

Genesis of and Exploration of an Idea

Where and When Ideas

Experience

Becoming an Expert

Creativity

Lateral Thinking

Testing Ideas

Hypothesis Testing

Potential Pitfalls

Strong Inference

External Validity

Facing Complexity

Challenge of Applications

Distinguishing Science From Pseudoscience

Ten Criteria

A Real Example

Initial Promising Results

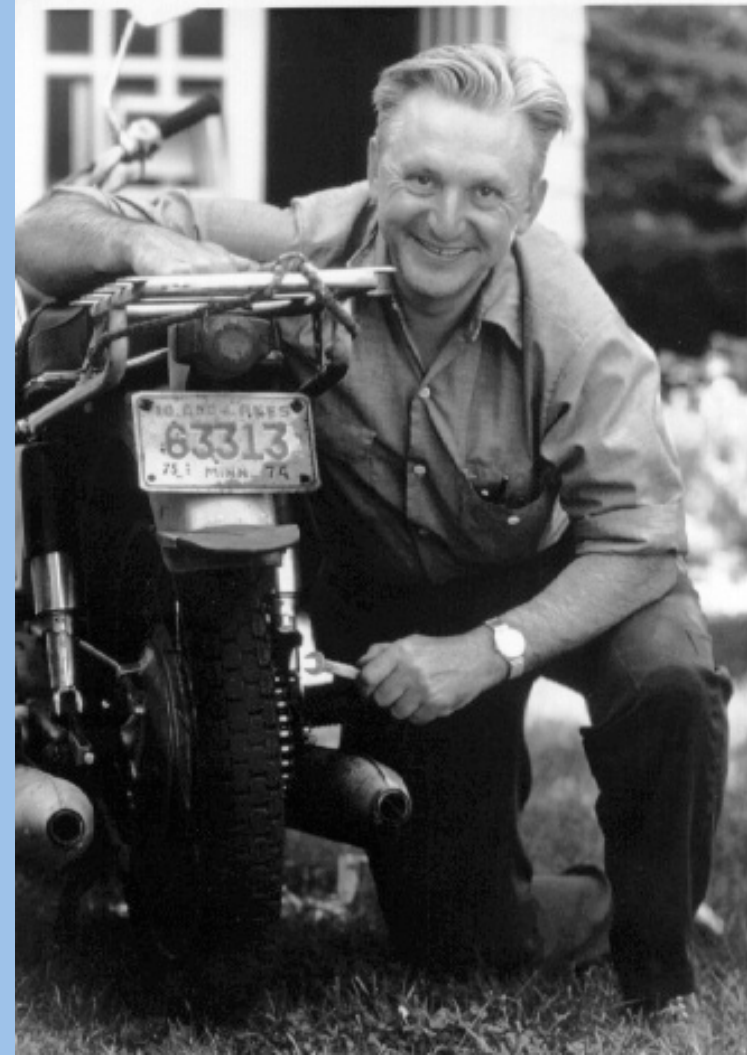
Meta-Analysis

Continued Practice

Time on Task

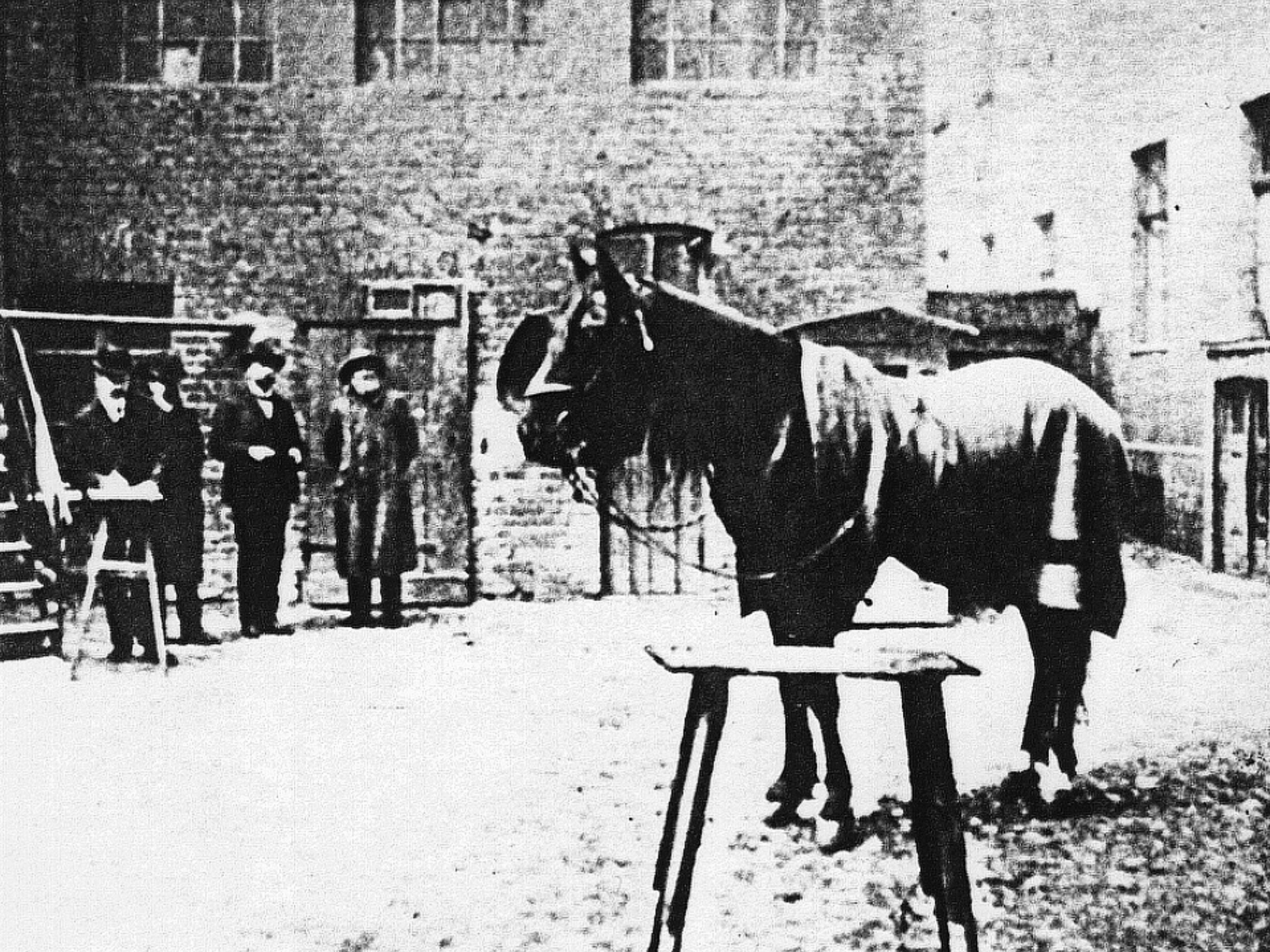
The real purpose of [the] scientific method is to make sure Nature hasn't misled you into thinking you know something you actually don't know.

