Literacy and Task Complexity in the Self-Management of Diabetes

Linda S. Gottfredson
School of Education
University of Delaware
Newark, DE 19716 USA

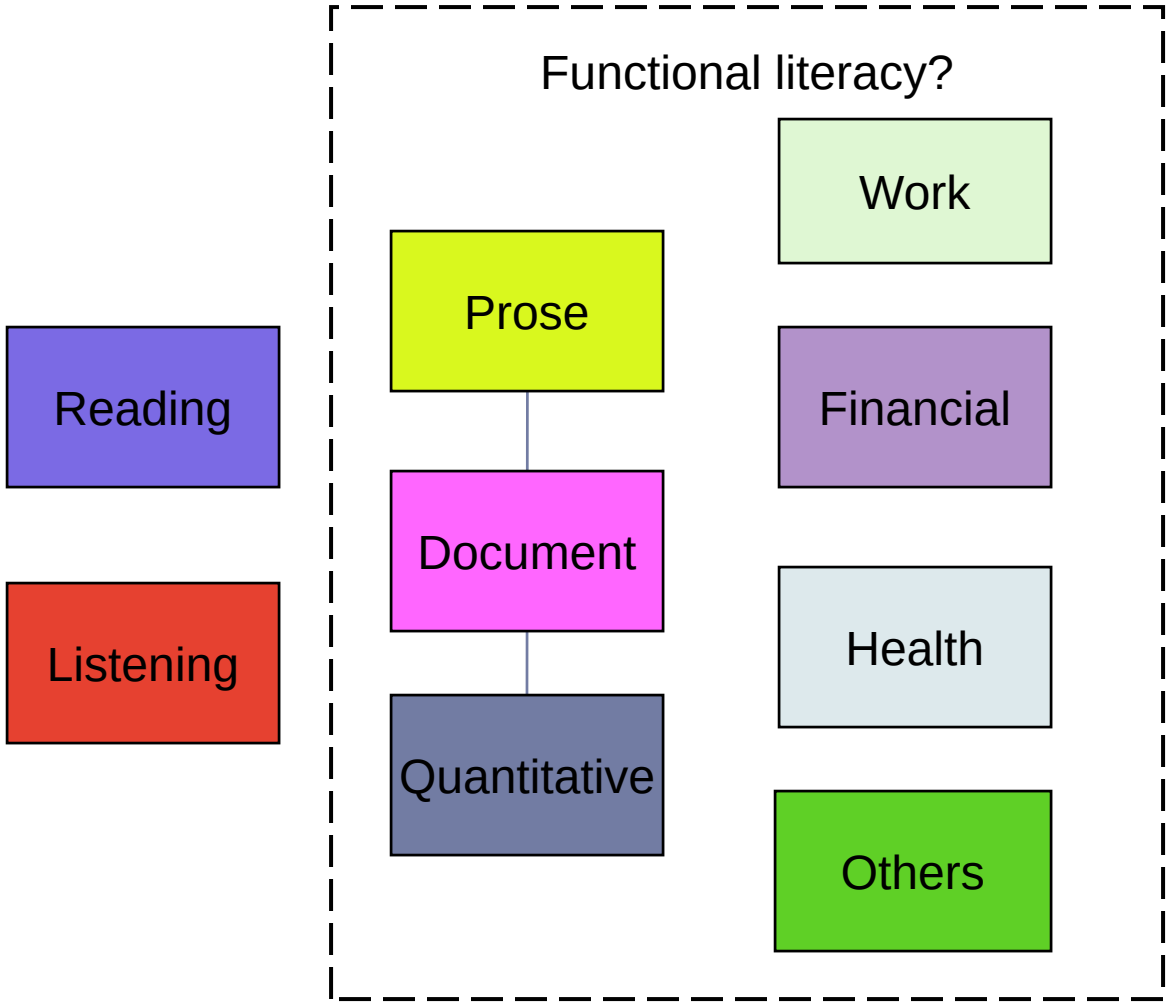
Presented in the symposium, *"Lower Literacy Predicts Poorer Self-Management of Diabetes: Why, and What Can Practitioners Do About It?"*

2009 Diabetes Translation Conference
April 22, 2009

Most Crucial Points Today

1. Health literacy = functional literacy
   - Doing something practical, not just knowing about it
   - Domain general capability, not content specific
2. Task performance depends on:
   a. Cognitive resources of patient
      - Rests on general capacity to learn, reason, solve problems
      - Huge differences across individuals
   b. Cognitive load of task
      - Rests on complexity of information processing
      - Huge differences across tasks
   c. Quality of instruction
3. Diabetes self-management is complex, lifelong job
   - Fluid constellation of tasks
   - Requires independent judgment

Literacy: How many? How different?



Functional Literacy: 4 Decades, Just 1 Literacy

"Literacy" is general
- not reading per se , but comprehension
- not content specific
- not modality specific

"Literacy" ≈ "trainability" = AFQT (Armed Forces Qualification Test)
- Can teach specific knowledge & skills
- Cannot teach "literacy"

Literacy is domain general:
- 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"

