Teaching and Assessing Critical Thinking: Helping Medical Students Become Better Thinkers

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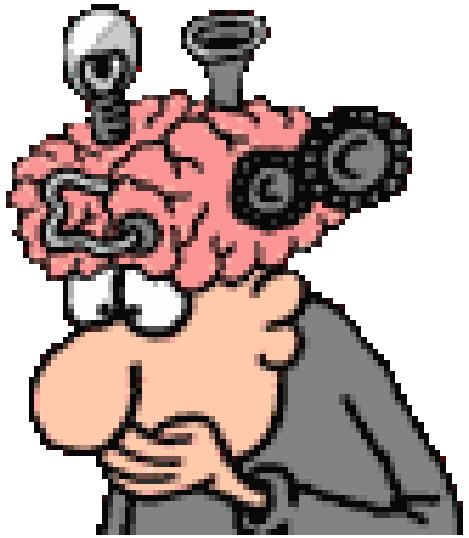


A Family Story

According to the cupping therapy web site, cupping is "very beneficial" for

- **High blood pressure**
- **Anxiety**
- **Fatigue**
- **Fibromyalgia**
- **Neuralgia**
- **Chronic Headache**

http://www.cuppingtherapy.org/?gclid=CL2L7-y6-KsCFQd-hwodsg-QpA

Correlation is not Cause—Not as Easy as it Seems

- **Several years ago a Congressman (Bart Stupak) blamed an acne drug for his son's suicide. Is it a rare side effect or is it coincidence?**
- **Almost 10% of US adolescents are not immunized for measles—many parents believe the vaccine causes autism.**

It is extraordinarily difficult to convince someone with a strong belief about the cause of something.

The Need for Critical Thinking—More Than Medical Thinking

- 6% of Americans say the moon landing of 42 years ago was staged (Gallup, 2009)

- In Egypt, 43 percent of people think Israel was behind the 9/11 attacks in America, a poll by WorldPublicOpinion.org found last year.

- 20% of more than 200 adults surveyed believed that the sun revolves around the earth (Asimov, 1989)

- And then, there is the flat earth society…

Too much information

"A weekday edition of The New York Times contains more information than the average person was likely to come across in a lifetime in 17th. century England."
Information Anxiety, R.S.Wurman

- **U.S. Adults**
  - **spend 26 hours per week on the internet or television** (Morrissey, 2010)

In Industrialized countries people are exposed to 6 times as many advertisements compared to 30 years ago. (Koomey, 2001)

We need to sort the good from the bad information!

The Need for Critical Thinking Skills

- You might work at a medical specialty that does not exist today.

- New information is replacing old information at an accelerating pace.

What is Critical Thinking?

Critical thinking is the use of those cognitive skills and abilities that increase the probability of a desirable outcome.

It is purposeful, reasoned, and goal directed. It is the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions. Critical thinkers use these skills appropriately, without prompting, and usually with conscious intent, in a variety of settings. That is, they are predisposed to think critically. When we think critically, we are evaluating the outcomes of our thought processes--how good a decision is or how well a problem is solved. Critical thinking also involves evaluating the thinking process--the reasoning that went into the conclusion we've arrived at or the kinds of factors considered in making a decision.

What is Critical Thinking?

- **Numerous definitions of Critical Thinking**

  Effortful, careful, consciously controlled processing that maximizes the use of all available evidence and cognitive strategies, and purposefully strives to overcome individual biases **(for reviews see Ennis, 1993; Halpern, 2003; Riggio & Halpern 2006; Moseley et al. 2005; Sternberg, Roediger, & Halpern, 2007)**

- **Researchers generally agree that critical thinking is attempting to achieve a desired outcome by thinking rationally in a goal-oriented fashion**

- **Critical Thinking is not the same construct as Intelligence** **(Stanovich, 2008)**

What is Critical Thinking?

Critical thinking is a skill and disposition

- **the use of those cognitive skills or strategies that increase the probability of a desirable outcome**
- **purposeful, reasoned, and goal directed**
- **involved in solving problems, formulating inferences, calculating likelihoods, and making decisions**
- **An attitude and approach to information**

When teaching for critical thinking

- **Understanding information at a deep, meaningful level**
- **Overcoming fallacies and biases.**

Demonstration—Powerful Learning Strategies

Please:

1. Starting from the left of each row, pair up
2. The person on the **left of each pair** should decide whether each word in the following list names a living thing (e.g., “tree” versus “rock”)
3. The person on the **right of each pair** should decide whether each word has a taller letter at the beginning than at the end (e.g., “house” but not “mouse” or “most”)

Thanks to Dr. Stephen Kosslyn for this demonstration

Please:

Raise your hand after you've gone through the entire list.

frog
harp
rat
sheet
deer
brick
rug
bear
forge
hare
stone
ape
lamp
snail
chair
worm

Please:

Recall as many words as you can that were on the list.

Now:

Look at the list again, and count how many words you correctly recalled.

frog
harp
rat
sheet
deer
brick
rug
bear
forge
hare
stone
ape
lamp
snail
chair
worm

And, finally:

Compare the number you got right with the number your partner got right. Raise your hands if the person on the left (who judged living/non-living) got more correct.

Judging whether a word names a living thing requires more processing than judging surface properties.

The more deeply you process information, the more likely you are to remember it and be able to use it.

Deep Level Processing—Any Theory in Any Discipline

Q: What is photosynthesis?

A: Photosynthesis is a process used by plants to synthesize foods from carbon dioxide and water using sunlight.

Write the theory in your own words.

Teach it someone else and that person will take the test.

What is the evidence for (and against) this theory?

What is it explaining?

What theory is it replacing? (if applicable)

What is its history?

How could it be applied to an everyday problem?

How to foster deep understanding

Design

38 surgical residents assigned at random to

massed learning (1 day)

spaced learning (weekly)

Skills –microvascular anastomosis

Operated on a live rat

Better retention, global ratings, checklist scores, product analysis, competency (all values $p < .05$)

Moulton et al. (2006). Annals of Surgery, v. 244 (3).

