lab tech	96-116
Meter reader, Teller	91-110
Welder, Security guard	85-105
Packer, Custodian	80-100



Typical IQs in Occupations



IQ predicts performance in all jobs—but especially higher up

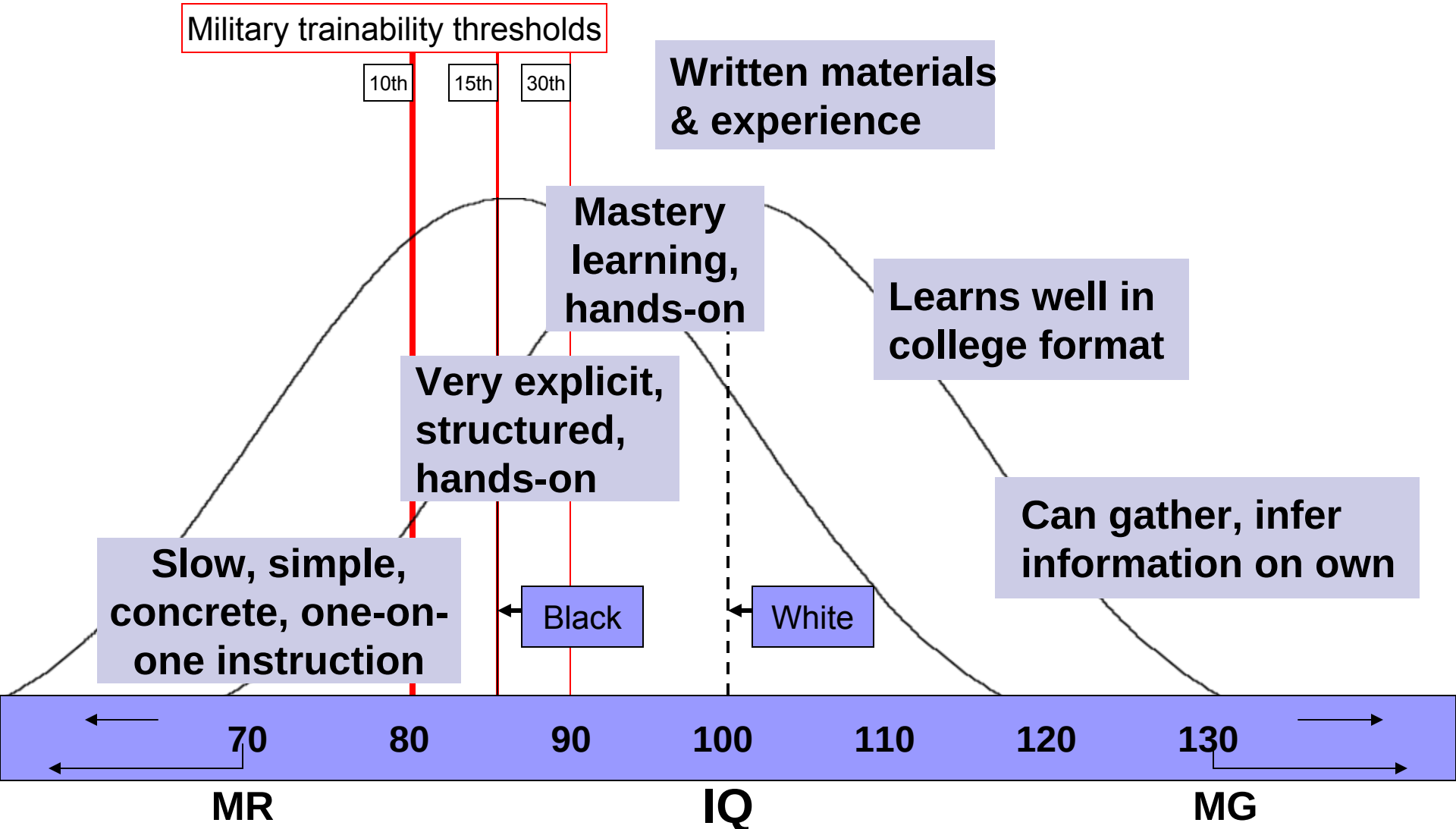


Judgment & Reasoning Factor

Job analysis 1 (Arvey, 1986)

Job requirements:	Correlation with factor
▪ Learn and recall relevant information	**.75**
▪ Reason and make judgments	**.71**
▪ Deal with unexpected situations	**.69**
▪ Identify problem situations quickly	**.69**
▪ React swiftly when unexpected problems occur	**.67**
▪ Apply common sense to solve problems	**.66**
▪ Learn new procedures quickly	**.66**
▪ Be alert & quick to understand things	**.55**

Typical Learning Needs by IQ Level



Overall Complexity Factor

Job analysis 2 (Gottfredson, 1997)

Complex	*r*		
Attorney	.88	Self-direction	Combine information
	.86	Reason	Advise
	.85	Update knowledge	Write
	.83	Analyze	Plan
	.79	Lack of structure	Negotiate, Persuade
	.71	Criticality of position	Coordinate
			Instruct
Teller	.51	Transcribe	
	.36	Recognize	
	-.49	Repetitive	
	-.56	Physical exertion	
Custodian			
Simple	-.73	Supervision	

Patient?

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

Like life itself!

“Functional literacy”

Daily self-maintenance in modern life

(2 decades of research)

Functional Literacy (NALS)

(nationally representative sample, ages 16-65)

Items in life's "test"?

NALS Level	% pop. (white)	Simulated Everyday Tasks
5	4%	▪ Use calculator to determine cost of carpet for a room ▪ Use table of information to compare 2 credit cards
4	21%	▪ Use eligibility pamphlet to calculate SSI benefits ▪ Explain difference between 2 types of employee benefits
3	36%	▪ Calculate miles per gallon from mileage record chart ▪ Write brief letter explaining error on credit card bill
2	25%	▪ Determine difference in price between 2 show tickets ▪ Locate intersection on street map
1	14%	▪Total bank deposit entry ▪ Locate expiration date on driver's license

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Difficulty based on "process complexity"

- level of inference
- abstractness of info
- distracting information

Not reading per se, but "problem solving"

“Health literacy”

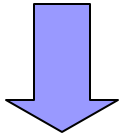
Adherence to treatment

(decade of research)

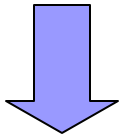
Example (TOFHLA)

(Controlling for personal resources, access, insurance, education, etc.)

Health literacy



More health knowledge
Better adherence



Better health
Less hospitalization
Lower health costs/year

Sample TOHFLA Items & Error Rates

Patients examine the actual vials or documents

% of urban hospital outpatients ***not*** knowing: **Many professionals have no idea how difficult these "simple" things are for others**	Health literacy level		
	V-low	Low	OK
How to take meds 4 times per day	24	9	5
When next appointment is scheduled	40	13	5
How many pills of a prescription to take	70	34	13
What an informed consent form is saying	95	72	22

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But how representative?