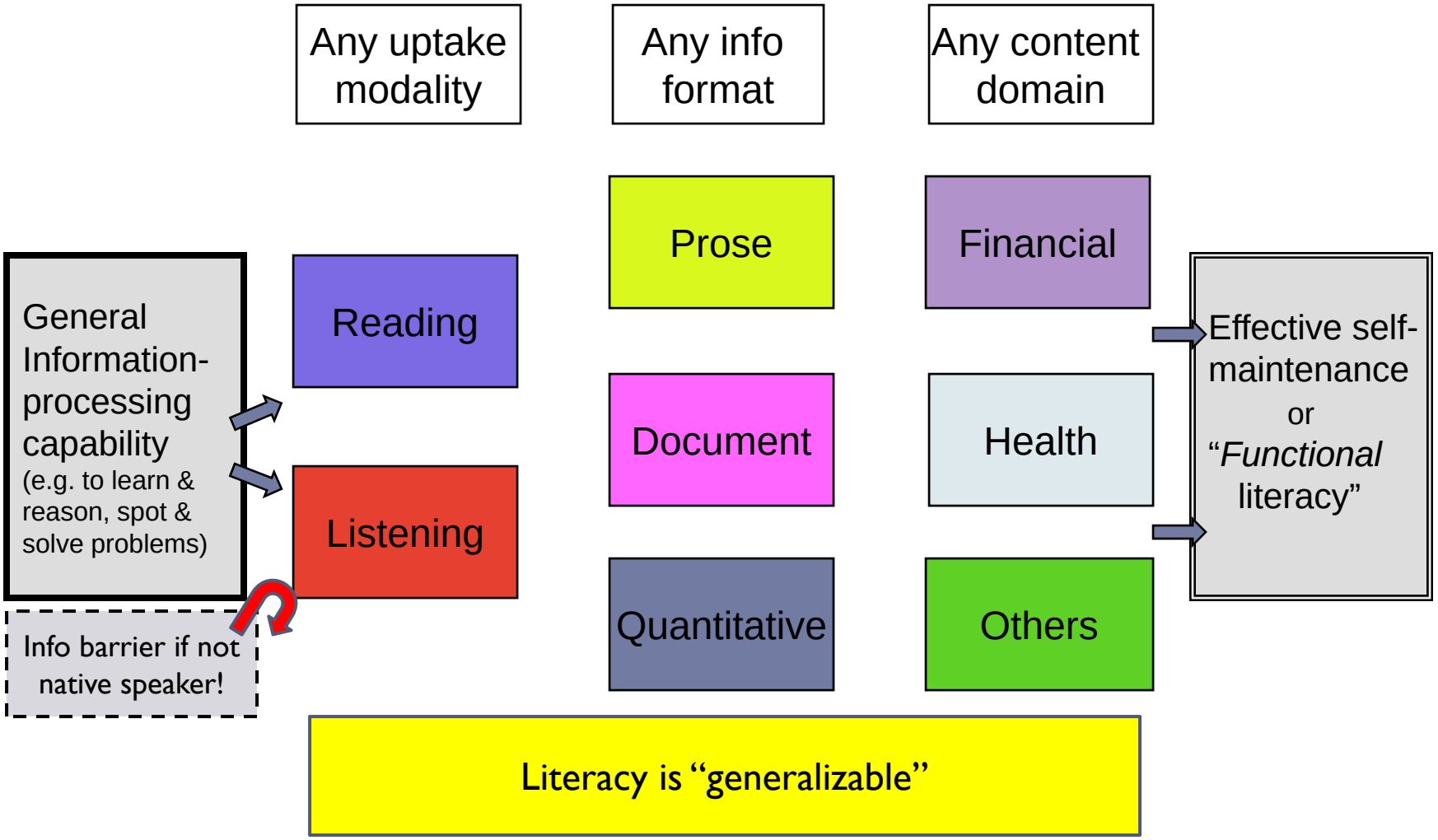
•"children and young adults have adequate abilities for basic tasks, *but are poor problem solvers*….Skills can be applied in isolation but not in combination" (p. 28).

Common Conclusion

"Literacy" is ability to process information effectively & efficiently

- Highly general ability to learn, reason, solve problems, think abstractly
- Not knowledge per se, but ability to accumulate and apply it
- Peaks in early adulthood, then steadily declines

So, Now Order From the Confusion



Tests of functional literacy

- Individuals use written info to accomplish a task
- Items simulate everyday tasks with familiar materials

Quiz: What HALS literacy level is this?

(HALS=Health Activities Literacy Scale, see *"Literacy & Health in America," 2004)*

Pediatric Dosage Chart

Recommend

ALCOHOL-FREE
ASPIRIN-FREE
Tempra®
ACETAMINOPHEN

A Caring Sponsor of
Ronald McDonald House®
Ronald McDonald House is a program of
Ronald McDonald Children's Charities®

Pediatric Dosage Chart Drops, Syrup, & Chewables

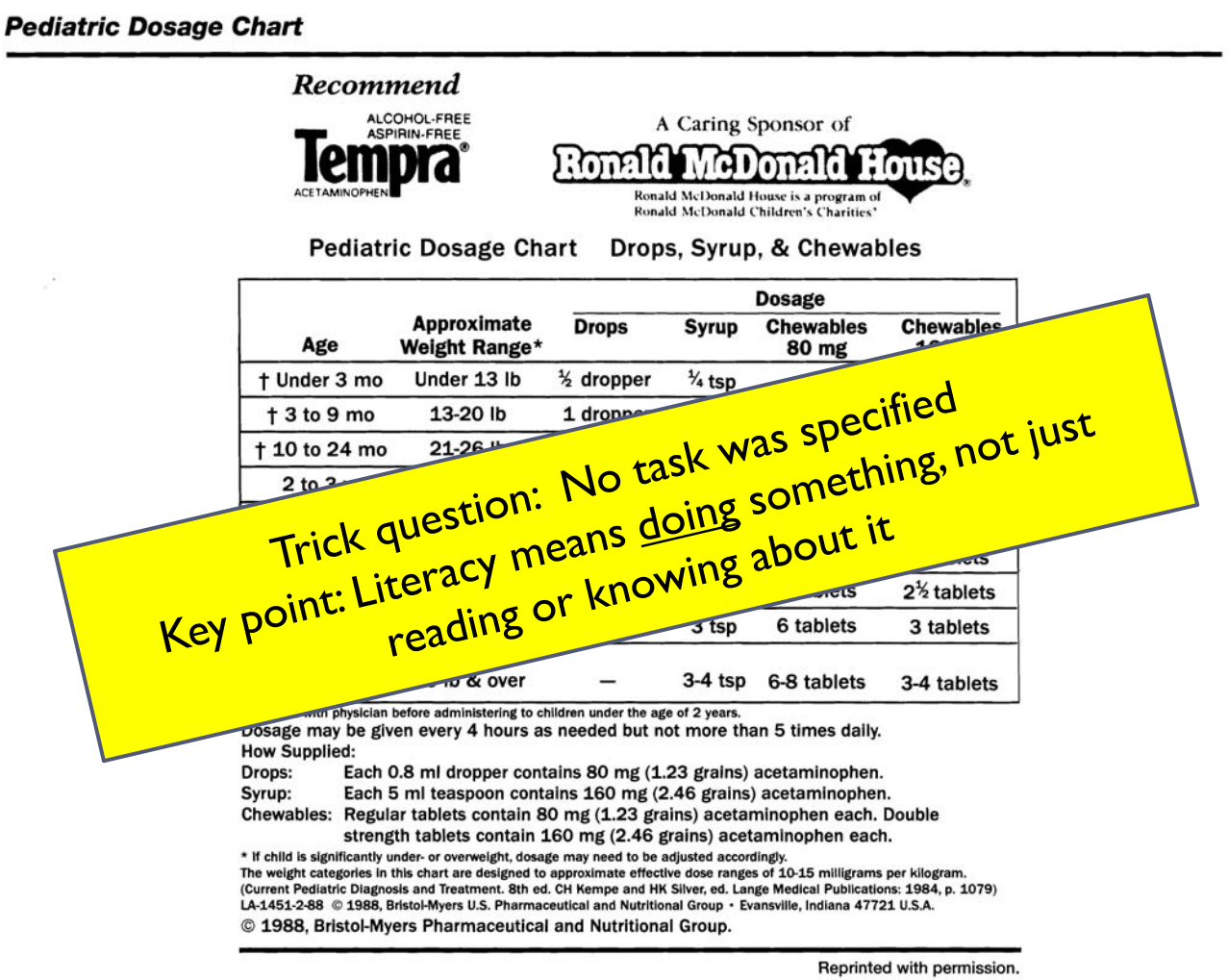
Age	Approximate Weight Range*	Dosage			
		Drops	Syrup	Chewables 80 mg	Chewables 160 mg
† Under 3 mo	Under 13 lb	½ dropper	¼ tsp	—	—
† 3 to 9 mo	13-20 lb	1 dropper	½ tsp	—	—
† 10 to 24 mo	21-26 lb	1½ droppers	¾ tsp	—	—
2 to 3 yr	27-35 lb	2 droppers	1 tsp	2 tablets	—
4 to 5 yr	36-43 lb	3 droppers	1½ tsp	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)