- **Clear evidence that spaced learning is better**

Systems of Thinking: Fast and Slow

SYSTEM 1

Intuition

- Automatic
- Fast
- Error-prone
- Less effort
- Less control

SYSTEM 2

Effortful Thinking

- Deliberate
- Slow
- Less error
- Choice

The Classic Bat and Ball Problem

- **A bat and a ball cost $1.10**
- **The bat costs $1.00 more than the ball**
- **How much does the ball cost?**

The Classic Bat and Ball Problem

- **Was your answer 10 cents? (*this is wrong!)***

- **Over half the students tested at Harvard, MIT, and Princeton said 10 cents (Frederick, 2005)**
- **The correct answer is 5 cents!**

Ball - $0.05

Bat - $1.05

Total $1.10

Is Fast Thinking *always* wrong?

- **Certainly Not!**
- **The intuition of experts is actually good!**
  - **Need regular outcomes learned from experience**
  - **Need immediate feedback (might expect differences between surgeons and psychiatrists, for example)**
- **We NEED mental shortcuts *(otherwise it would take days to select a jar of peanut butter)***
  - **Effective when time and information are limited**

“Bounded Rationality”

- **We are not always rational thinkers**
- **Limitations to our thinking:**
  - **Never have complete knowledge of the consequences of our decision because they occur in the future**
  - **Can never generate a complete list of alternative solutions**
  - **Too much information to consider at one time**
- **We are “satisficers” – good enough decisions**

If critical thinking is so important, why do we often get it wrong?

- **Self-serving attributes for success and failure**
- **Dissonance reduction after free choice**
- **Positive halo effect**
- **Biased assimilation of new information into pre-existing beliefs**
- **Fundamental attribution error (blaming the victim)**
- **Allowing one's judgment about greater good to be influenced by self-interest**

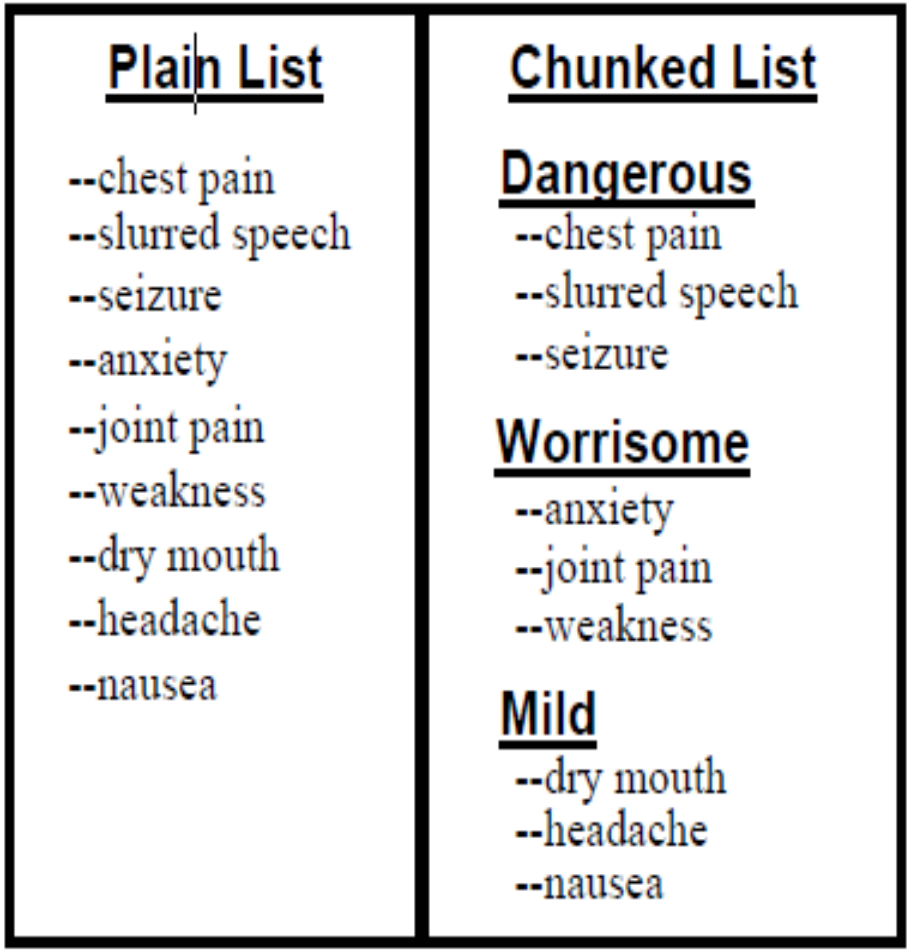
How common are these biases—what do you think?

Principles in Cognitive Psychology that Should be Guiding the Design of Learning Activities

- **The curse of expertise**
- **Need to reduce cognitive overload—group items, visually separate them, reduce extraneous "noise"**

Example of Information on Side Effects

- **Possible side effects include chest pain, slurred speech, seizure, anxiety, joint pain, weakness, dry mouth, headache, and nausea.**



Different Formats for Teaching

Line

Mild		Dangerous
dry mouth	anxiety	chest pain
headache	joint pain	tingling
nausea	weakness	seizure