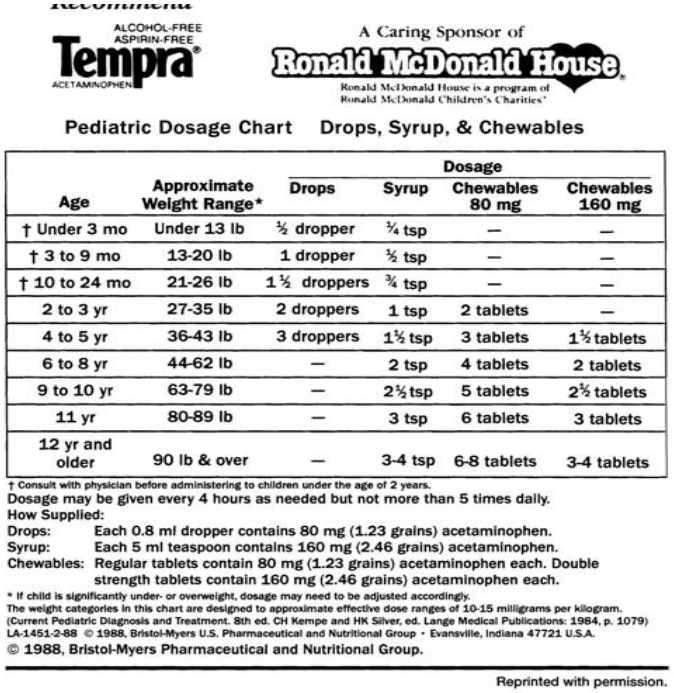
error

Health Adult Literacy Survey (HALS)

(nationally representative sample)

- Items simulate everyday health tasks
- Analyzed what increases item difficulty (error rates)
- 3 increasingly difficult questions for this item

Sample item



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Pediatric Dosage Chart **Drops, Syrup, & Chewables**

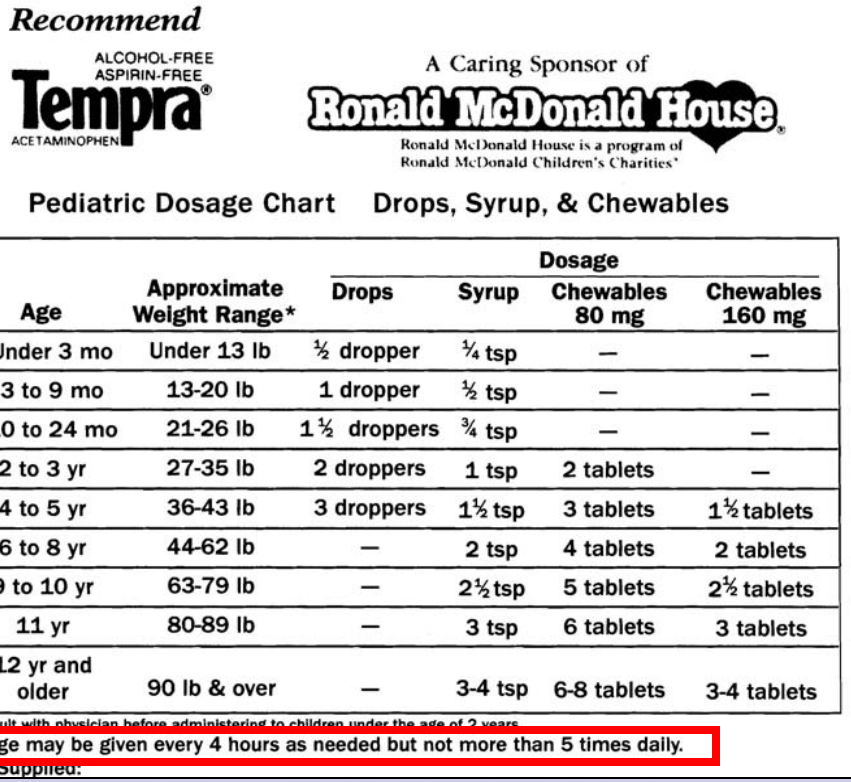
Age	Approximate Weight Range*	Dosage			
		Drops	Syrup	Chewables 80 mg	Chewables 160 mg
† Under 3 mo	Under 13 lb	½ dropper	¼ tsp	—	—
† 3 to 9 mo	13-20 lb	1 dropper	½ tsp	—	—
† 10 to 24 mo	21-26 lb	1½ droppers	¾ tsp	—	—
2 to 3 yr	27-35 lb	2 droppers	1 tsp	2 tablets	—
4 to 5 yr	36-43 lb	3 droppers	1½ tsp	3 tablets	1½ tablets
6 to 8 yr	44-62 lb	—	2 tsp	4 tablets	2 tablets
9 to 10 yr	63-79 lb	—	2½ tsp	5 tablets	2½ tablets
11 yr	80-89 lb	—	3 tsp	6 tablets	3 tablets
12 yr and older	90 lb & over	—	3-4 tsp	6-8 tablets	3-4 tablets

† Consult with physician before administering to children under the age of 2 years.
Dosage may be given every 4 hours as needed but not more than 5 times daily.
How Supplied:
Drops: Each 0.8 ml dropper contains 80 mg (1.23 grains) acetaminophen.
Syrup: Each 5 ml teaspoon contains 160 mg (2.46 grains) acetaminophen.
Chewables: Regular tablets contain 80 mg (1.23 grains) acetaminophen each. Double strength tablets contain 160 mg (2.46 grains) acetaminophen each.

* If child is significantly under- or overweight, dosage may need to be adjusted accordingly.
The weight categories in this chart are designed to approximate effective dose ranges of 10-15 milligrams per kilogram.
(Current Pediatric Diagnosis and Treatment, 8th ed. CH Kempe and HK Silver, ed. Lange Medical Publications: 1984, p. 1079)
LA-1451-2-88 © 1988, Bristol-Myers U.S. Pharmaceutical and Nutritional Group • Evansville, Indiana 47721 U.S.A.

#1—Underline sentence saying how often to administer medication

- One piece of info
- Simple match
- But lots of irrelevant info



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Dosage may be given every 4 hours as needed but not more than 5 times daily.

How Supplied:

% US adults routinely functioning <u>below</u> this level?

20%

Caution!
Could train them do this item, but not all like it

239

HALS LEVELS:	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5
HALS SCORES:	175	225	275	325	375	500

#2—How much syrup for 10-year-old who weighs 50 pounds?

- Spot & reconcile conflicting info
- Inference from ambiguous info
- Multiple features to match

Recommend

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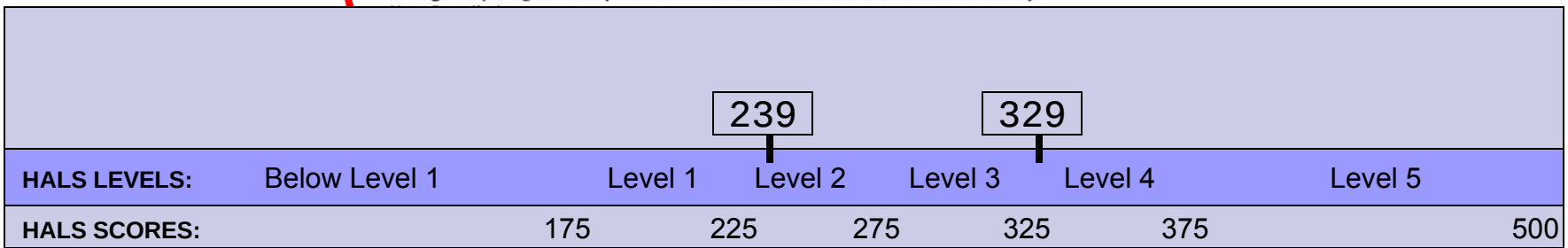
Dosage may be given every 4 hours as needed but not more than 5 times daily.