What % of people could use it?
Could format be simplified?

Quiz: What HALS literacy level is this?

(HALS=Health Activities Literacy Scale, see *"Literacy & Health in America," 2004)*



Pediatric Dosage Chart

Recommend

ALCOHOL-FREE
ASPIRIN-FREE
Tempra®
ACETAMINOPHEN

A Caring Sponsor of
Ronald McDonald House®
Ronald McDonald House is a program of
Ronald McDonald Children's Charities®

Pediatric Dosage Chart Drops, Syrup, & Chewables

Age	Approximate Weight Range*	Dosage Drops	Syrup	Chewables 80 mg	Chewables
† Under 3 mo	Under 13 lb	½ dropper	¼ tsp		
† 3 to 9 mo	13-20 lb	1 dropp			
† 10 to 24 mo	21-26 lb				
2 to 3					
					2½ tablets
			3 tsp	6 tablets	3 tablets
	& over	—	3-4 tsp	6-8 tablets	3-4 tablets

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.
© 1988, Bristol-Myers Pharmaceutical and Nutritional Group.

Reprinted with permission.

Trick question: No task was specified
Key point: Literacy means doing something, not just reading or knowing about it

Task #1—Underline sentence saying how often to administer medication

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

Pediatric Dosage Chart

Recommend

ALCOHOL-FREE
ASPIRIN-FREE
Tempra®
ACETAMINOPHEN

A Caring Sponsor of
Ronald McDonald House®
Ronald McDonald House is a program of
Ronald McDonald Children's Charities®

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.

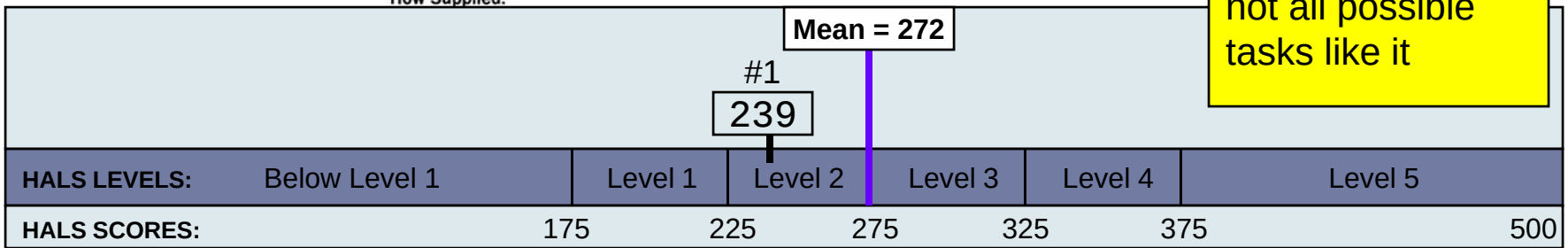
Dosage may be given every 4 hours as needed but not more than 5 times daily.

How Supplied:

% US adults routinely functioning <u>below</u> Level 2?

20%

Caution!
Could train them do this task, but not all possible tasks like it



Task #2—How much syrup (one dose) for 10-year-old who weighs 50 pounds?

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

Pediatric Dosage Chart

Recommend

ALCOHOL-FREE
ASPIRIN-FREE
Tempra®
ACETAMINOPHEN

A Caring Sponsor of
Ronald McDonald House®
Ronald McDonald House is a program of
Ronald McDonald Children's Charities®

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	½ 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)

Task #2—How much syrup (one dose) for 10-year-old who weighs 50 pounds?

- Spot & reconcile conflicting info
- Inference from ambiguous info
- Multiple features to match
- Conditional (if-then)

Pediatric Dosage Chart

Recommend

ALCOHOL-FREE ASPIRIN-FREE Tempra® ACETAMINOPHEN

A Caring Sponsor of Ronald McDonald House®

Ronald McDonald House is a program of Ronald McDonald Children's Charities®

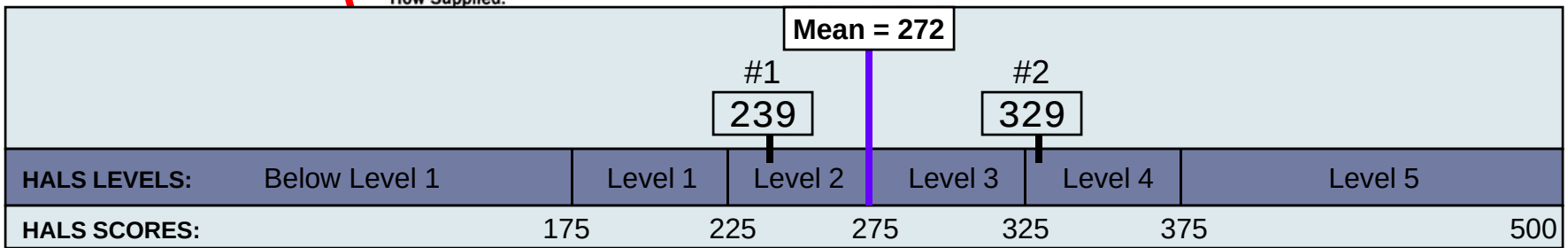
Pediatric Dosage Chart Drops, Syrup, & Chewables

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:

% US adults routinely functioning <u>below</u> Level 4?