Arrow

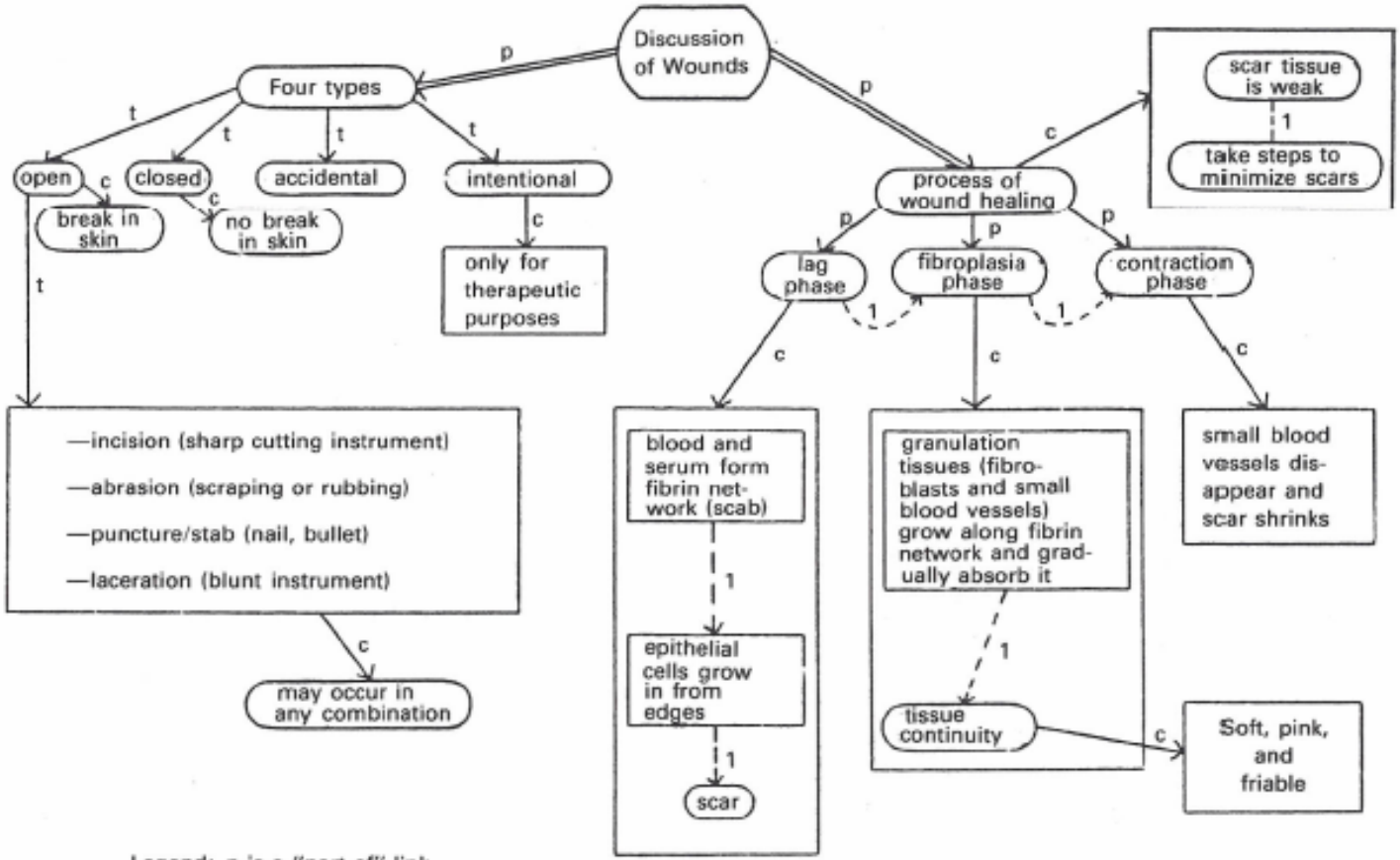
dry mouth	anxiety	**chest pain**
headache	joint pain	**tingling**
nausea	weakness	**seizure**

We need to direct learning activities that make transfer more likely

- Draw a diagram/graphic that organizes information.
- What additional information would you want before answering the question?
- Explain why you selected (a particular) multiple choice question.
- State the problem in at least two ways.
- Which information is most important? Why?
- Which information is least important? Why?
- Categorize the information in a meaningful way.

Principles in Cognitive Psychology that Should be Guiding the Design of Learning Activities

- **Dual Coding of Information in Visuospatial and Verbal Formats Will Enhance Learning and Memory**



Legend: p is a "part of" link
t is a "type of" link
l is a "leads to" link
c is a "characteristic of" link

Medication schedule for an actual patient. It is written in list format, exactly as written by his physician.

List

Inderal – 1 tablet 3 times a day

Lanoxin – 1 tablet every a.m.

Carafate – 1 tablet before meals and at bedtime

Zantac – 1 tablet every 12 hours (twice a day)

Quinaglute – 1 tablet 4 times a day

Coumadin – 1 tablet a day

Day, R.S. Comprehension of prescription drug information: Overview of a research program. http://www.aaai.org/Papers/Symposia/Spring/2006/SS-06-01/SS06-01-005.pdf

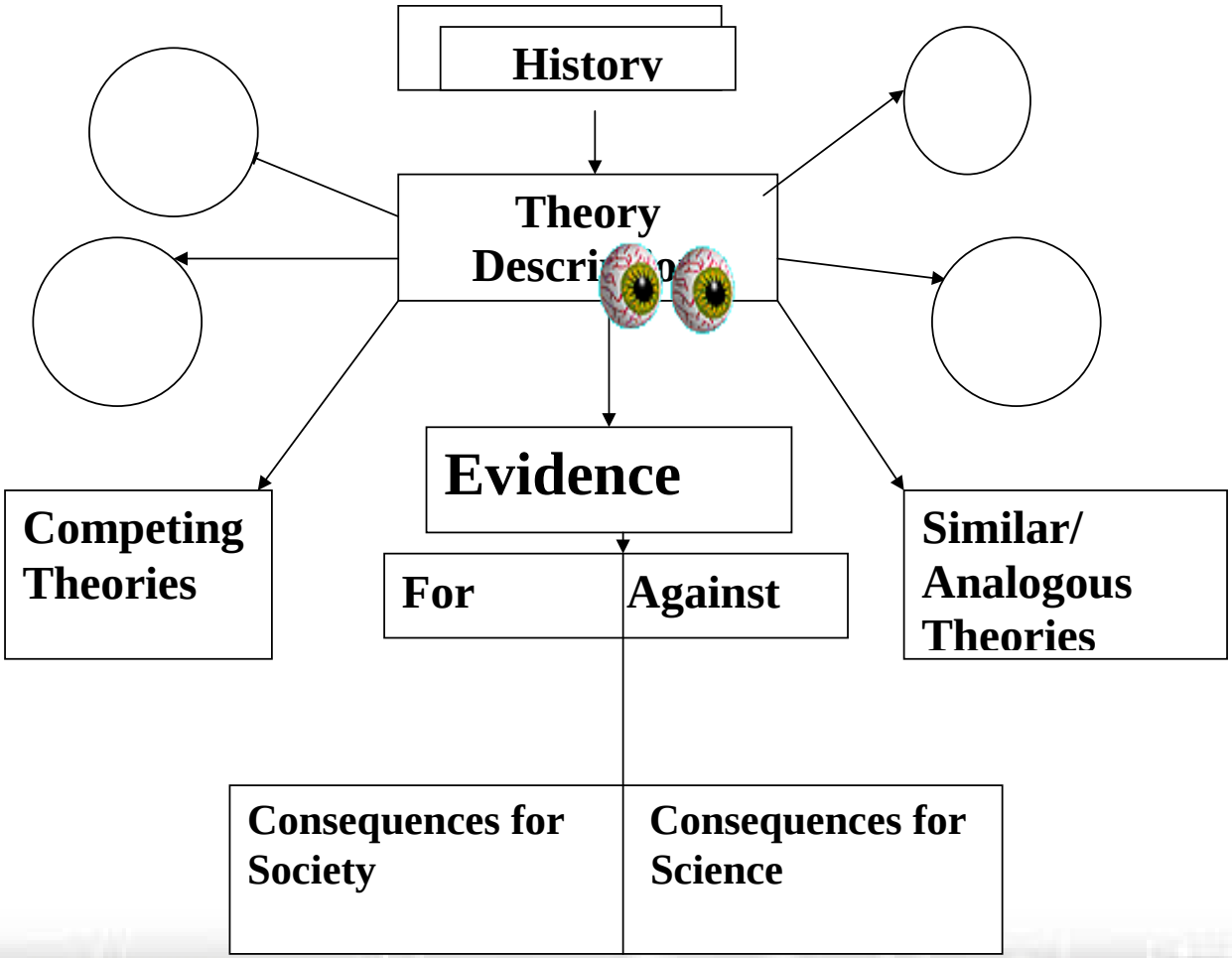
Matrix representation for the same medication schedule.