R. Pirsig, Zen and the Art of Motorcycle Maintenance



Barriers to Critical Thinking

- Direct Experience can be Misleading
 - Clever Hans
 - Mystery Spot
- Overconfidence
 - Medical Judgments vs. Weather





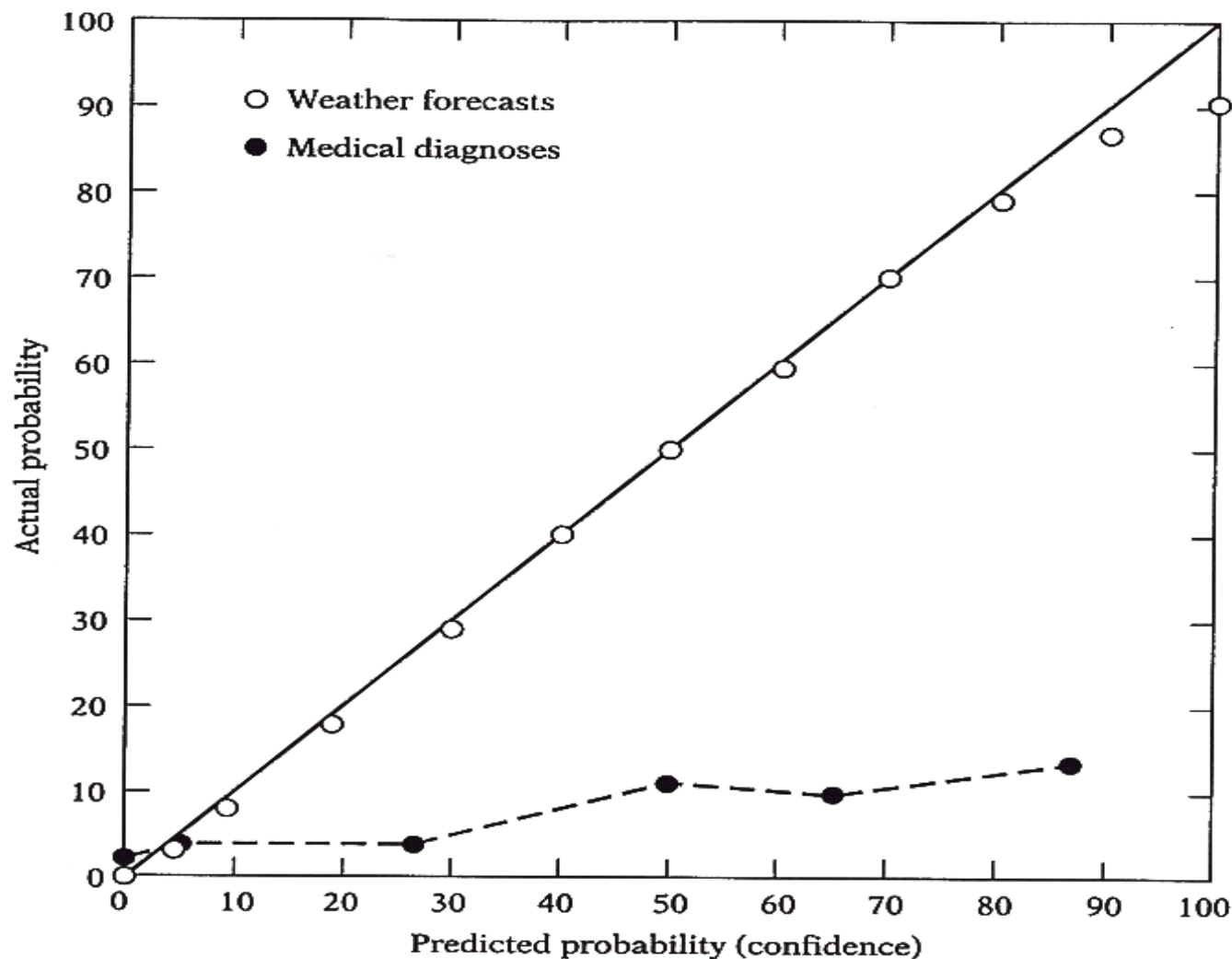
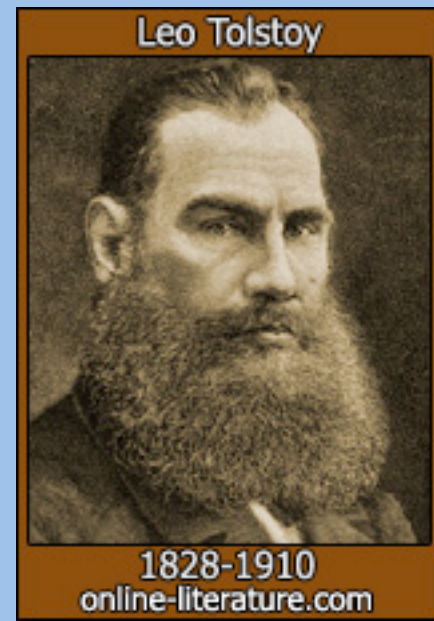


FIGURE 19.2

This figure contains calibration curves for weather forecasters' predictions of precipitation (hollow circles) and physicians' diagnoses of pneumonia (filled circles). Although the weather forecasters are almost perfectly calibrated, the physicians show substantial overconfidence (i.e., unwarranted certainty that patients have pneumonia). The data on weather forecasters comes from a report by Allan Murphy and Robert Winkler (1984), and the data on physicians comes from a study by Jay Christensen-Szalanski and James Bushyhead (1981).