82%



#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

ALCOHOL-FREE
ASPIRIN-FREE
Tempra®
ACETAMINOPHEN

A Caring Sponsor of
Ronald McDonald House®
Ronald McDonald House is a program of
Ronald McDonald Children's Charities®

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.

#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

ALCOHOL-FREE
ASPIRIN-FREE
Tempra®
ACETAMINOPHEN

A Caring Sponsor of
Ronald McDonald House®
Ronald McDonald House is a program of
Ronald McDonald Children's Charities®

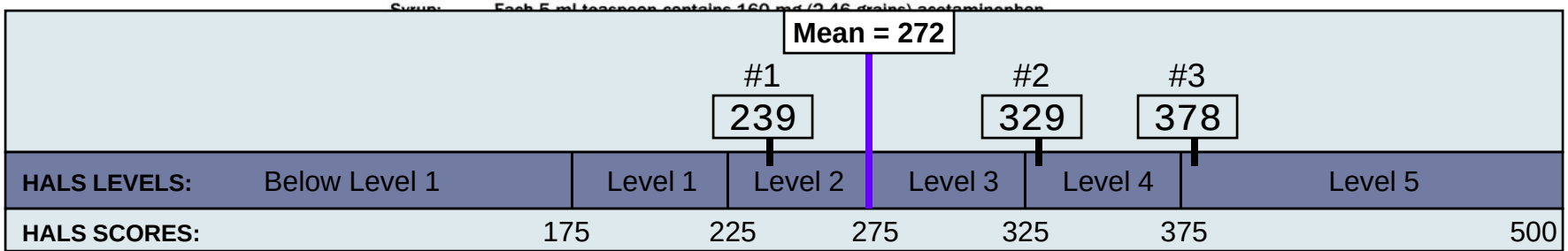
Pediatric Dosage Chart Drops, Syrup, & Chewables

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 one age or 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.

% US adults routinely functioning <u>below</u> Level 5?

99%



So, The Answers Are:

Pediatric Dosage Chart

1. What % of people could use it?

- Depends on what they have to do with it
  (the graphic is just a job aid)
- More complex tasks increase cognitive load
- People differ in when load exceeds their capacity
- Shockingly low %s for "simple" tasks

2. Could format be simplified?

- Not clear how (essential info can be inherently complex)
- Most cognitive load created by complexity of tasks performed

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.

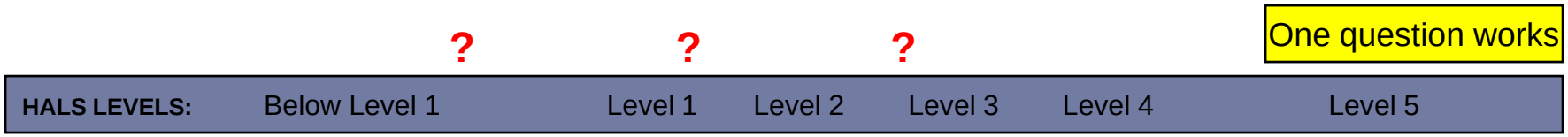
Item difficulty rests on "processing complexity" Sample components (NALS & HAALS)

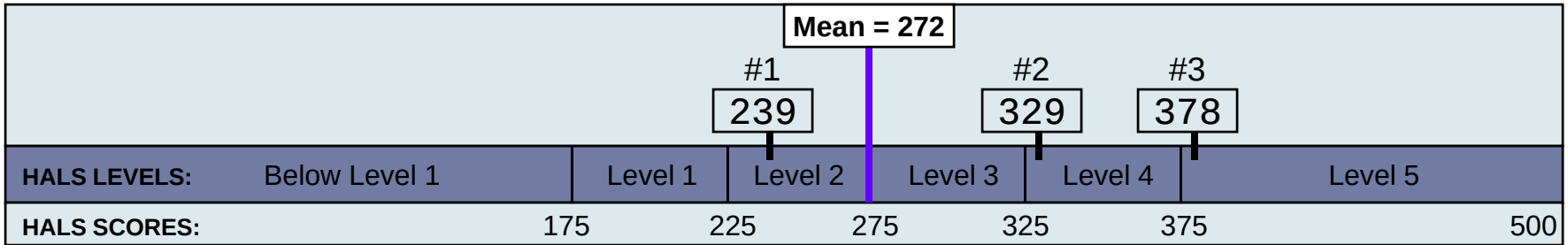
Prose items	Pts	Document	Pts	Quantitative	Pts
Need only locate in text	+1	Need only locate in text	+1	Numbers in row/column format	+0
Must cycle through text	+2	Must cycle through text	+2	Numbers not in rows/columns	+2
Must integrate as searching	+3	Must integrate as searching	+3	Numbers adjacent	+0
Must generate as searching	+5	Must generate as searching	+5	Numbers not adjacent	+1
1 phrase to search on	+0	1 feature to match	+0	Labels/amts identified c/o search	+0
2 phrases to search on	+1			abels present, amts require search	+1
3 phrases to search on	+2			abels inferred, amts require earch	+2
4 phrases to search on	+3			abels ambiguous	+4
Match is literal or synonymous	+0			peration signaled by +, -, x, /, or ates 'add,' 'subtract,' etc.	+0
Match requires low-level text-based inference	+1	based inference or estimation		emantic relationship stated, e.g., 'how much less,' 'calculate the difference,' etc.	+1
Match requires high text-based inference	+3	Match requires both a condition & low-level text-based inference	+2	Operation easily inferred; 'how much saved,' or 'deduct'	+2
Number of responses unspecified	+1	Match requires high text-based inference	+3	Operation based on known ratios; e.g., 'percent 0'	+3