Matix

	Break-fast	Lunch	Dinner	Bed-time
Lanoxin	✓			
Inderal	✓	✓	✓	
Quinaglute	✓	✓	✓	✓
Carafate	✓	✓	✓	✓
Zantac		✓		✓
Coumadin				✓

Day, R.S. Comprehension of prescription drug information: Overview of a research program. http://www.aaai.org/Papers/Symposia/Spring/2006/SS-06-01/SS06-01-005.pdf

Use elaboration to create interconnected knowledge structures (Dansereau)



Guiding Thought-Provoking Questioning

(King, 1994)

Generic Questions	Specific Thinking Skill Is Induced
What is a new example of. ..?	Application
How could. ..be used to. ..?	Application
What would happen if. ..?	Prediction/hypothesizing
What are the implications of. ..?	Analysis/inference
What are the strengths and weaknesses of. ..?	Analysis/inference
What is. ..analogous to?	Identification and creation of analogies and metaphors
What do we already know about.?	Activation of prior knowledge
How does. ..affect. ..?	Activation of relationship (cause-effect)
How does. ..tie in with what we learned before?	Activation of prior knowledge
How does. ..apply to everyday life?	Application
What is the counterargument for. ..?	Different perspectives

Critical Thinking is What Intelligence Tests Miss

- **"IQ tests measure only a small set of the thinking abilities that people need."**
- **IQ tests are good measures of how well a person can hold beliefs in short-term memory and manipulate those beliefs, but they do not assess at all whether a person has the tendency to form beliefs rationally when presented with evidence." What we really want for our politicians, lawyers, doctors, and everyone else is to gauge their ability to think critically, which is largely absent from intelligence tests.**

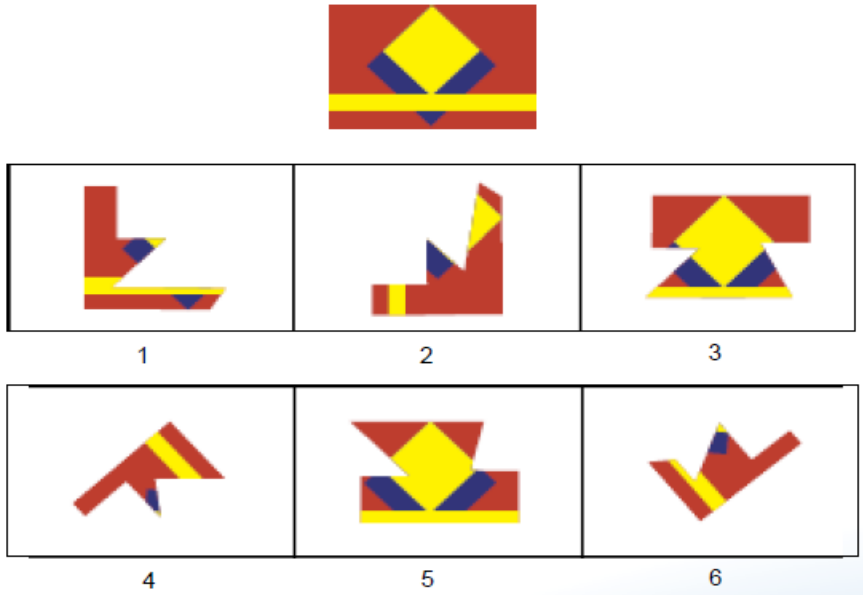
- **"Rational thinking can be surprisingly dissociated from intelligence."**

Keith Stanovich (2009, p. 3 and 39)

Example from WAIS

- **Wechsler Adult Intelligence Scale (WAIS)**
  - **Most widely used test of intelligence**
  - **Wechsler Intelligence Scale for Children (WISC)**

"Which 3 of these pieces go together to make this puzzle?"



Thinking “Hot” and “Cold”

- **If we were always rational thinkers then emotions would not influence our thinking, but they do.**
- **The Ultimatum Game (2 players)**
  - **One of the players is given some money and told to divide it between herself and a second player.**
  - **If the second player accepts the split, each side keeps what they have, but if the second player rejects the split, neither side gets to keep any money. Ready to play?**

Is this ok with you?

- **Game 1. I am given $50 and I decided to give you $25. Is this ok with you?**
- **Game 2. I am given $50 and I decide to give you $1. Is this ok with you?**
- **Most are ok with game 1, but not with game 2. Why?**

Critical Thinking Predicts Important Real-Life Variables

- **Wise reasoning made a significant contribution to well-being, a marginally significant contributor to longevity (assessed with**
- **death records for the older participants five years later), and**
- **better social relations, whereas cognitive ability as measured with intelligence tests did not (Grossmann et al, 2013).**
- **Critical thinking predicted many real-life outcomes that vary from mildly negative (e.g., paying a late fee for returning a movie rental late) to severely negative (e.g., filing bankruptcy; Butler, 2013).**
- **Critical thinking scores were a better predictor of outcomes than**
- **IQ scores (Butler et al., in press).**

So, if you are thinking critically, you are wondering if it is possible to help students improve how they think? Why not?