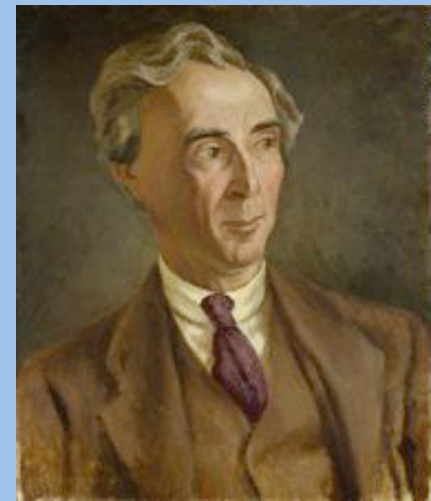
I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth if it be such to oblige them to admit the falsity of conclusions which they have delighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives.

Tolstoy, L. (1894). *The kingdom of God is within you* (Trans. C. Garnett). New York, NY: Cassell. (Original work published 1893)



What a man believes upon grossly insufficient evidence is an index into his desires -- desires of which he himself is often unconscious. If a man is offered a fact which goes against his instincts, he will scrutinize it closely, and unless the evidence is overwhelming, he will refuse to believe it. If, on the other hand, he is offered something which affords a reason for acting in accordance to his instincts, he will accept it even on the slightest evidence. The origin of myths is explained in this way.

Bertrand Russell. "Proposed roads to freedom: socialism, anarchism and syndicalism" (1919)



Science Game

- There is a rule that generated 2 4 6
- Generate sequences to test the rule

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Caveat: Confirmation Bias

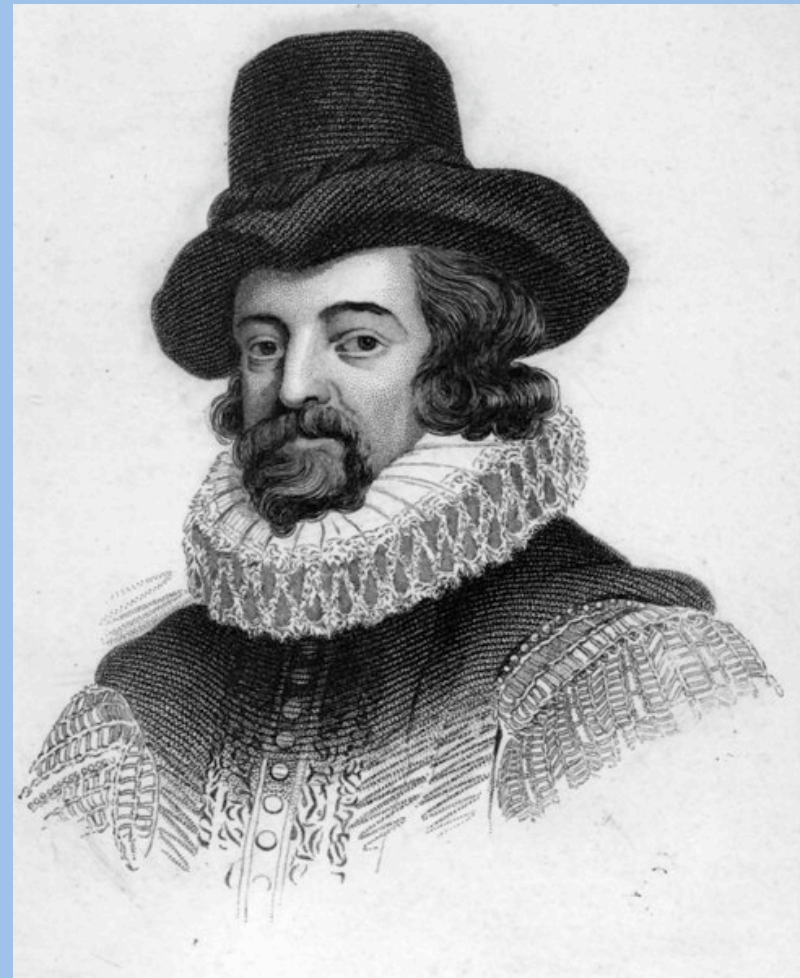
- Seek Positive Evidence
- Ignore Negative Evidence
- View Ambiguous Evidence as Positive
- With Multiple Sources, Overweight the Positive Relative to the Negative
- Einstein was not Immune

Confirmation Bias



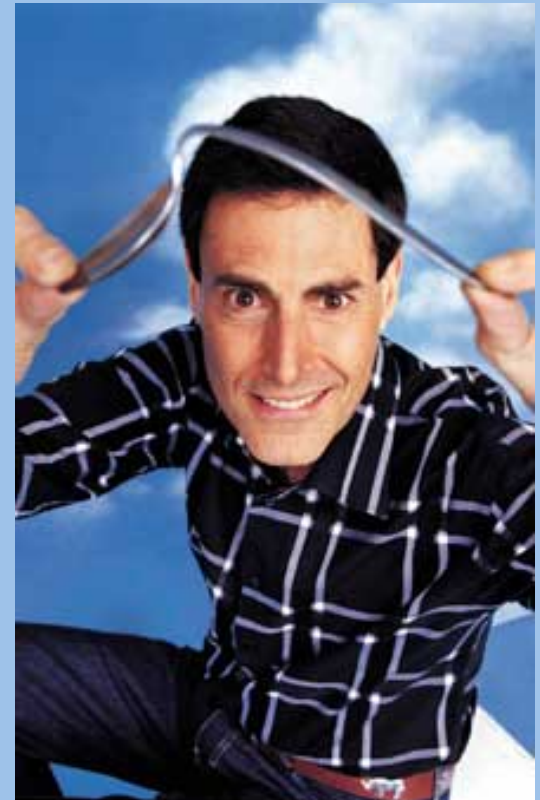
Imposing More Order Than Appropriate
Ambiguous Evidence Taken as Support for
Beliefs