- Abstract, not concrete
- More elements to match
- More inferences to draw
- More distracting info
- Conflicting or ambiguous info
- Operations not specified

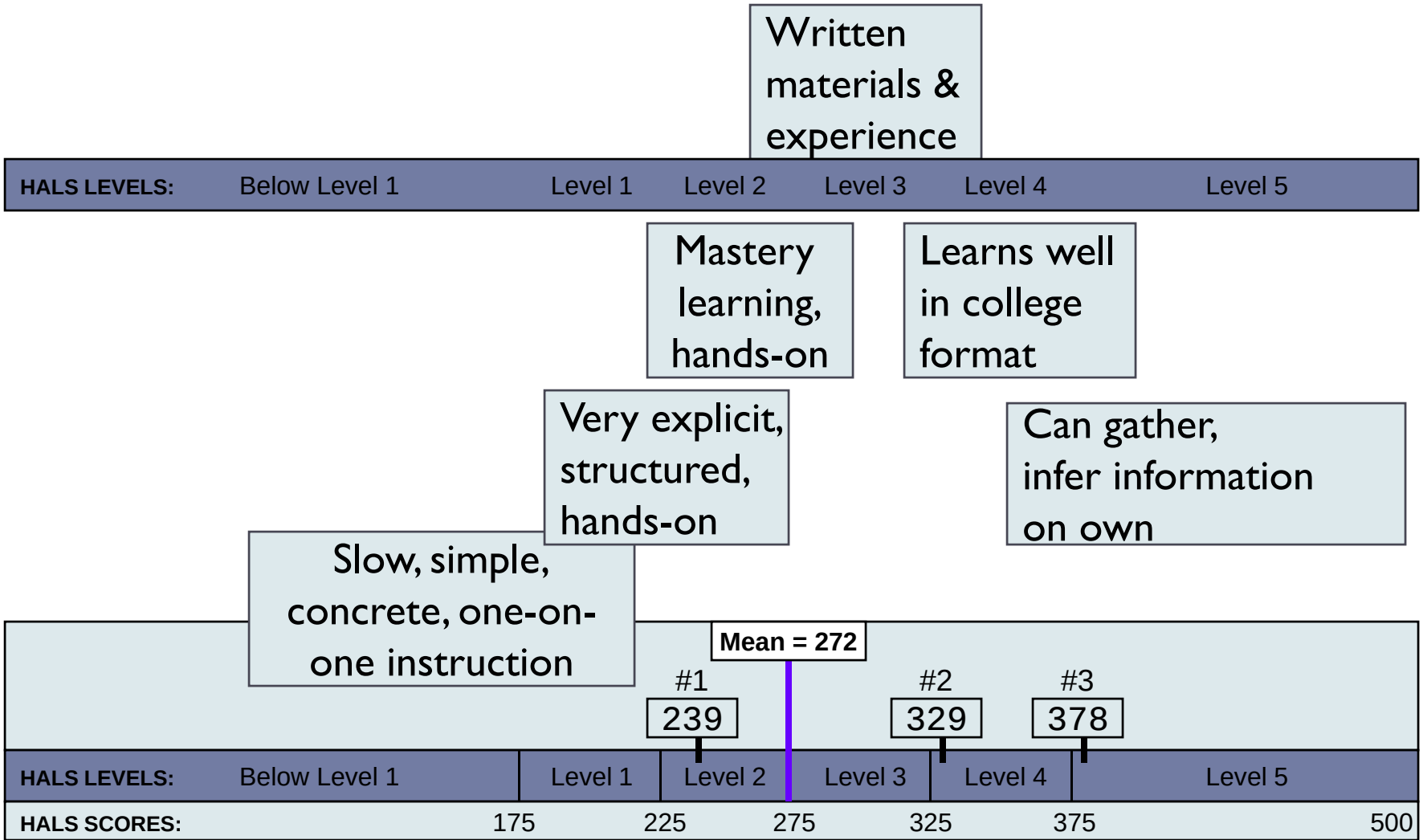
What can practitioners do?

1. Estimate patient literacy level (cognitive capacity)





Summary of learning needs by literacy level



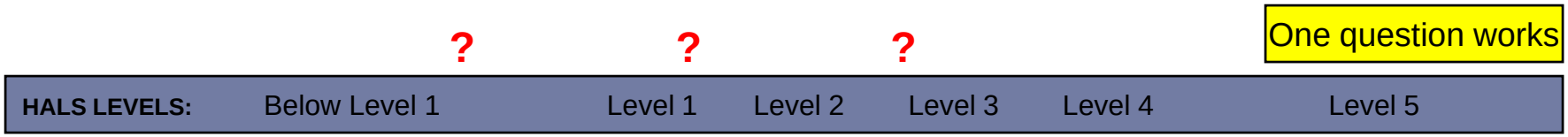
Bloom's Famous Taxonomy for Instructional Goals: Cognitive Realm

Bloom difficulty level	*Sample verbs*	*Diabetes Tasks*
1. Remember	Recognize, recall, identify, retrieve	?
2. Understand	Paraphrase, summarize, compare, predict, infer	?
3. Apply	Execute familiar task, apply procedures to unfamiliar task	?
4. Analyze	Distinguish, focus, select, integrate, coord	?
5. Evaluate	Check, monitor, detect inconsistencies, judge effectiveness	?
6. Create	Hypothesize, plan, invent, devise, design	?

Key to active self-management

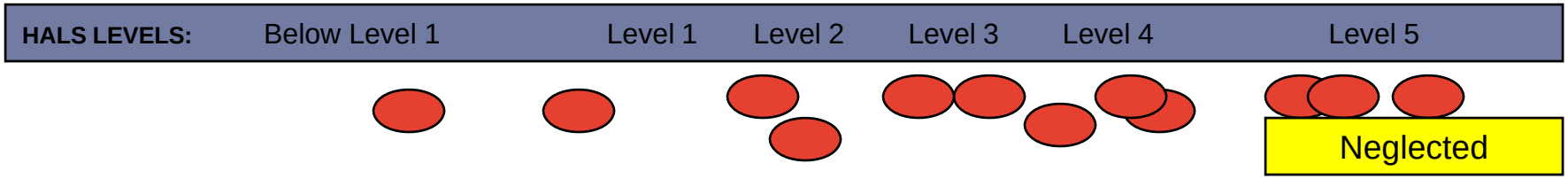
What can practitioners do?—cont.