We teach writing, oral communication, math with the belief that these skills will transfer to appropriate situations.

Evidence That Better Thinking Can Be Learned with Appropriate Instruction

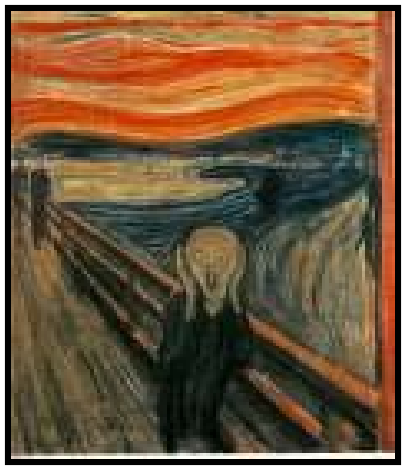
- "Blind" evaluations of programs designed to enhance thinking skills (e.g., the Venezuela project)
- Student self reports (weak evidence, but students believe that they have improved)
- Gains in cognitive growth and development (e.g., Piagetian tasks that measure cognitive stages)
- More expert-like mental representations following instruction (relative to control groups)
- Decision makers trained to “reorganize” existing knowledge in naturalistic settings showed more “expert-like” performance
- Tests of cognitive skills (e.g., standardized tests for critical thinking)
- Spontaneous and uncued transfer (e.g., call students at home months after the class is completed under the guise of a survey)
- Inductive reasoning tasks were taught to college students using realistic scenarios form many different domains. The authors conclude that critical thinking is “a skill” and that “it is transferable”

Most important robust finding:

- **“The majority of studies report positive impact on pupil’s attainment across a range of noncurriculum measures (such as reasoning or problem-solving). No studies reports reported negative impact on such measures (Thinking Skills Review Group).**

“You’ve taught me how to think.”

Thinking About Critical Thinking Instruction



Effective critical thinking instruction is predicated on two assumptions:

(1) There are clearly identifiable and definable thinking skills that students can be taught to recognize and apply, and

(2) If recognized and applied, the students will be more effective thinkers.

Teaching & Learning to Think Critically: A Four-Part Model

1. Explicitly teach/learn the skills of critical thinking
2. Encourage/develop the disposition of effortful thinking and learning
3. Direct learning activities in ways that increase the probability of transfer
4. Make metacognitive monitoring explicit and overt

(Halpern, 1998, 2004)

Build on critical thinking skills throughout the curriculum

- **Identify the skills you want students to learn, then be sure they are used in other classes**
- **Deliberately add new skills throughout the curriculum—may be some differences by discipline, but ensure overlap among courses**
- **Some critical thinking skills that are firmly rooted in psychology**
  - **Understanding that small samples yield more extreme results**
  - **Recognizing and avoiding hindsight bias**
  - **Knowing why we need control groups**
  - **Avoiding either-or thinking (e.g., is it nature or nurture)**
  - **Being aware of the fallibility of memory**
  - **Self-serving attributes for success and failure**
  - **Halo effects**

Dispositions for effortful thinking and learning

Model and provide explicit instruction in the

- **willingness to engage in and persist at a complex task**
- **conscious use of plans and suppression of impulsivity**
- **flexibility and open-mindedness**
- **willingness to abandon nonproductive strategies and self-correct**

Pop Quiz: Embedding Multiple Choice Questions Enhances Memory

What are the assumptions that underlie instruction in critical thinking?

A. **If students stop and reflect on their thinking they will be better thinkers.**
B. **Students need to learn the formal rules of reasoning to become better thinkers.**
C. **Critical thinkers will become more moral.**
D. **Students can learn critical thinking skills and apply them appropriately.**

HCTA Facets of Critical Thinking

Verbal Reasoning	The skills needed to comprehend and defend against persuasive techniques embedded in everyday language.
Argument Analysis	The skills of identifying conclusions, rating the quality of reasons, and determining the overall strength of an argument.
Hypothesis Testing	The skills used in thinking as hypothesis testing are the same ones that are used in scientific inquiry.
Likelihood and Uncertainty	Correct use of probability and likelihood in everyday decision making.
Decision Making and Problem Solving	Ability to use multiple problem statements to define the problem, identify possible goals, generate and evaluate solutions.

1. Verbal Reasoning Skills

The skills listed under this rubric include those that are needed to comprehend and defend against the persuasive techniques that are embedded in everyday language (also known as natural language). Thinking and language are closely tied constructs, and the skills included in this section recognize the reciprocal relationship between language and thought in which an individual's thoughts determine the language used to express them, and the language that is used shapes the thoughts.

Framing Decisions

Suppose you are a haemophilia carrier and have to decide whether or not to abort a child

You are told either:

--there is a 50% chance of having an affected child

or

--there is a 50% chance of having a "normal" child

You are more likely to decide to abort the child under the first condition

Similar results for chances of surviving surgery or when deciding which of two patients should get a bed in intensive care when space is limited.

Wilson, et al. (1987). Social Behaviour, 2, 51-59.

2. Argument Analysis Skills

An argument is a set of statements with at least one conclusion and one reason that supports the conclusion. In real life settings, arguments are complex with reasons that run counter to the conclusion, stated and unstated assumptions, irrelevant information, and intermediate steps. Arguments are found in commercials, political speeches, textbooks, and anywhere else where reasons are presented in an attempt to get the reader or listener to believe that the conclusion is true. The skills of identifying conclusions, rating the quality of reasons, and determining the overall strength of an argument should be sharpened in college course work.

The following example was taken from a catalogue that sells copper bracelets.
I have altered it only slightly for this context.

For hundreds of years people have worn copper bracelets to relieve pain from arthritis. This folklore belief has persisted and copper bracelets continue to be popular. These bracelets promote close contact between the copper and your wrist.

What is the conclusion? What is the evidence or reasoning to support the conclusion? What is implied?