Francis
Bacon



Inconsistent Scientists

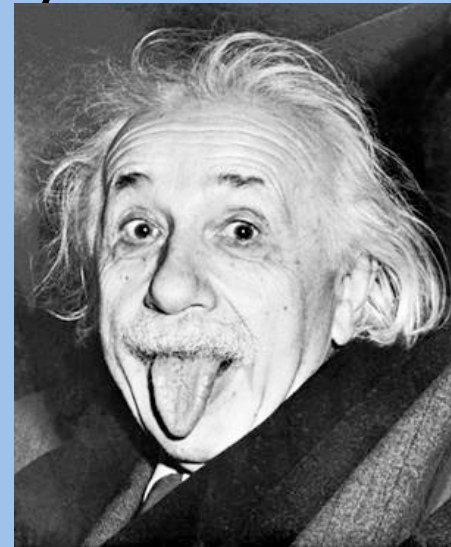
- Physicists and Uri Geller
 - Ideal Scientific Minds
 - Fooled by Alleged Paranormal



Confirmation Bias in Einstein's Advocacy of Communism

Time Magazine's "Person of the Century"

- Presented Socialism As a Non-falsifiable "Truth"
- Strong advocate of universal freedom, but accepted that freedom had to be temporarily suspended in the Soviet Union in order to build up the country.



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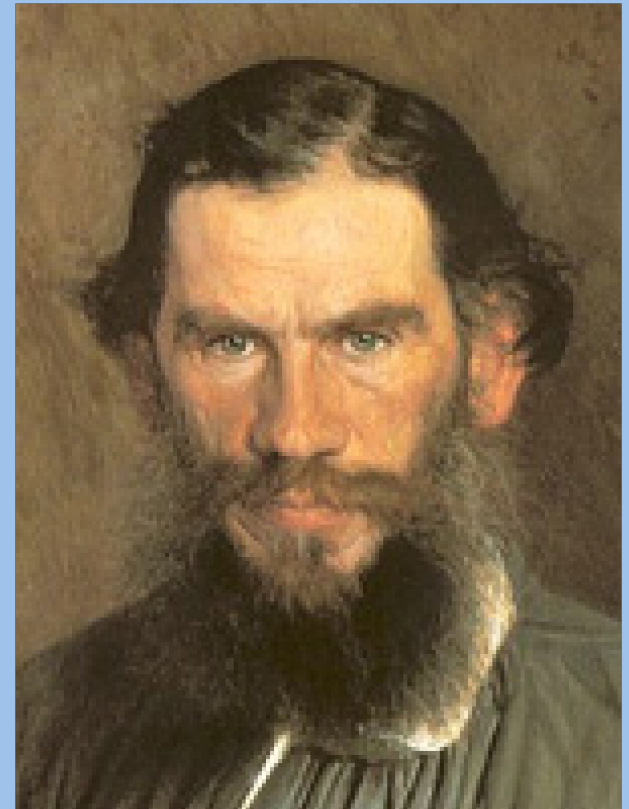
Testing Hypotheses

- Many Safeguards
 - Random Sampling
 - Double Blind Procedure
- Fast ForWord
 - Behavioral Science Findings
 - Extrapolate to Application
 - Test in Application

I believe that one of the greatest moral reforms that lies immediately before us consists in the general introduction into social and civic life of that habit of mental procedure which is known in investigation as the method of multiple working hypotheses.

Thomas Chrowder Chamberlin, 1890

(Repinted, 1965, p. 759.)



Fast ForWord

- Initial Support
 - Empirical Studies
 - Endorsements
 - Former UC president & renowned scientist
 - “Check it out. It helped my grandson.”
 - Appropriate Controls
 - Always an Issue

Fast ForWord

- Appropriate Controls
 - Always an Issue
- Confoundings
 - Time on Task
 - Value of MetaAnalysis
 - Strong GK, Torgerson CJ, Torgerson D, Hulme C (March 2011). "A systematic meta-analytic review of evidence for the effectiveness of the 'Fast ForWord' language intervention program". J Child Psychol Psychiatry 52 (3): 224–35. doi:10.1111/j.1469-7610.2010.02329.x. PMC 3061204. PMID 20950285.

Meta-analysis

- In statistics, a meta-analysis refers to methods focused on contrasting and combining results from different studies, in the hope of identifying patterns among study results, sources of disagreement among those results, or other interesting relationships that may come to light in the context of multiple studies.[1] In its simplest form, this is normally by identification of a common measure of effect size, of which a weighted average might be the output of a meta-analysis. The weighting might be related to sample sizes within the individual studies.

Example of Fast Forward

- Strong GK, Torgerson CJ, Torgerson D, Hulme C (March 2011). "A systematic meta-analytic review of evidence for the effectiveness of the 'Fast ForWord' language intervention program". *J Child Psychol Psychiatry* 52 (3): 224–35. doi:10.1111/j.1469-7610.2010.02329.x. PMC 3061204. PMID 20950285.

Survey of Psychological Literacy

- <http://mambo.ucsc.edu/psl/surv2007.html>
- Basis of Short Course



I am just as deaf as I am blind. The problems of deafness are deeper and more complex, if not more important, than those of blindness.