??

??

% US adults routinely functioning below this level?

54%



#3—Your child is 11 years old and weighs 85 pounds. How many 80 mg tablets can you give in 24-hr period?

- Multiple features to match
- Two-step task
- Infer proper math operation
- Select proper numbers to use
- Ignore the most obvious but incorrect number
- Calculate the result

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How Supplied:

% US adults routinely functioning below this level?

95%

"Below minimum standard for today's labor market"

			239		329	378	
HALS LEVELS:	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5	
HALS SCORES:	175	225	275	325	375	500	

Literacy Researchers' Conclusion

Non-compliance with treatment

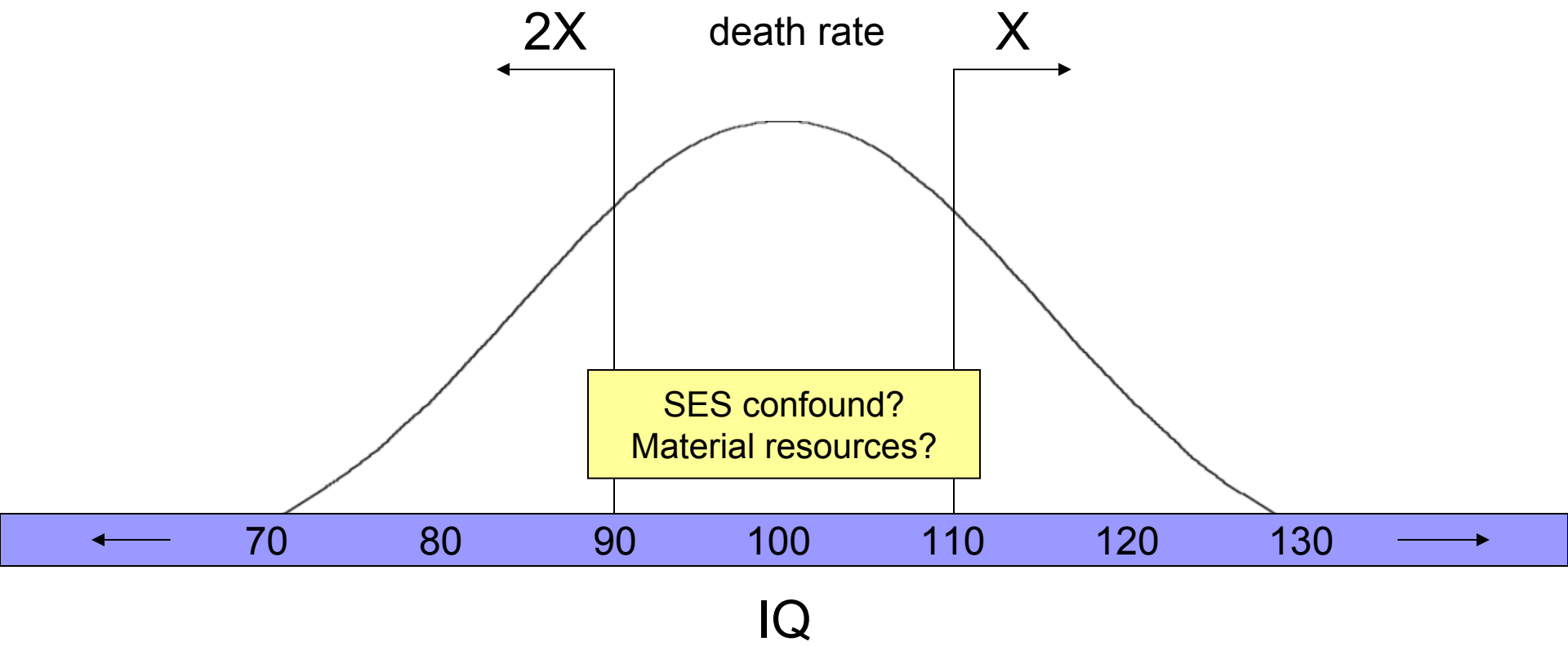
- Often due to a failure to "learn, reason, & problem-solve"
- Leads to higher morbidity
- Leads to higher mortality
- Can create new health problems (e.g., by taking medication incorrectly)

Childhood IQ Predicts Adult Mortality

8 large studies

(Batty, Deary, & Gottfredson, 2007)

1 more IQ point = 1% lower death rate



Material resources not enough

- Equalizing resources *increases* health disparities
  - When Britain introduced **national health care**
  - When media made **health information** *more* widely available (signs and symptoms of cancer, diabetes, etc.)
- Old story—average rises, but variance too
  - Like in schools—some students more effectively exploit the same instruction
- Mental resources matter too—insufficiency means:
  - Inefficient use of available care
  - Inappropriate criticism of care

“Health”

Health self-care

(new research)

Health Self-Care Is a Lifelong Job: Yours!

- Constellation of tasks to perform, actions to avoid
- Training required
- Coordinate & communicate with others
- Exercise independent judgment
- Only occasional supervision or consultation
- Job changes as technology & conditions evolve
- Sometimes tiring, frustrating, affects family life
- Central to personal well-being
- But no vacations, no retirement

Major Causes of Premature Death

- Chronic illnesses (heart disease, cancer, etc.)
  - Middle-age & older
- Unintentional ("accidental") injury
  - Childhood & early adulthood

All are "preventable."

Avoiding Chronic Illness Requires Foresight & Prevention

- Keep informed
- Live healthy lifestyle
- Get preventive checkups
- Detect signs and symptoms
- Seek timely, appropriate medical attention

Chronic Illnesses Require Self-Regulation

- Follow treatment regimen
  - Use medications as prescribed
  - Diet, exercise, no smoking, etc.
  - Including for diseases without outward signs (e.g., hypertension)
- Monitor daily signs and symptoms
- Adjust medication and behavior in response to signs
- Have regular check-ups

Accidents: Prevention Is Key

- Recognize hazards
- Prevent incidents starting
- Halt progress of incidents
- Limit damage during incidents
- Recover and redesign

• Same process as with chronic illnesses
• Myriad low-probability, often-hidden hazards