1. Estimate patient literacy level (cognitive capacity)

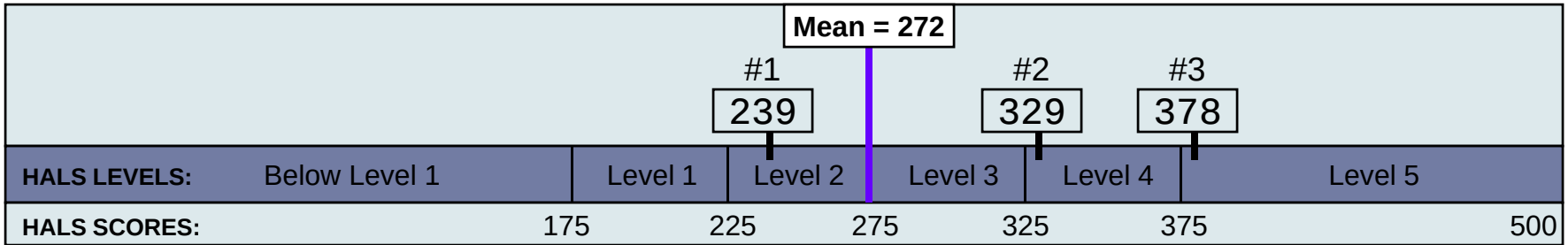


2. Tailor instruction to capacity

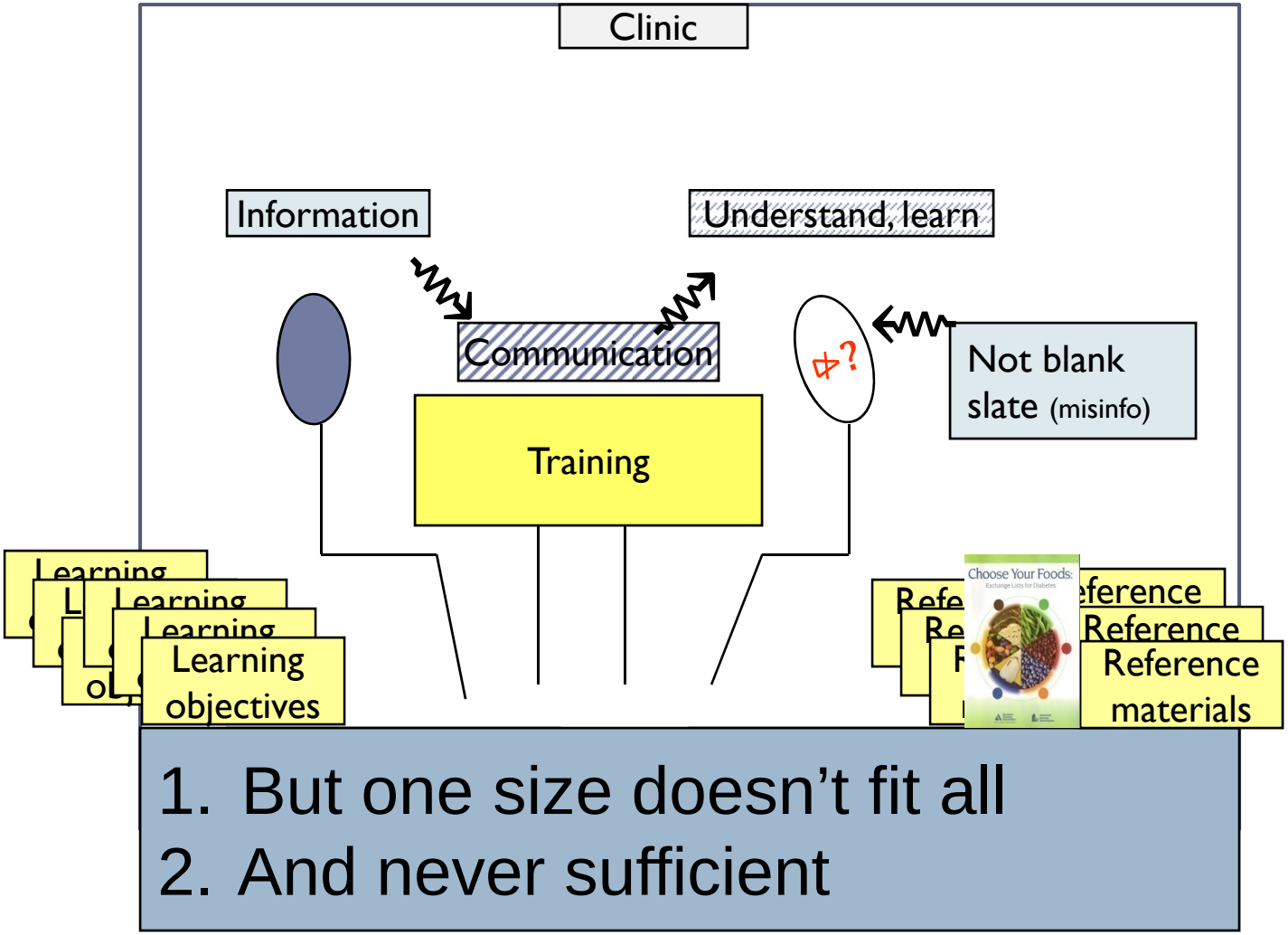
- Amount of scaffolding, repetition, feedback, reteaching, etc.