Helen Keller



Language Tutoring with a Virtual Teacher



Direct Vocabulary Instruction



Language Tutoring with a Virtual Teacher



Direct Vocabulary Instruction



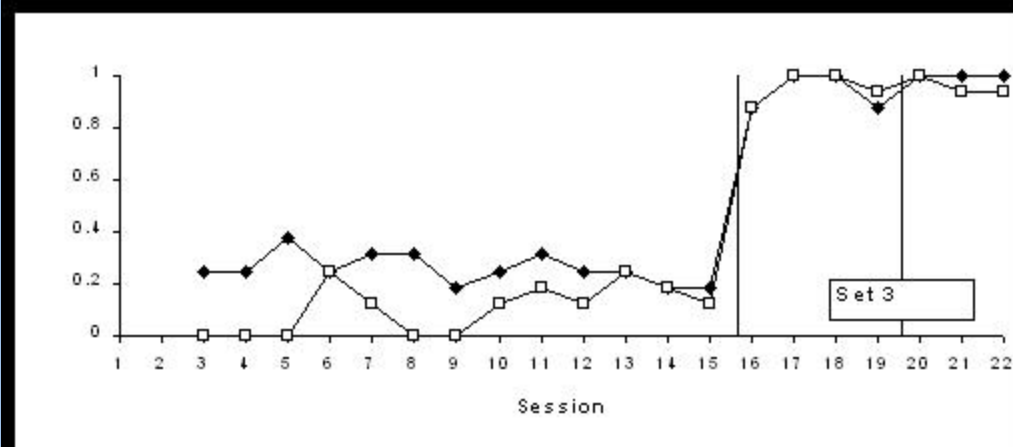
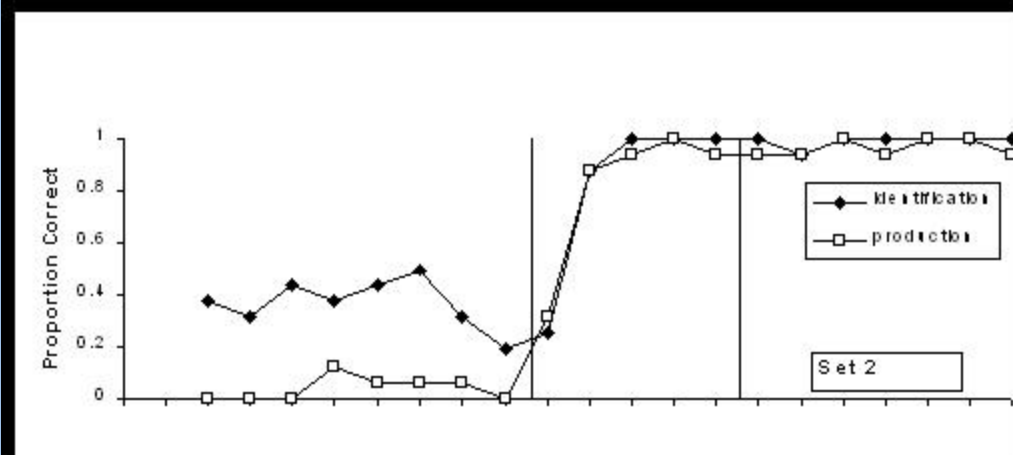
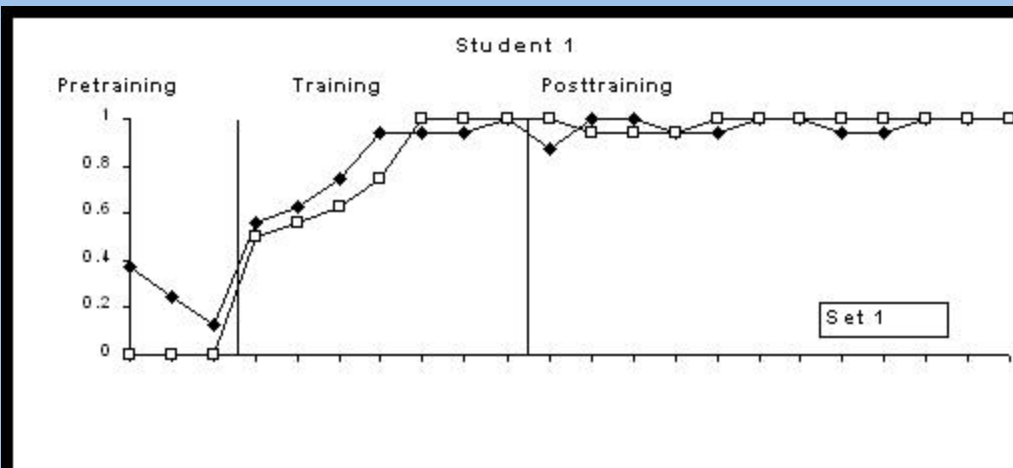
"I like Baldi because... I can hear him... He understands me... He doesn't get mad at me... He sounds good... He knows about everything... I learn from him... He teaches me how to say words... He helps me remember... He lets me do my lessons many times..."

*—Responses from multiple
Tucker-Maxon students*

Exercise: Propose Test For:

- Whether Baldi tutoring is responsible for learning.

Hard of Hearing First Grader



- Multiple Baseline Procedure
- Each child receives 3 sets of words
- Test all words
- Train 1 set at a time

Vocabulary Learning

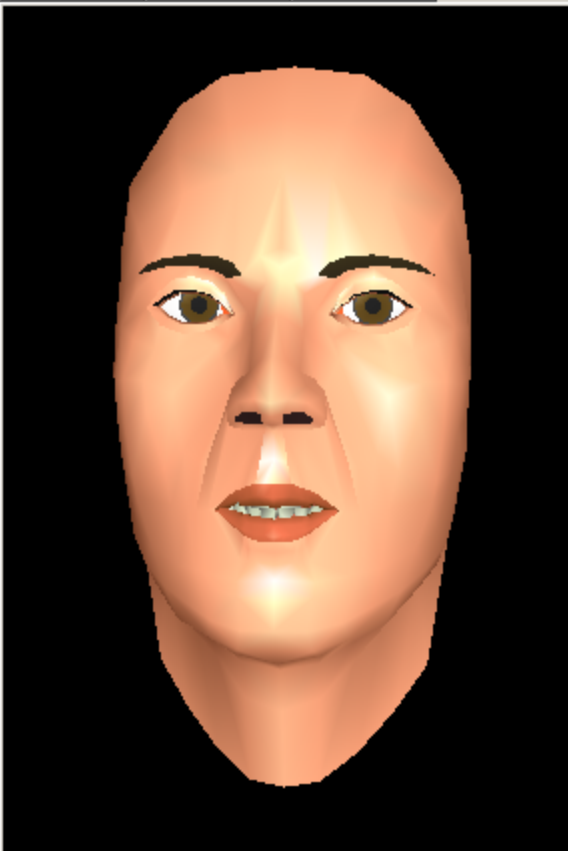
- Occurred with Baldi as Tutor
- Questions Remain
 - Is Baldi actually responsible?
 - Assess retention and transfer?