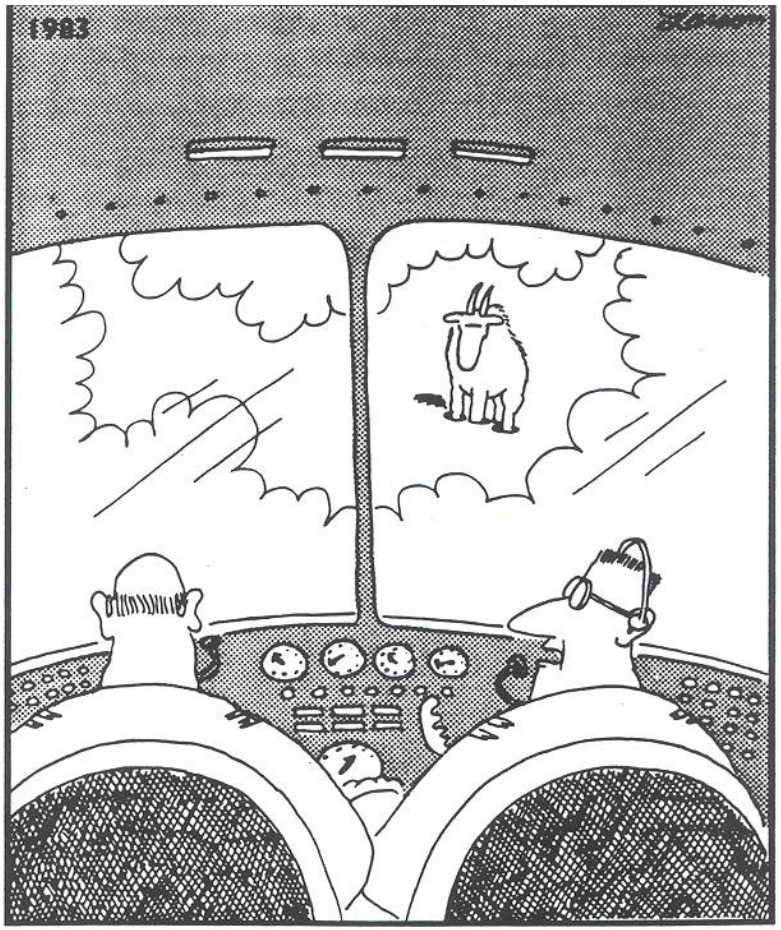
Motor Vehicle Fatalities. Are They Just "Accidental"?

- IQ is best predictor
- Predicts net of 56 other variables

Australian veterans followed to age 40	Death rate per 10,000	
IQ: above 115	51.3	
100-115	51.5	
85-100	92.2	**2x**
80- 85	146.7	**3x**

Life requires "defensive driving"

Dealing with the unexpected



"Say … what's a mountain goat doing
way up here in a cloud bank?"

Recall: All this is complex

Complex jobs require workers to: (Arvey, 1986) (Applied to health)	Correlation with overall job complexity
▪ Learn and recall relevant information (symptoms)	**.75**
▪ Reason and make judgments (timely preventive care)	**.71**
▪ Deal with unexpected situations (meal delayed)	**.69**
▪ Identify problem situations quickly (hazards)	**.69**
▪ React swiftly when unexpected problems occur (injuries, asthma attack)	**.67**
▪ Apply common sense to solve problems	**.66**
▪ Learn new procedures quickly (treatment regimens)	**.66**
▪ Be alert & quick to understand things (feverish child)	**.55**

Chronic Illnesses as Demanding “Careers”

Example: Diabetic's Job

- **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

- **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

Extremely Complex

Error Rates Among Diabetics

(insulin dependent)

Urban hospital outpatients: % diabetics ***not*** knowing that:	Health literacy level		
	V-low	Low	OK
Signal: Thirsty/tired/weak usually means blood sugar too high →	40	31	25
Action: Exercise lowers blood sugar →	60	54	35
Signal: Suddenly sweaty/shaky/hungry usually means blood sugar too low →	50	15	6
Action: Eat some form of sugar →	62	46	27

Treatment regimens becoming more complex

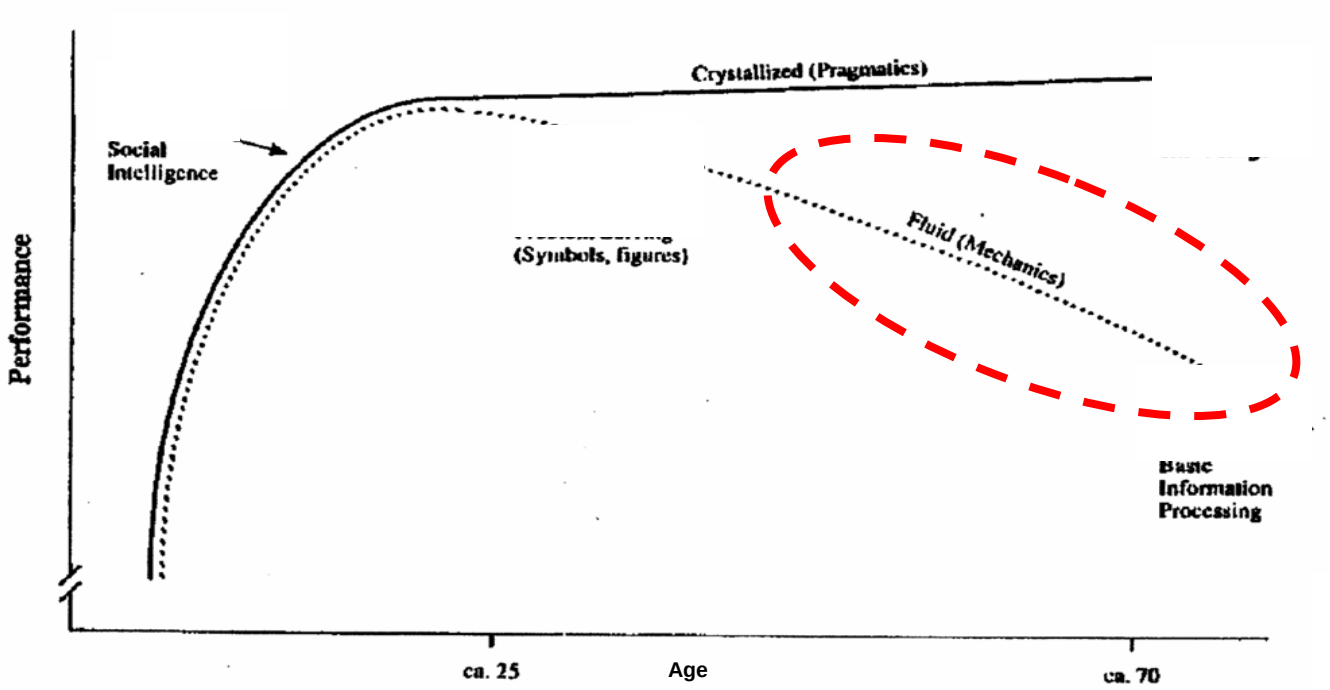
- Heart attacks
  - 1960's—just "good luck"
  - Now often includes:
    - regimen of aspirin, β-blocker, angiotensin-converting enzyme inhibitor
    - low-salt and low-cholesterol diet
    - Medicine to control hypertension, diabetes, & hypercholesterolemia

Brighter individuals can better capitalize on medical advances

Increasing Complexity Favors the Young

Raw mental horsepower (ability to learn and reason) rises into early adulthood, then falls

Average profile only



Basic cultural Knowledge (G_C)

***g* - Basic information processing (G_F)**

Score *relative to age mates* ("IQ") is stable from adolescence on

Complexity & Aging

"Okay your father
managed to get a mouse.
Now how do we use it?"