Making Arguments Worksheet

Example 1 Should you recommend surgery, radiation, or vigilant watching for a particular patient with cancer?

1. State your conclusion. (although you may begin your formal writing here, but sure that the conclusion follows from your reasons). As you work, this is the last part this is filled in, not the first.

2. Give three reasons (or some other number) that support your conclusion.

3. Rate each reason as weak, moderate, strong, or very strong.

4. Give three counterarguments (or some other number) that weaken your conclusion. Rate how much each counterargument weakens the conclusion: little, moderate, much, or very much.

5. List any qualifiers (limitations on the reasons for or against—for example some evidence may be restricted to early childhood)

6. List any assumptions.

7. Are your reasons and counterarguments directly related to your conclusion?

8. What is the overall strength of your argument: weak, moderate, strong, or very strong?

Now that you have completed this worksheet, rate the overall strength of your argument.

Common Argument Fallacies

Straw Person: A type of propaganda technique in which an opponent to a conclusion distorts the argument that supports the conclusion by substituting a weaker argument

"A cancer specialist at another hospital recommends vigilant watching. I don't understand how she could just sit by and watch your cancer grow."

3. Skills in Thinking as Hypothesis Testing

The rationale for this category is that much of our day-to-day thinking is like the scientific method of hypothesis testing. In many of our everyday interactions, people function like intuitive scientists in order to explain, predict, and control the events in their life. The skills used in thinking as hypothesis testing are the same ones that are used in scientific reasoning--the accumulation of observations, formulation of beliefs or hypotheses, and then using the information collected to decide if it confirms or disconfirms the hypotheses.

Concern about psychologists' critical thinking—Paul Meehl stopped attending case conferences because of sloppy patterns of thought and inability to distinguish weak from strong evidence

- "A casual anecdote about one's (demented) uncle as remembered from childhood is given the same group interest and intellectual respect that is accorded to the citation of a high-quality (research) study." (Meehl, 1973, p. 228).

- People love and recall stories—numbers are not intuitive or easy to recall.

Clinical Example:

- **Design a study to compare a new mood enhancing drug, participation in an exercise program and group therapy for depressed teenagers. Be sure to include combination treatments.**

Applying Research to Practice

Consider this hypothetical example:

- **Researchers at Snooty University have studied the causes of divorce. They found that 53% of recently divorced couples reported that they had serious disagreements over money during the two-year period that preceded the divorce. The researchers concluded that disagreements over money are a major reason why couples divorce. They go on to suggest that couples should learn to handle money disagreements as a way of reducing the divorce rate.**

4. Using Likelihood and Uncertainty

Because very few events in life can be known with certainty, the correct use of probability and likelihood plays a critical role in almost every decision. Huff's (1954) tiny, popular book How To Lie With Statistics is still widely quoted because it explains how easy it is to mislead someone who does not understand basic concepts in probability. The critical thinking skills that are subsumed under this heading are an important dimension of a college-level critical thinking taxonomy.

Using Likelihood and Uncertainty

- **A health survey was conducted in a sample of adult males in British Columbia, of all ages and occupations.**
- **Please give your best estimate of the following values:**
- **What percentage of the men surveyed have had one or more heart attacks? _____**
- **What percentage of the men surveyed both are over 55 years old and have had one or more heart attacks? ____**
- **Stop now and fill in the blanks above with your best estimate of these values.**

- **Over 65% of the respondents believed that a higher percentage of the men would be both over 55 and have had a heart attack than the percentage of men who reported that they had a heart attack. Do you recognize this as an example of a conjunction error? The probability of two uncertain events both occurring cannot be greater than the probability of just one of them occurring.**

The Problem of False Positives

- **Researchers designed a test that can correctly identify 99% of all ___ (people who will be terrorists or people with a rare disease)**
- **Someone you know was identified with this test? What is the probability that the diagnosis is correct?**
- **It is very hard to convince the general public to cut back on mammograms or prostate cancer screening because of false positives.**

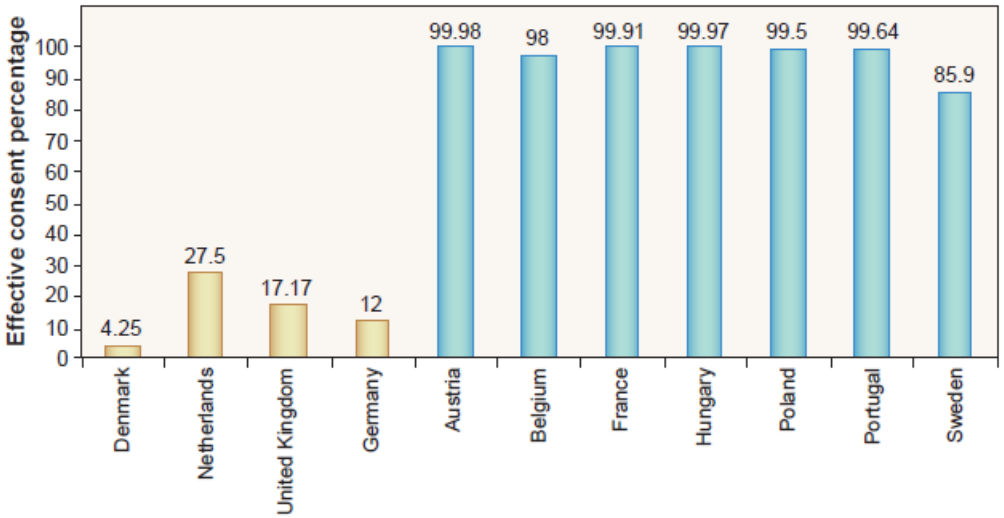
Decision Making and Problem Solving—What Solutions Come to Mind?