3. Know complexity (cognitive load) of diabetes tasks



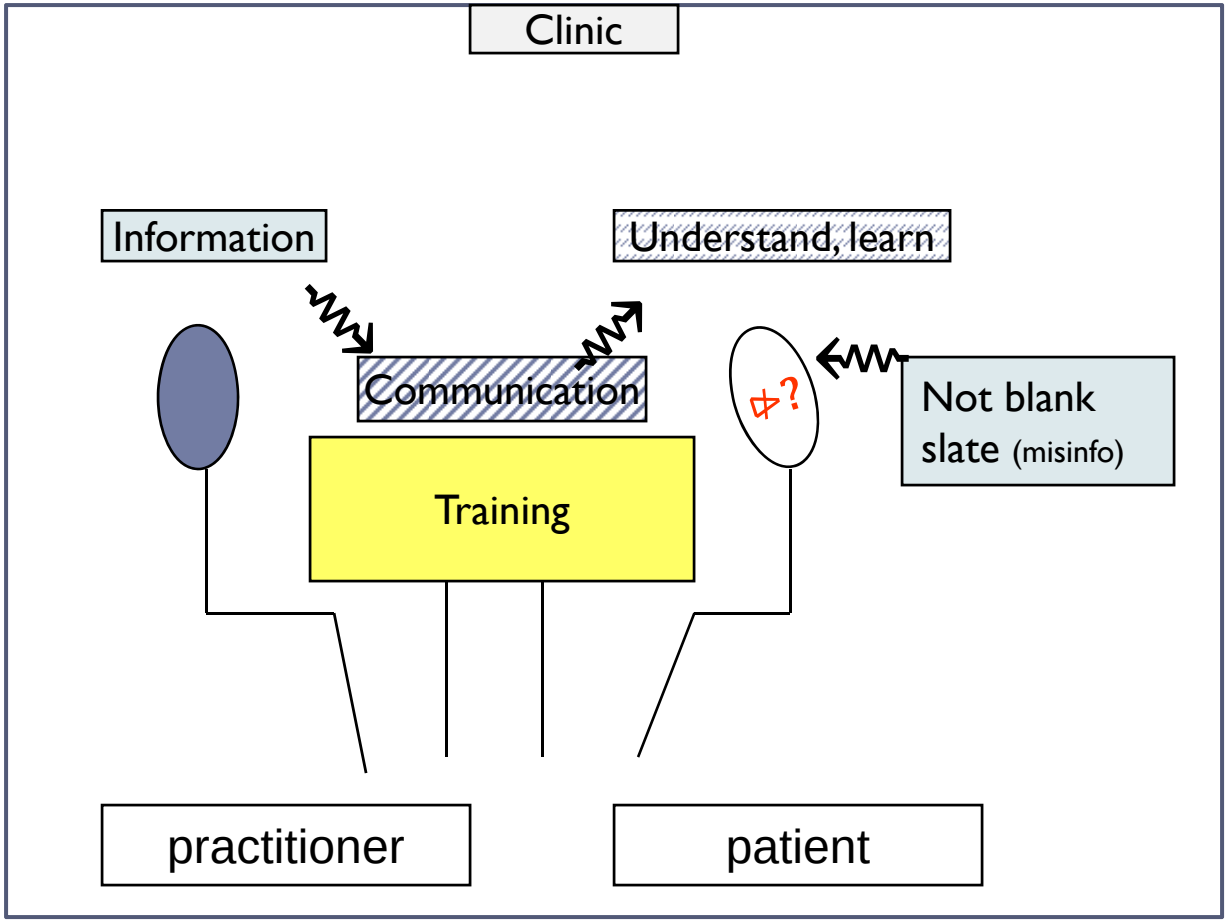
Good patient instruction—Crucial



Because diabetes is complex job with little training or supervision

Must apply info "on the job"

- 24 hours/day
- 7 days/week
- No vacations
- No retirement



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 practitioners
- **Update knowledge & adjust regimen (Occasionally)**
  - When other chronic conditions or disabilities develop
  - When new treatments available
  - When life circumstances change

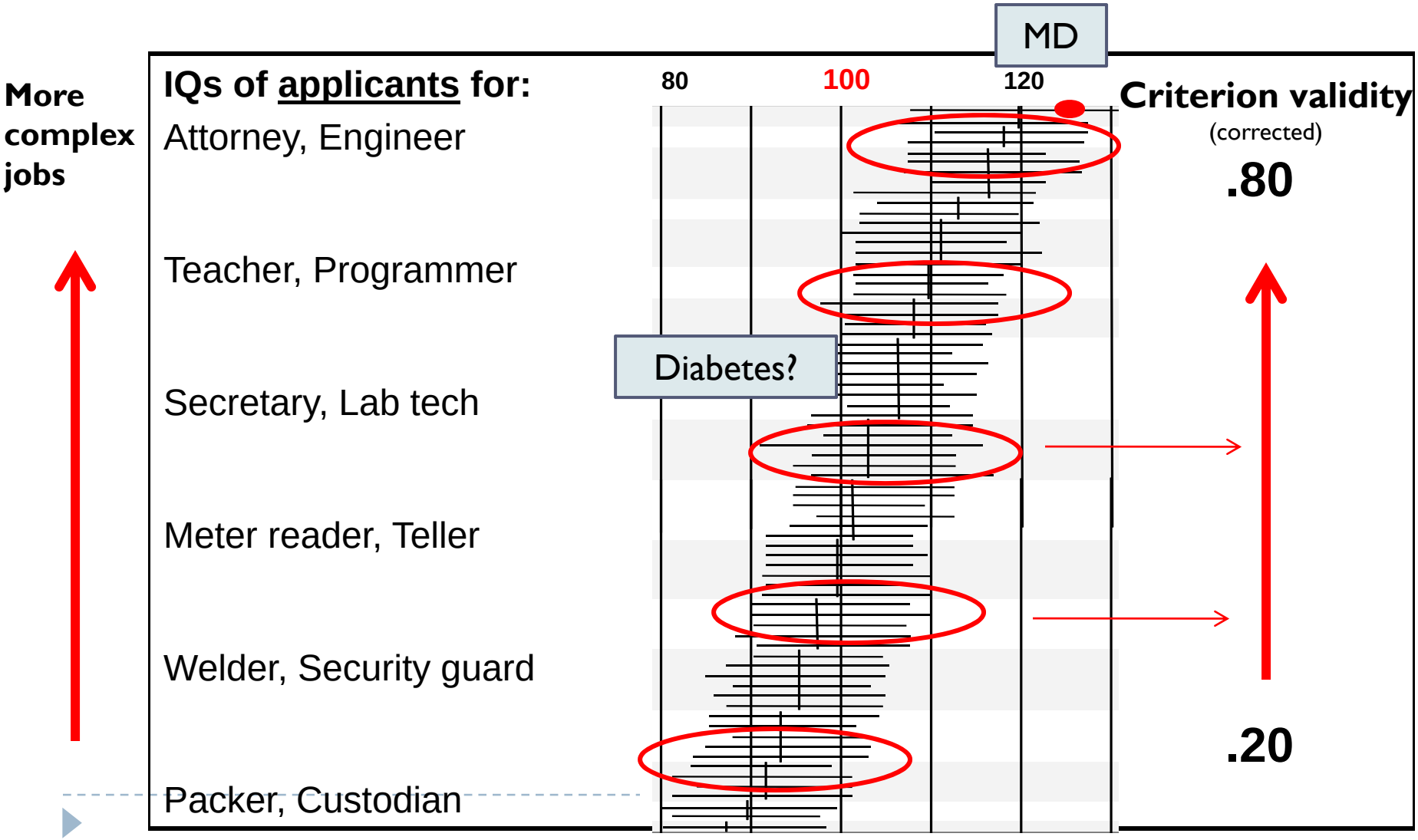
Self-management

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)