“Ultimate Intelligence Test”

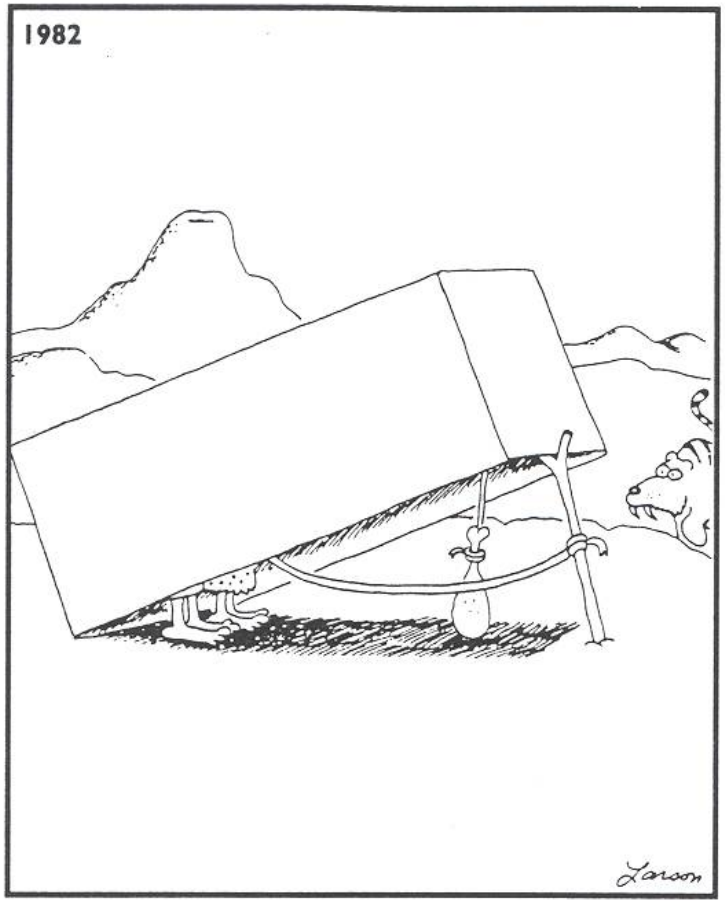
Evolution of human intelligence

(.1 to 1 MYA)

But wasn't life simpler in the early human EEA? No technology

- Yes, but it was never *g*-proof
- Opportunity to learn & reason + within-group *variation* in *g* = opportunity for selection
- Tiny effect size + many generations = big shift in distribution

Plan, Anticipate Problems



"Shhhh, Zog! … Here come one now!"

What Unique to Human EEA?

Human Innovation

- Changed physical environment or how humans interacted with it (e.g., fire, weapons)
- Improved average well-being but created novel risks (e.g., burns/scalds, inattention to snakes)
- Put a premium on independent learning and foresight,
  - especially for recognizing hazards and preventing "accidental" injury and death during core activities

Innovation & hazards require a mind's eye—imagination, foresight

Cause of Ache Deaths (N, <1971)

Age:	0-3		4-14		15-59		60+	
Sex:	F	M	F	M	F	M	F	M
Illness			**8**	**7**	**9**	**26**	**2**	**3**
Congenital/degenerative					**1**		**2**	**4**
Childbirth					**3**			
Accident			**1**	**10**	**6**	**23**	**4**	**3**
jaguar/snake				3	4	19	1	3
lightning				3	1	2		
lost				3		1	3	
drowned/falls/other			1	1	1	1		
Homicide			**14**	**3**	**4**	**7**	**1**	**4**
sacrificed with adult			10	1				
homicide/neglect			3					
buried alive/left behind			1	2	2		1	2
ritual club fights						6		2
non-sanctioned murder					2	1		

Most are "mistakes" (faulty mind's eye) during provisioning

Mistakes reverberate

Cause of Ache Deaths (N, <1971)

Age:	0-3		4-14		15-59		60+	
Sex:	F	M	F	M	F	M	F	M
Illness	**19**	**17**	**8**	**7**	**9**	**26**	**2**	**3**
Congenital/degenerative	**8**	**11**			**1**		**2**	**4**
Childbirth					**3**			
Accident	**1**	**2**	**1**	**10**	**6**	**23**	**4**	**3**
jaguar/snake				3	4	19	1	3
lightning		1		3	1	2		
lost				3		1	3	
drowned/falls/other	1	1	1	1	1	1		
Homicide	**26**	**26**	**14**	**3**	**4**	**7**	**1**	**4**
sacrificed with adult								
homicide/neglect								
buried alive/left behind	2	4	1	2	2		1	2
ritual club fights						6		2
non-sanctioned murder						1		

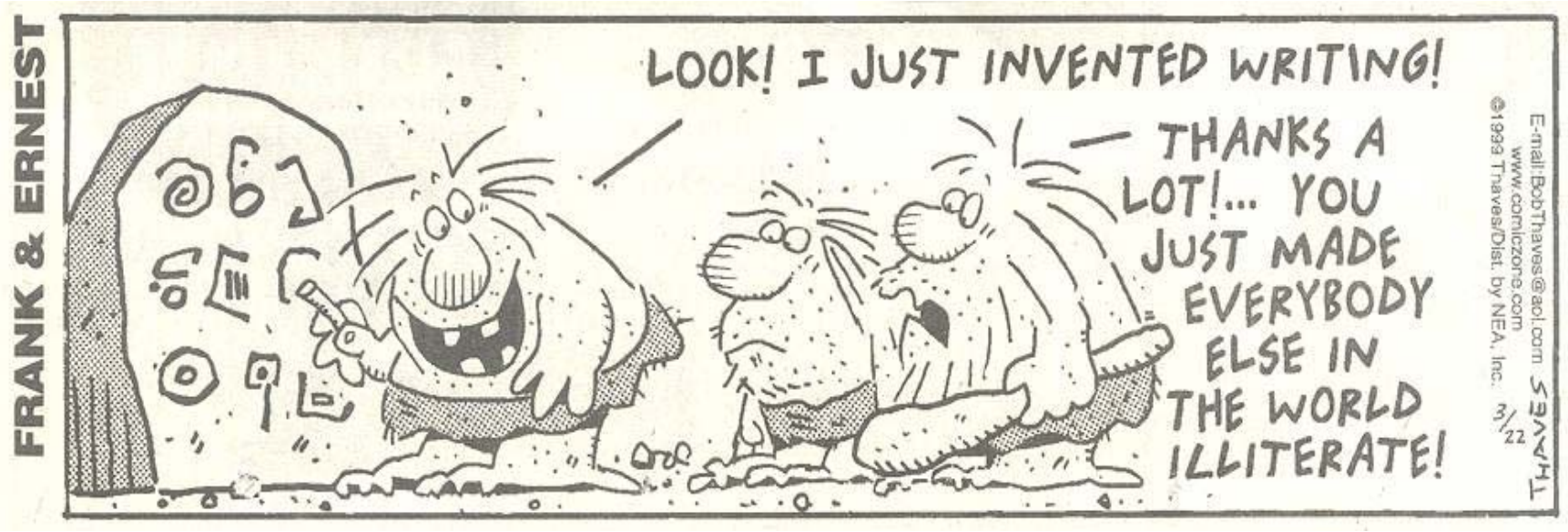
- "Accidents" are major opportunity for selection
- Tiny correlation g sufficient over generations

But why not monkeys too?