- **In a medical text written by Gifford-Jones (1977), the author discusses the difficult medical decision concerning whether women in their late thirties or early forties should have their ovaries removed when they are having a hysterectomy. Like all difficult decisions, there are pros and cons associated with each alternative. In discussing how this decision is often made, Gifford-Jones (pp. 174-175) wrote:**

His comments:

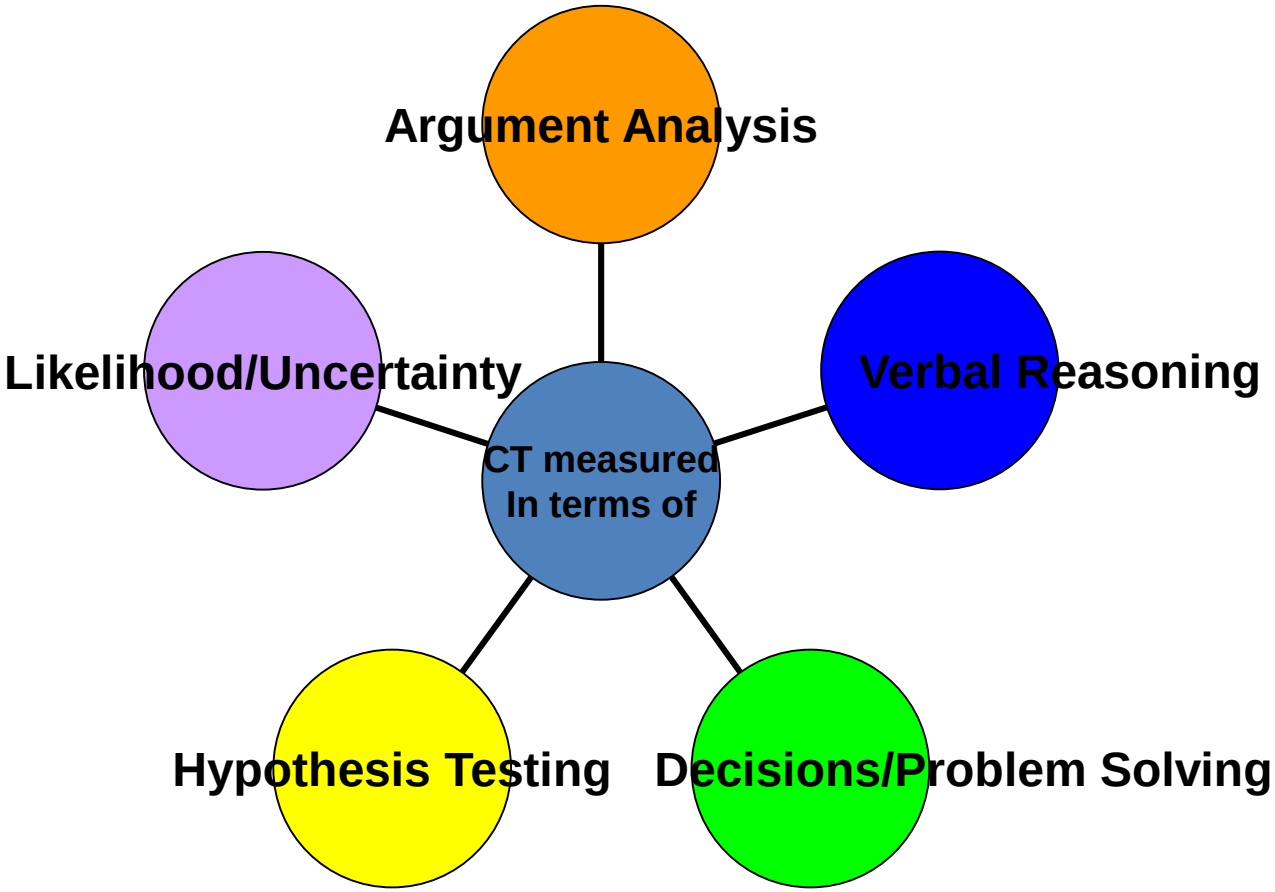
- **I recall operating some time ago with a former professor of gynecology at Harvard. He was in a rather philosophical mood and was pondering the pros and cons of what to do with the ovaries. "Sometimes whether or not I remove the ovaries depends on what has happened to me in the last few weeks," he said. "If I've watched a patient die from cancer of the ovary, I often remove them. But if I've been free of this experience for a while, I'm more inclined to leave them in."**

Are you an organ donor? If you live in Austria, Belgium, France or Poland, you almost certainly responded "yes." But if you live in Denmark, Netherlands, United Kingdom or Germany, you probably are not



Effective consent rates, by country. Explicit consent (opt-in, gold) and presumed consent (opt-out, blue).

Halpern's Taxonomy of Critical Thinking Skills
A Guide for Instruction & Assessment



Assessing Critical Thinking – the Halpern Critical Thinking Assessment (HCTA)

- Available on the Internet (3 versions)
  (Available in English, Portuguese, Vietnamese, Polish, Spanish, Chinese, Dutch, German)

- Scenario-based

- Each competency is evaluated with forced-choice & constructed responses

- Forced-choice: recognition memory

- Constructed response: free recall

Halpern Critical Thinking Assessment: Sample Question

- **A recent report in a magazine for parents showed that adolescents who smoke cigarettes also tend to get low grades in school. As the number of cigarettes smoked each day increase, GPA decreased. One suggestion made in this report was that we could improve school achievement by preventing adolescents from smoking.**
- **Based on this information, would you support this idea as a way of improving the school achievement of adolescents who smoke?**
- **Type “yes” or “no” and explain why or why not.**

Based on this information, which is the best answer?

1. **School grades probably will improve if we prevent adolescents from smoking.**

2. **School grades might increase, but we cannot be certain because we only know that grades go down when smoking increases.**

3. **There is no way to know because we only know that smoking and grades are related, not whether smoking causes grades to change.**

4. **There will probably be no effect on grades if we prevent adolescents from smoking because the magazine is written for parents, so it is probably biased against teen smoking.**

Based on this information, which is the best answer?