Baldi is helping children with autism
learn language and emotion

Plurals 1c

Quit Pause Repeat












	
	
	
	

Learning Plurals



Plurals 1C

Quit Pause Repeat



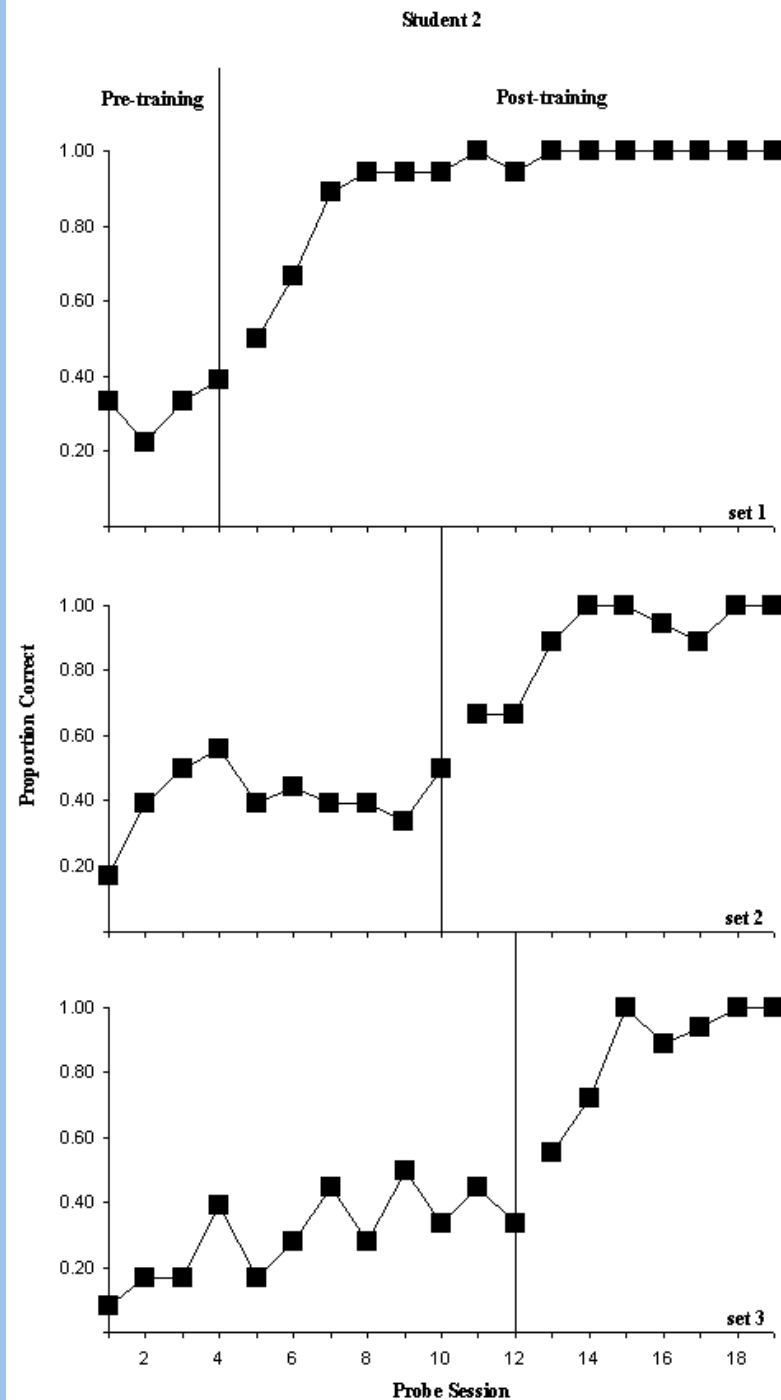
Multiple Baseline Procedure

Each child receives

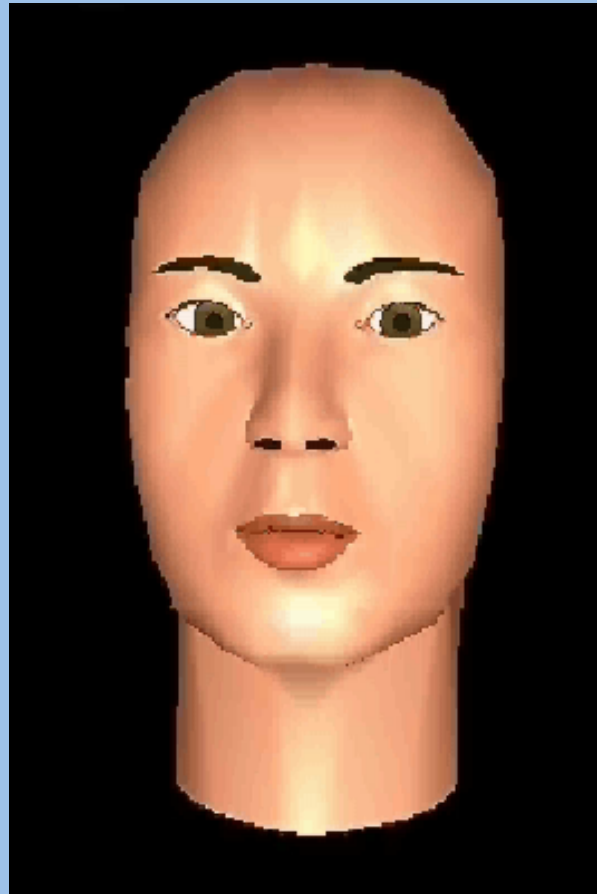
3 sets of words

Test all words

Train 1 set at a time



Baldi Speaks Spanish



Baldero

School F-258, Renaca, Chile

Deaf Children Learning Spanish Vocabulary





Baldi Guides Vocabulary

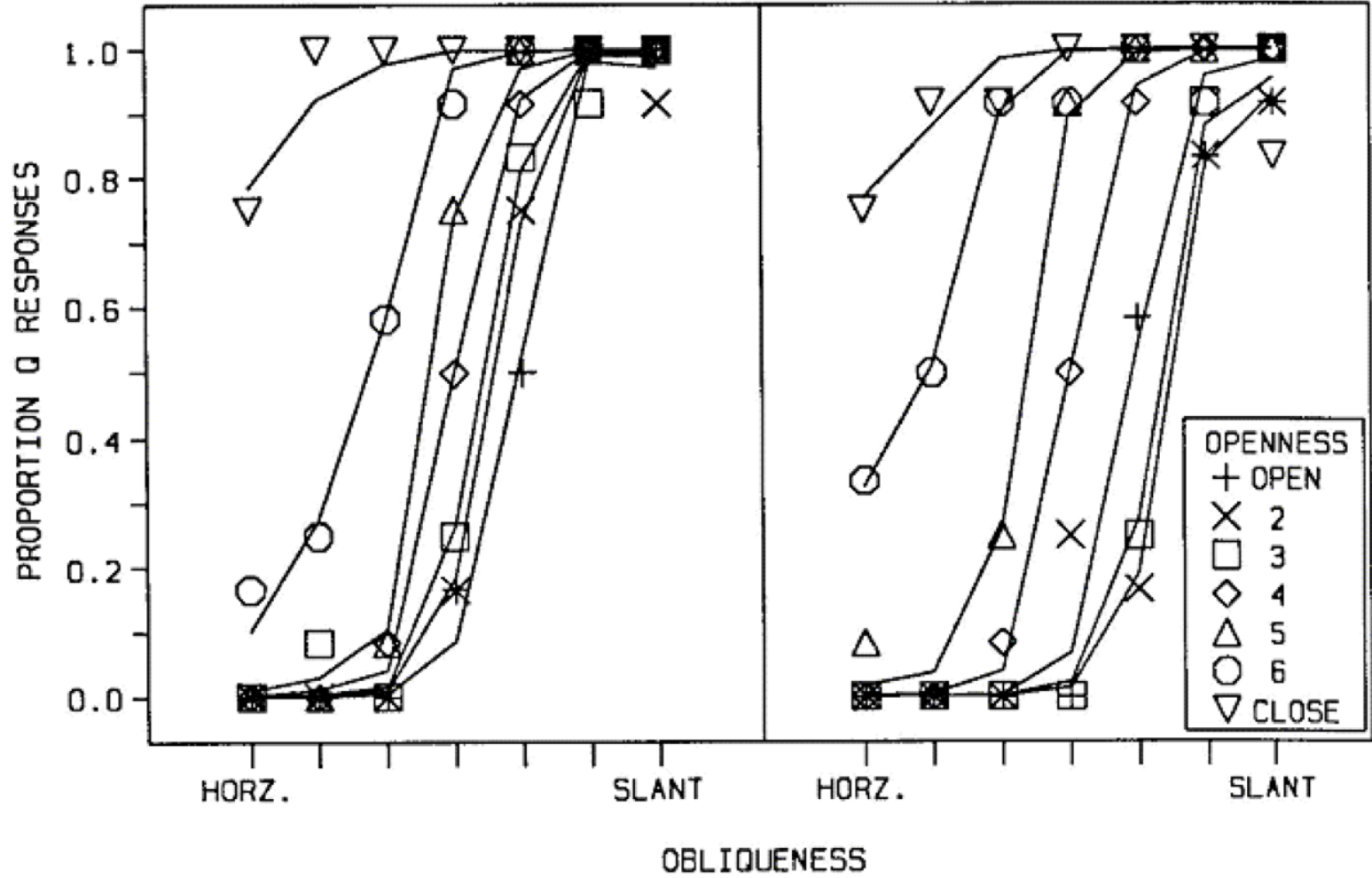
Learn





SUBJECT 5

SUBJECT 6

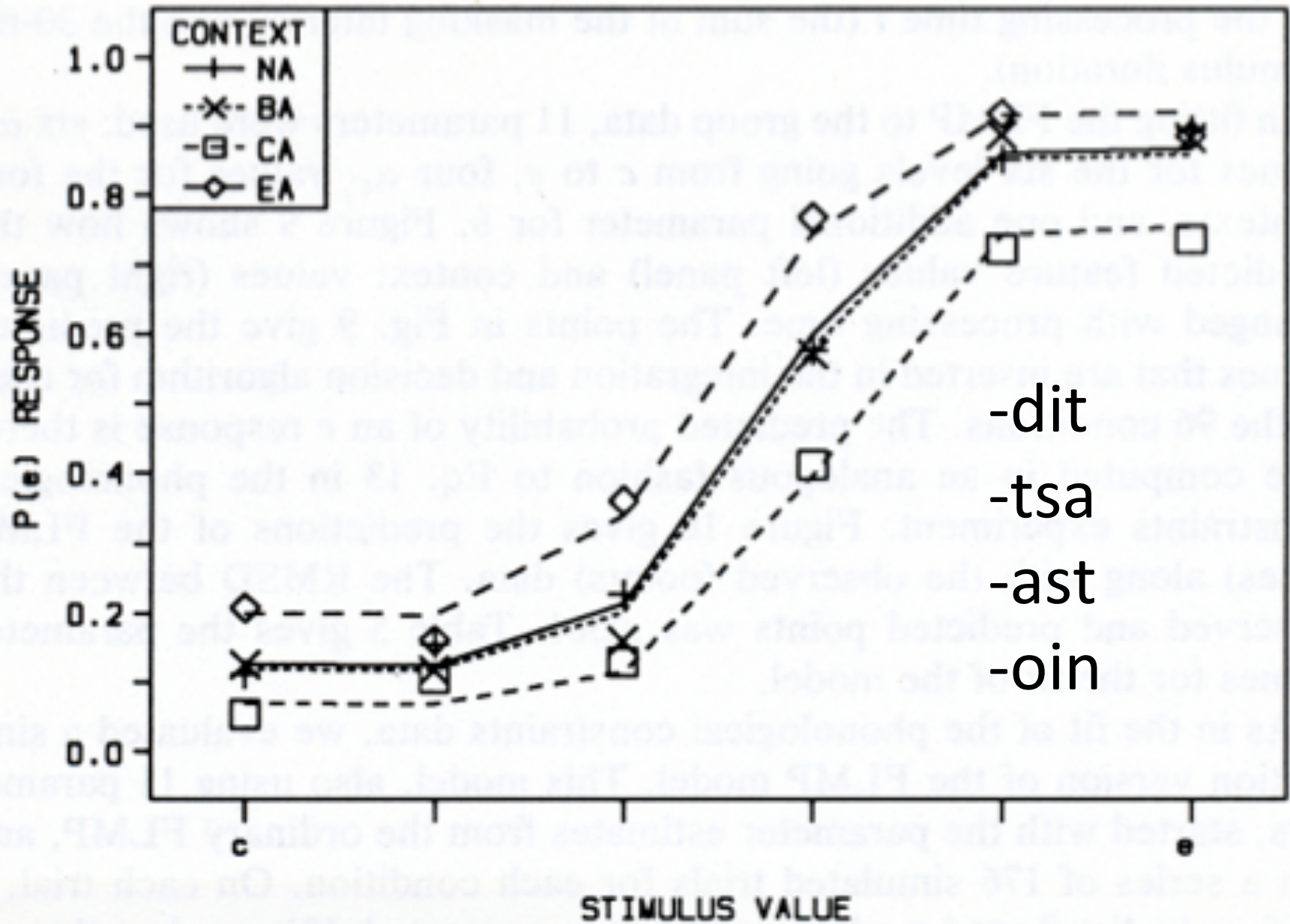