Human innovation itself

Smart people make life more complex for the rest of us

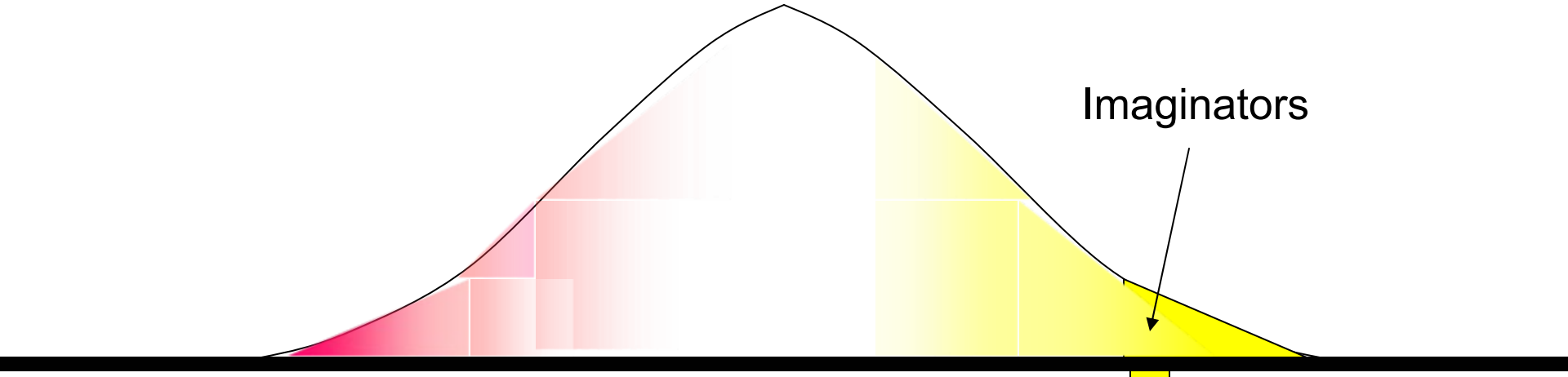
(Scott Adam's "Evolution of Idiots")



Innovation creates evolutionarily novel hazards

- Cooking/heating with fire, weapons, enclosures, dogs, ladders

One selection mechanism: Migration ratchet



Mean IQ rises

Innovate to adapt to harsher climates:

- clothing, shelter
- storage, preservation

Relative risk steepens

Bigger consequences ← More hazards ← More complexity ← More innovations

What Killed Differentially by *g* Level?

- **Not the obvious**
  - Not high-interest, high-probability threats to band's survival (e.g., starvation, harsh climate)
  - Because the fruits of competence are shared (e.g., meat from hunting)
- **But the "minor" side-effects of core tasks**
  - Myriad low-probability, chance-laden, oft-ignored risks in daily chores (e.g., "accidental" injury)
  - Costs of injury not shared widely

A lesson for today—what are we failing to notice?

Opportunities for Intervention

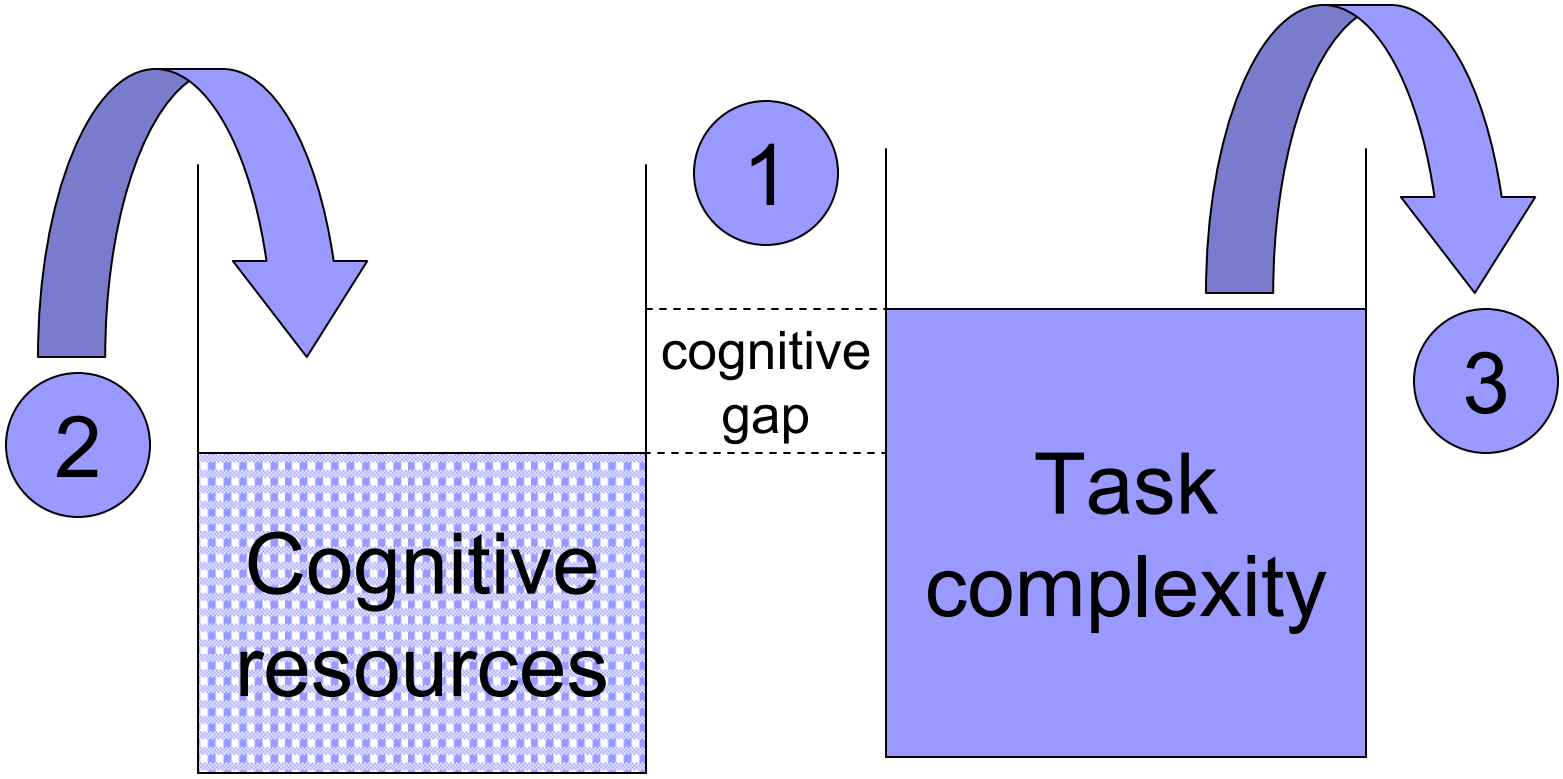
True, we cannot change intelligence (*g*)