1. School grades probably will improve if we prevent adolescents from smoking.

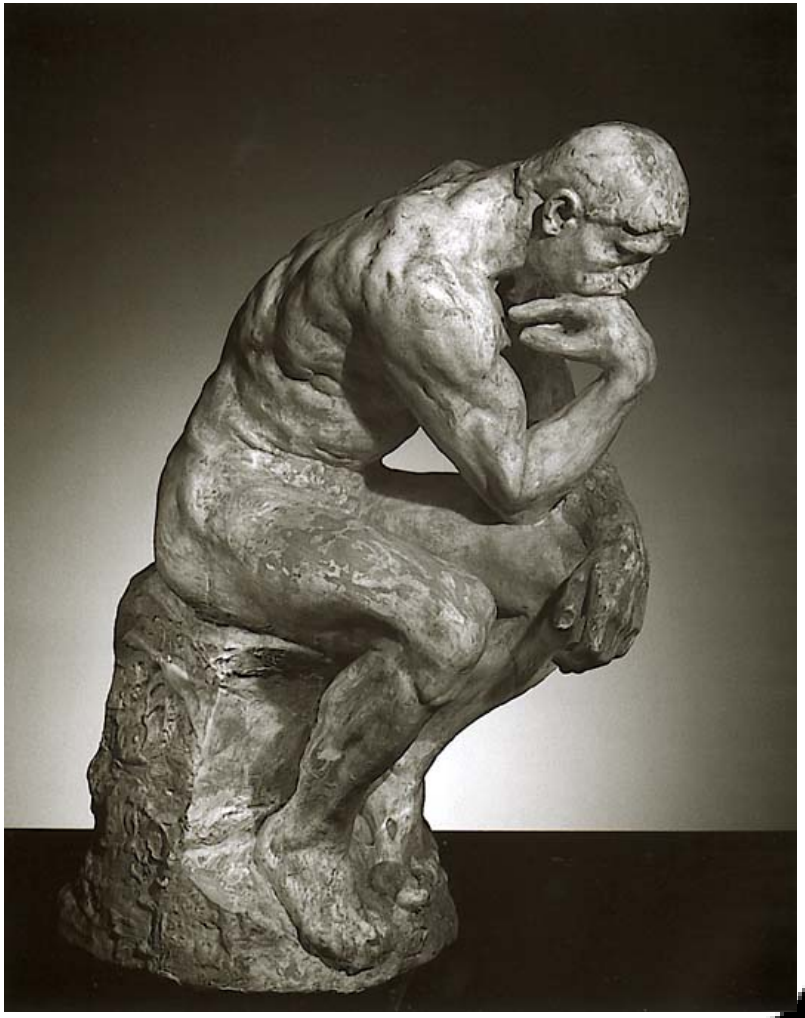
2. School grades might increase, but we cannot be certain because we only know that grades go down when smoking increases.

3. **There is no way to know because we only know that smoking and grades are related, not whether smoking causes grades to change.**

4. There will probably be no effect on grades if we prevent adolescents from smoking because the magazine is written for parents, so it is probably biased against teen smoking.

“Most people would sooner die than think, In fact, they do.”

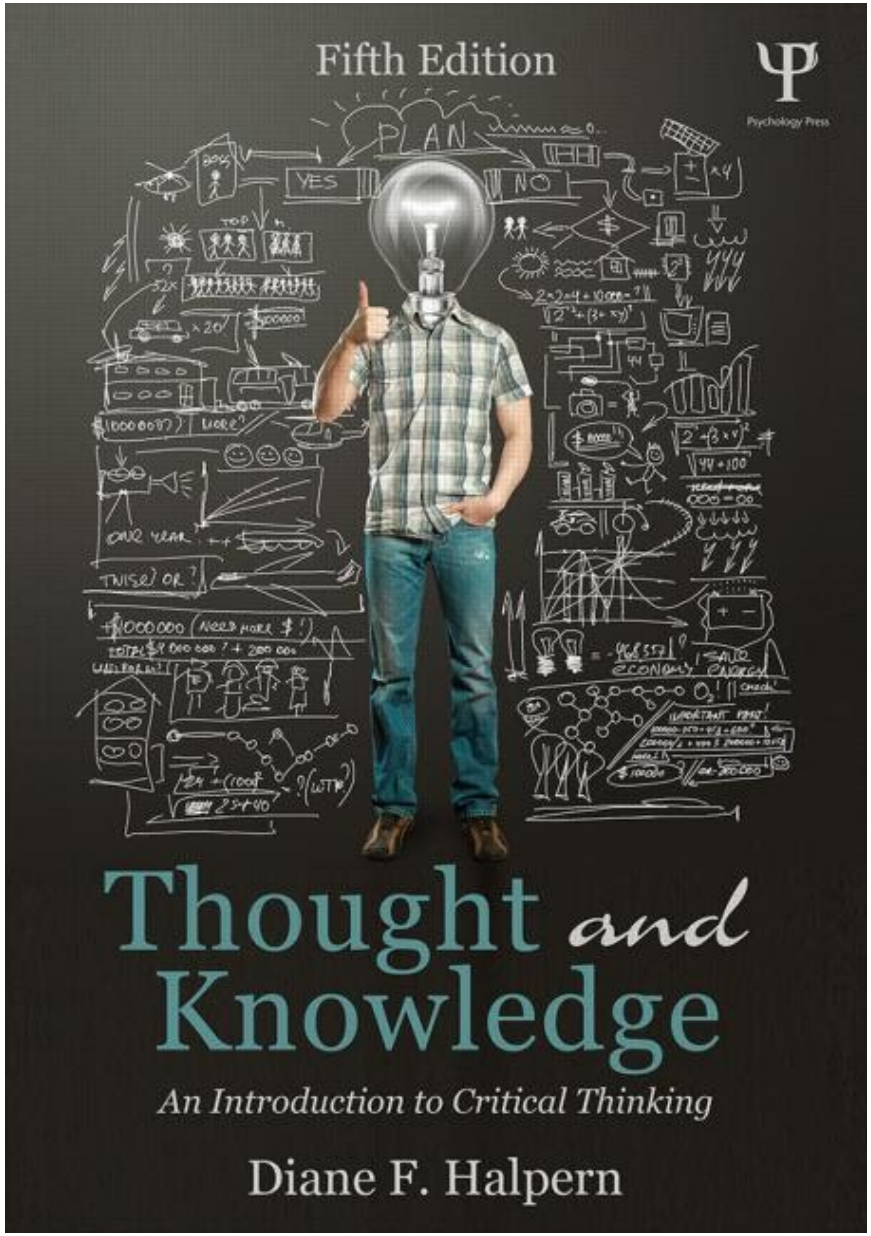
--Bertrand Russell



For more information:

http://routledgetextbooks.com/textbooks/_author/halpern-9781848726291/

For lots of free materials for students and instructors/



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