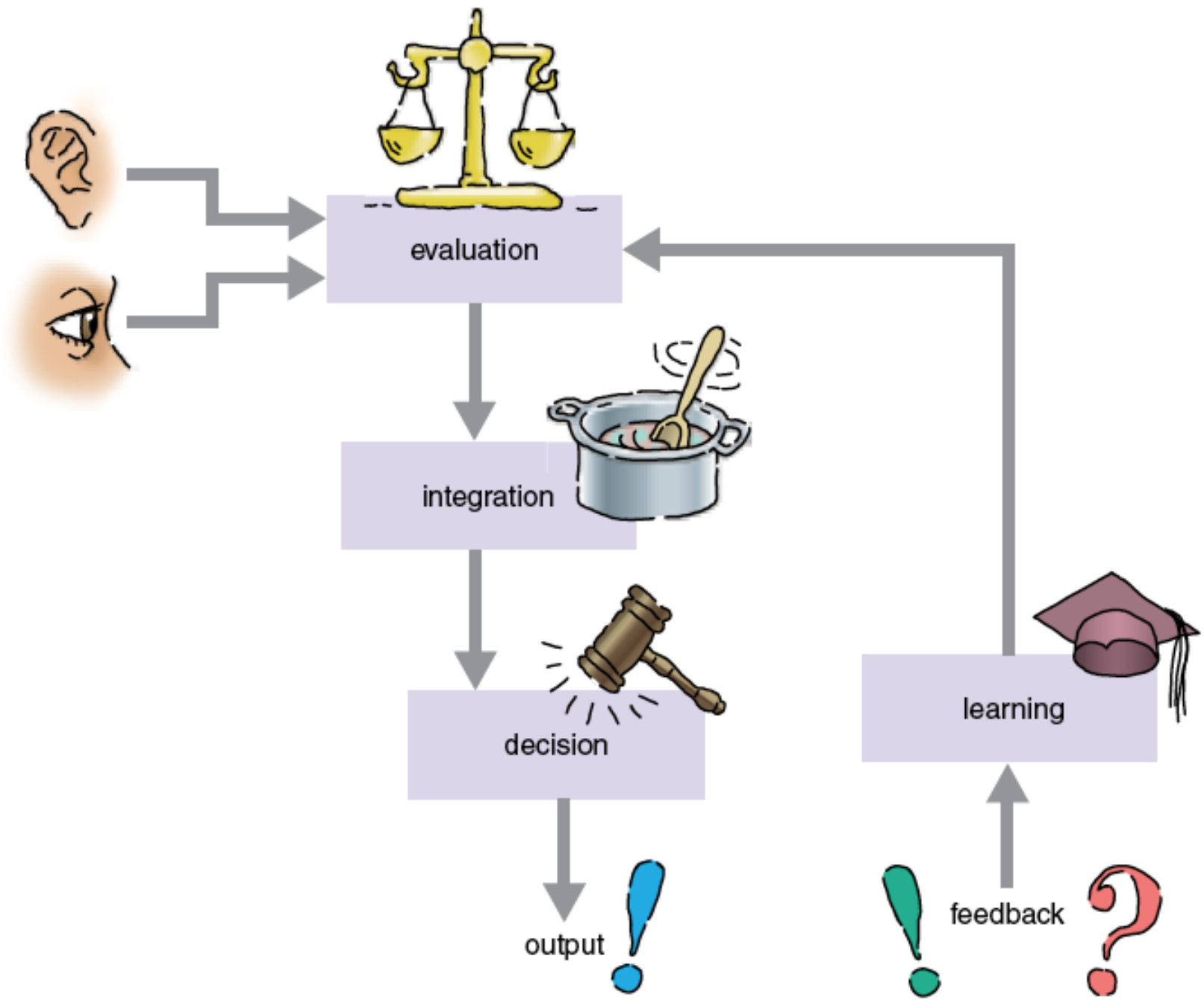
near snow acne sign
near snow acne sign
near snow acne sign
near snow acne sign
hear show ache sigh
hear show ache sigh

nurt tnis ecno disn
nurt tnis ecno disn
nurt tnis ecno disn
nurt tnis ecno disn
hurt this echo dish
hurt this echo dish

nice knap sing coin
nice knap sing coin
nice knap sing coin
nice knap sing coin
hice khap sihg coih
hice khap sihg coih

ndye snge tinr tlan
ndye snge tinr tlan
ndye snge tinr tlan
ndye snge tinr tlan
hdye shge tihr tlah
hdye shge tihr tlah





The hypothesis is:

If children are immersed in written language, they will learn to read naturally.

You observe the following 4 situations. What conditions have to be observed to test this hypothesis?

1. children immersed in written language
2. children not immersed in written language
3. children who are readers
4. children who are not readers

How do conclusions differ between deductive reasoning and inductive reasoning.

In deductive reasoning, the conclusion follows logically from the observations

In inductive reasoning, the conclusion goes beyond the observations and new observations can always falsify the conclusion