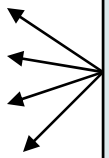
Cognitive ability predicts performance in all jobs—but especially higher up



Common building blocks of job complexity
(add to cognitive load, raise accident rates)

- 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
  - Multi-tasking, prioritizing
  - Sequencing, timing, coordinating
  - Evolving mix of tasks
  - Little supervision; need for independent judgment

Recall what created "processing complexity" in literacy items shown earlier



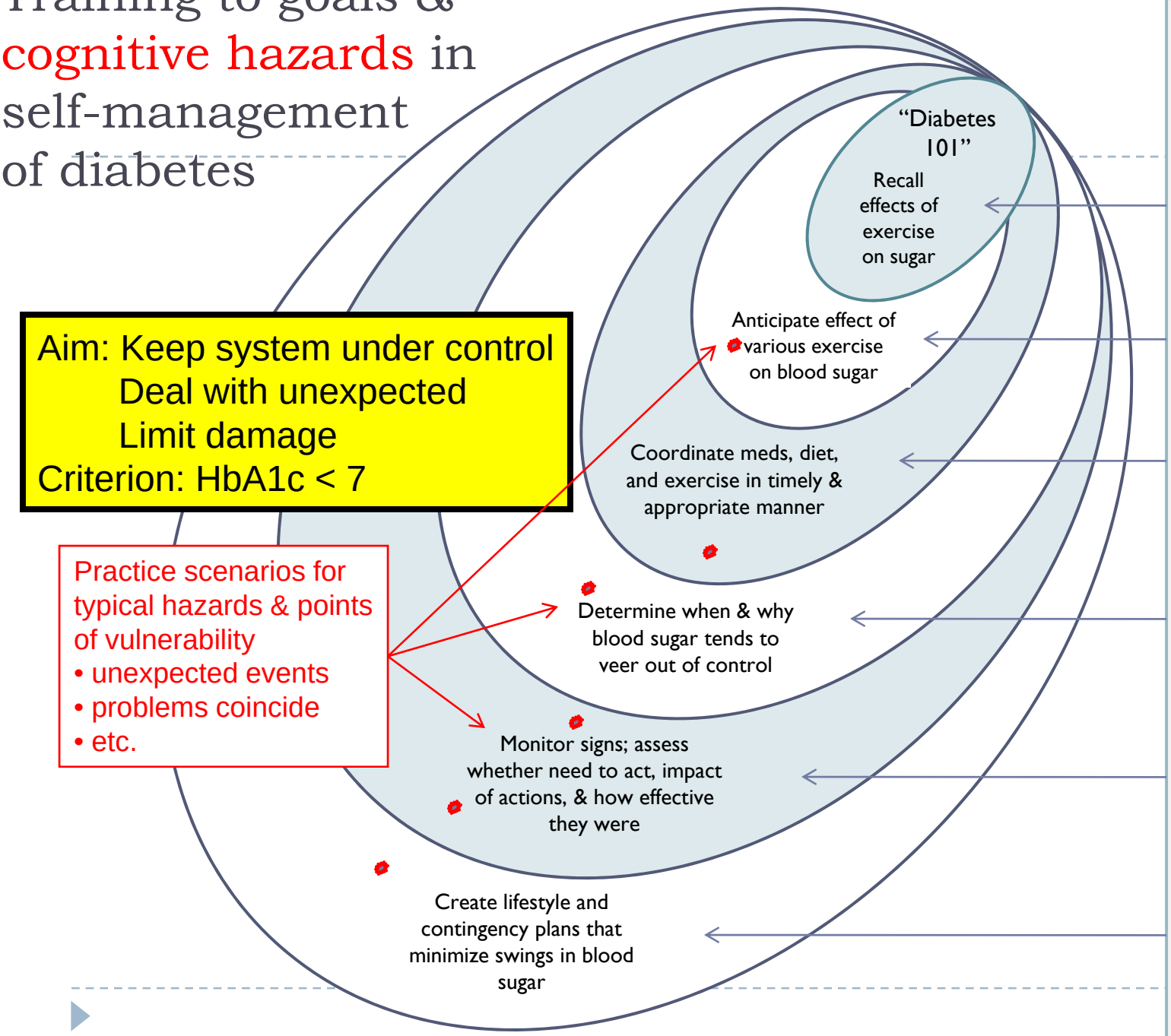
Literacy tests miss these sorts of "load multipliers"

2 + 2 = 5

Recommendations on Task Complexity?

- Interim
  - Educate for gathering/using info & dealing with contingencies
  - Presume need (till proved otherwise) for concrete, step-by-step instruction with repetition, follow-up, & retraining
  - Don't assume that any task is "simple" or the need to perform it obvious
  - Presume that non-adherence from cognitive overload
- Longer-term (research partners welcome)
  - Job analysis of diabetes ('critical incidents,' etc.)
  - Simple way to rate cognitive load on patients
  - Simple way to predict when & where overload (errors) most likely

Training to goals & cognitive hazards in self-management of diabetes



Aim: Keep system under control
Deal with unexpected
Limit damage
Criterion: HbA1c < 7

Practice scenarios for typical hazards & points of vulnerability
- unexpected events
- problems coincide
- etc.

Bloom's taxonomy of educational objectives (cognitive domain)

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

Thank you.

Slides available at:

http://www.udel.edu/educ/gottfredson/reprints/2009CDC_literacy.ppt

For more information:

- gottfred@udel.edu
- http://www.udel.edu/educ/gottfredson/reprints/