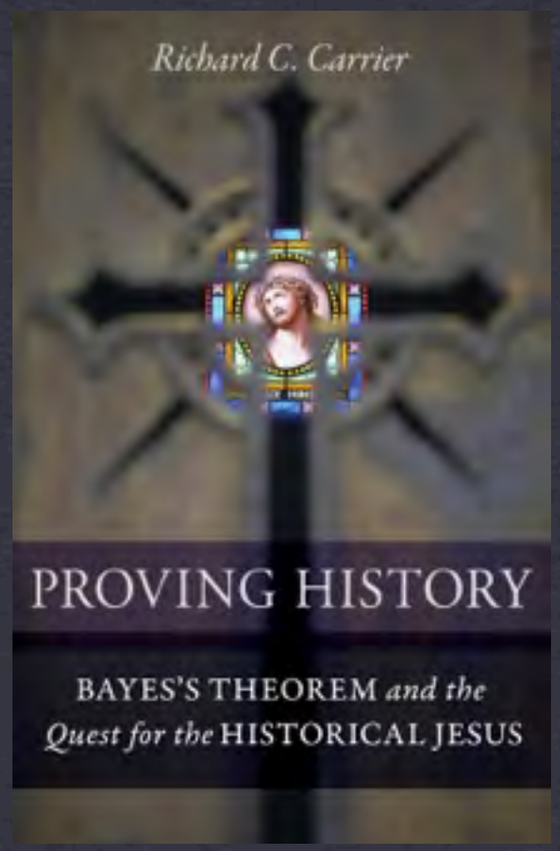

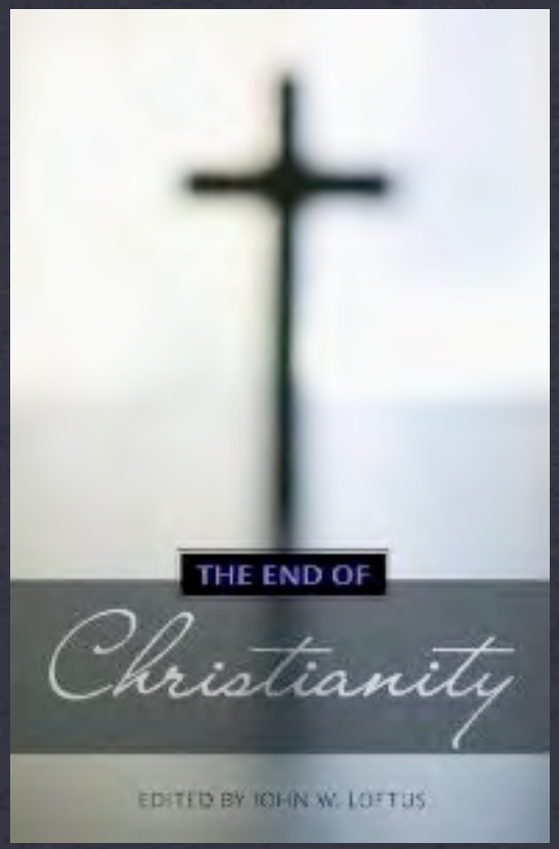

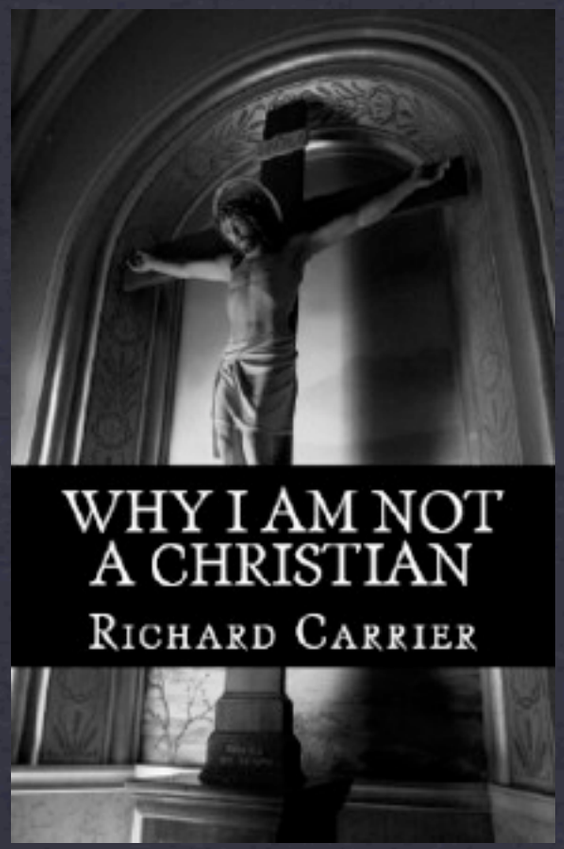

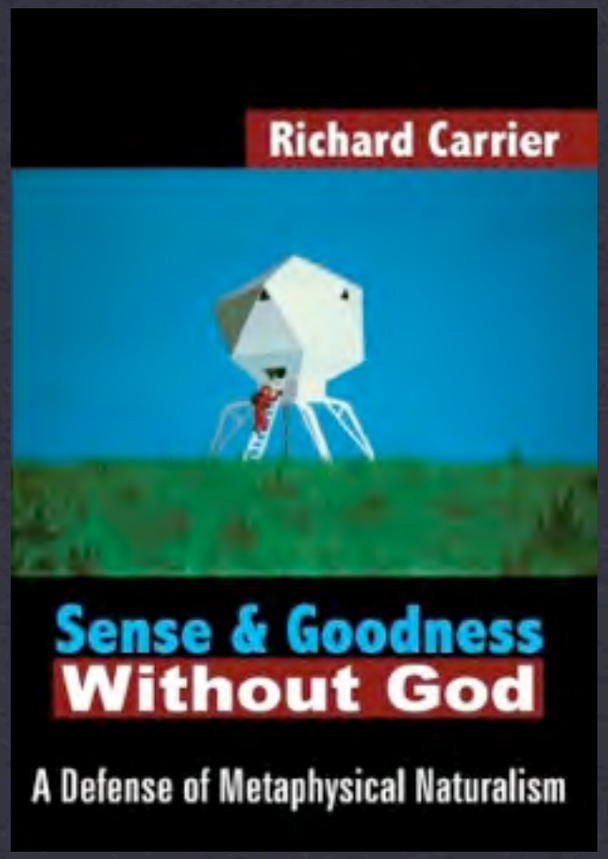

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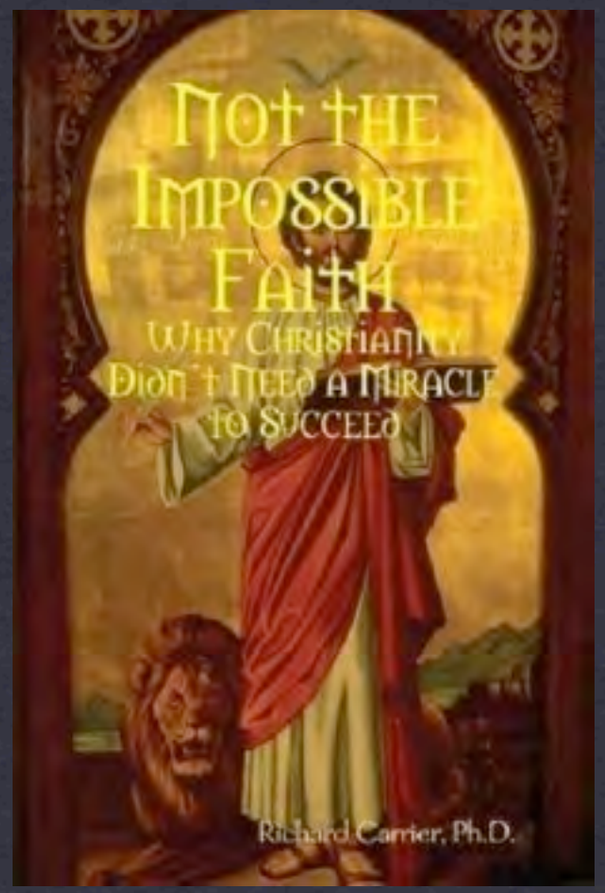


LOGIC AND CRITICAL THOUGHT IN THE 21ST CENTURY

What's New and Why It Matters

BREAKDOWN

- Traditional Principles of Critical Thinking
- Plus a Dash of **Cognitive Science**
- And a Dollop of **Bayesian Reasoning**

RESOURCE

- www.RichardCarrier.info/CriticalThinking.html

TO BE A CRITICAL THINKER…

- CT means **questioning information** rather than merely receiving it (trust but verify).
- CT is a **constant skill** applied to all domains of knowledge and belief (not to be compartmentalized).
- CT is not an exercise but a tool for belief testing and filtering (it is your **defense against false beliefs**).
- CT must be **applied to yourself** as well as others (always self-question, self-test, self-critique).
- CT is not radical skepticism (work out **when information is enough to settle a conclusion**).