BUT

Lots of opportunities to help patients and providers

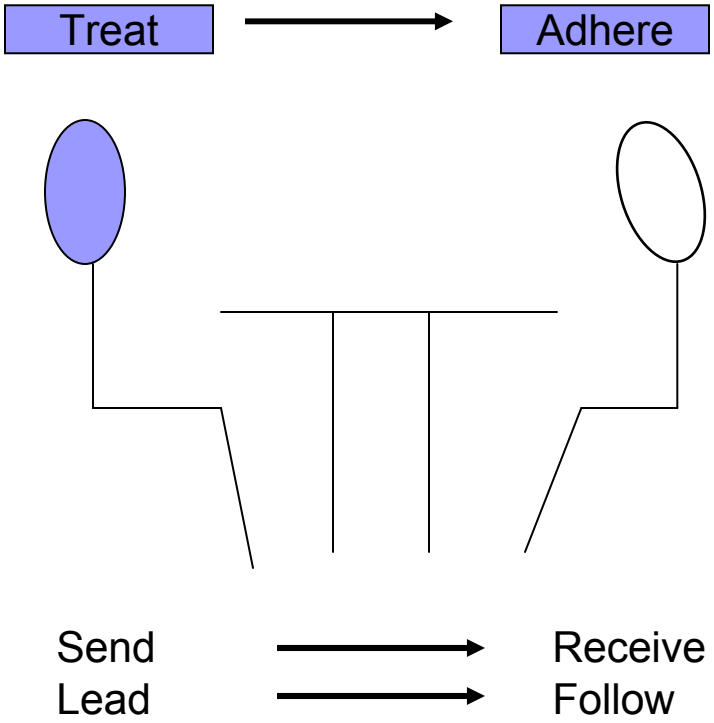
Can Reduce Risk of Error

1. Mind the gap
2. Provide cognitive assistance
3. Reduce task complexity



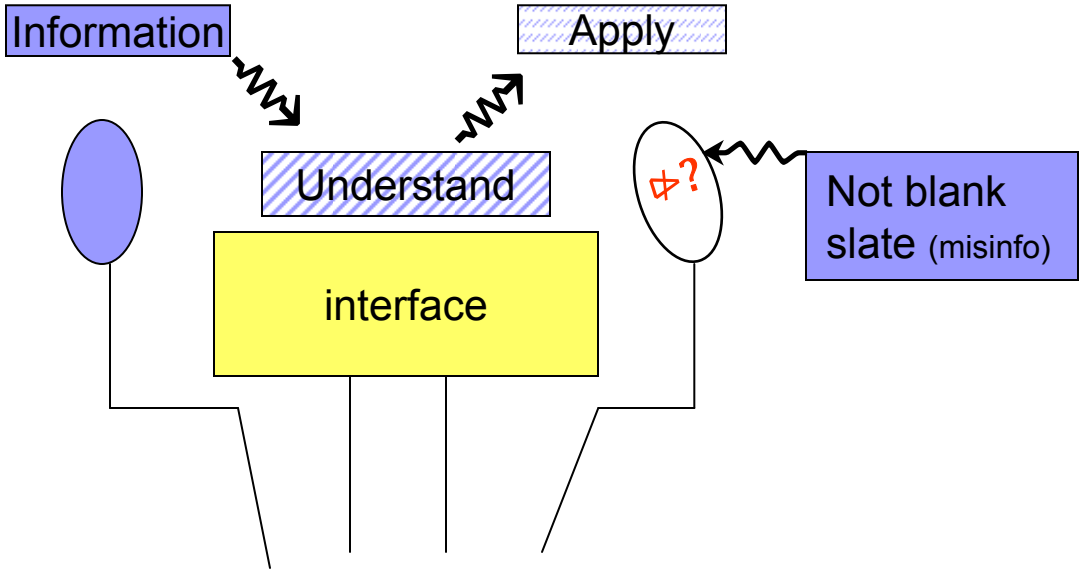
Reject Passive-Patient Model

False



Non-adherence = lack of motivation

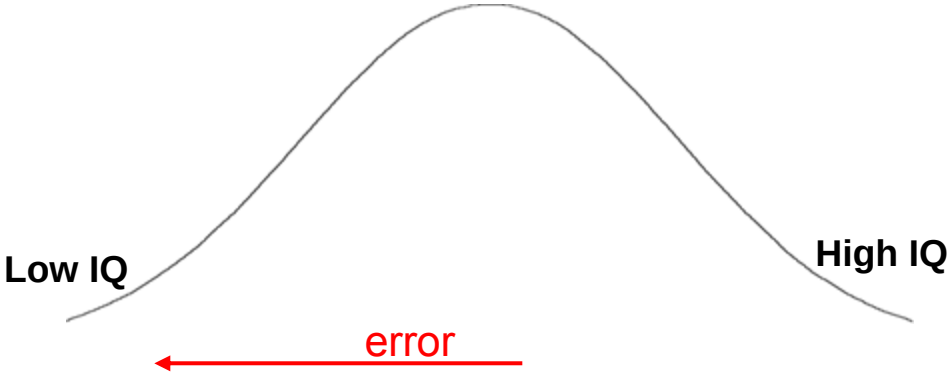
Reality: Faulty Receipt & Application



Conscientiousness is not enough
Errors rise with lower IQ/*g*

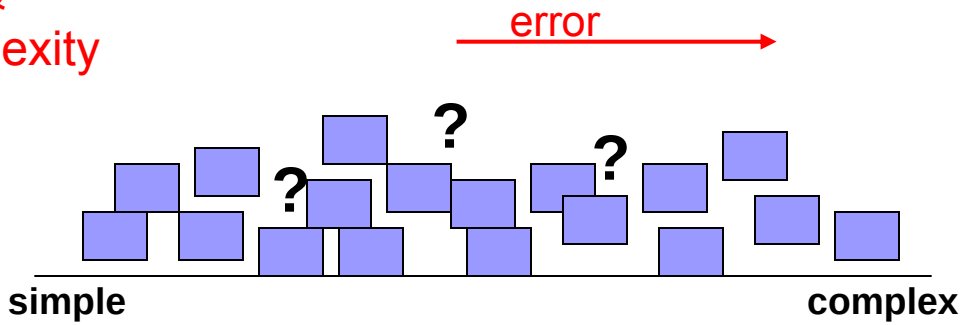
Need Epidemiology of Patient Error

1. Patients differ in cognitive ability (IQ/*g*)

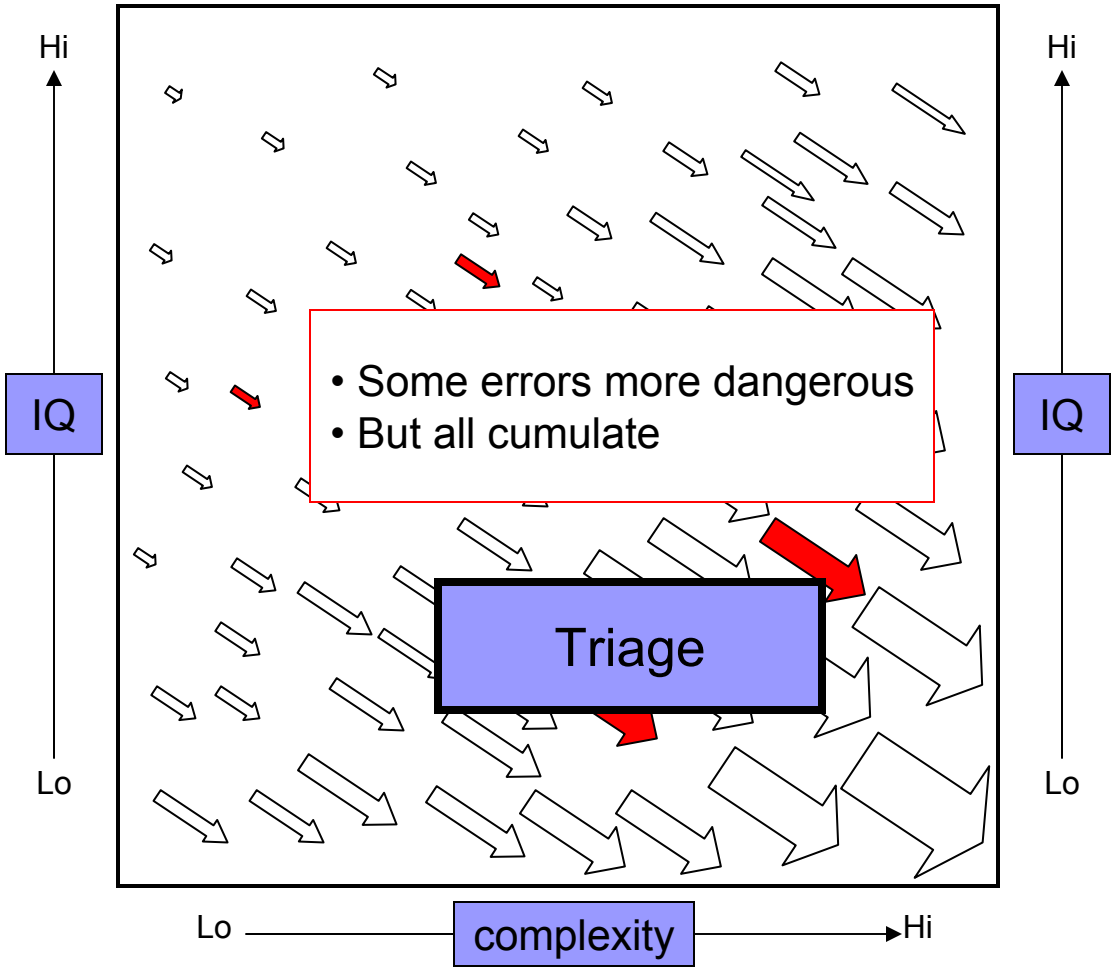


3. Error rates
   (non-adherence)
   - rise at lower IQ
   - rise with complexity

2. Health tasks differ in complexity (*g* loading)



Matrix of Cognitive Risk
(error rates)



Can predict error if we know:

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

Assess

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

Audit

Audit cognitive resources
Patients' own & supplementary

- Patient differences in *g*
  - Train providers
    - Size, nature, distribution, practical meaning of differences
    - Recognize/communicate across large IQ gaps
  - Create short unobtrusive measure of "literacy"
  - Target pockets of high error
  - Identify options for cognitive scaffolding
    - Tailored instruction, comprehension checks
    - Feedback, monitoring, retraining, reminders, hotlines
    - Auxiliary staff, family

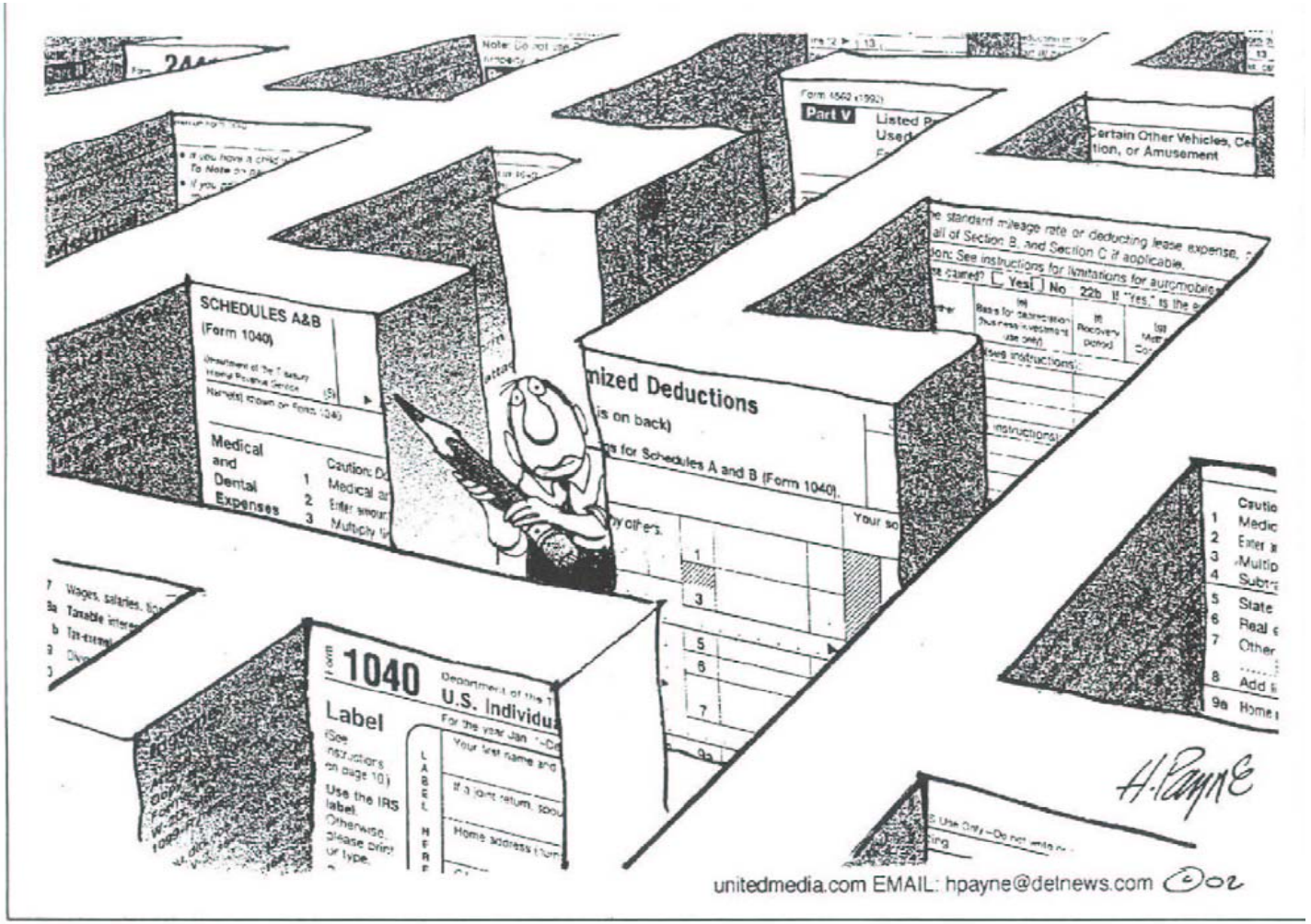
Schools do it, military and employers do it

Audit complexity of patients' "jobs"

- Task differences in complexity
  - Audit complexity in:
    - Information & instructions
    - Individual treatments, diseases
    - Clinic layout, patient interface
  - Target tasks with:
    - High expected error rates
    - Needless complexity
  - Write job descriptions for chronic diseases
    - Biggest cognitive barriers to adherence
    - Touch-points for intervention to surmount barriers
    - Set priorities for triage

Badly neglected, everywhere

Thank you.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