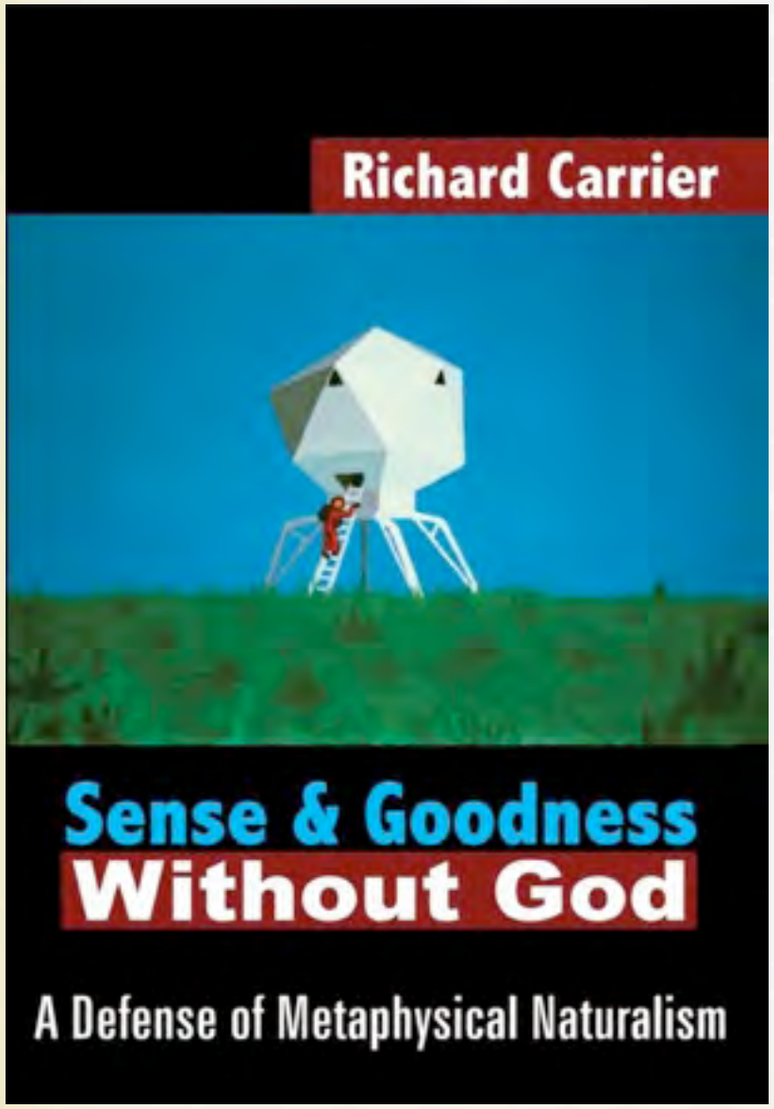
STAGES OF CRITICAL THOUGHT

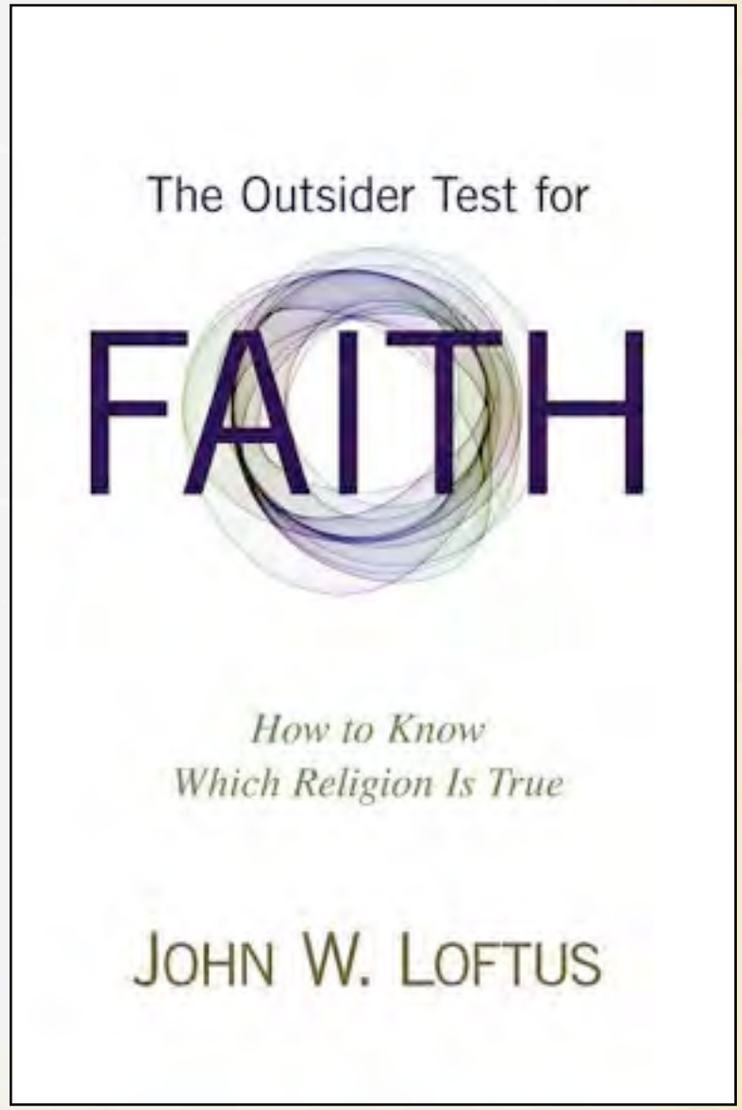
- **Step 1:** Check the facts (check multiple sources / original sources and evaluate their reliability).
- **Step 2:** Check for biases and fallacies (your own and those of others).
- **Step 3:** Consider alternative explanations of the evidence and give them a fair test, too.

AND THAT'S WHAT IT'S ALL ABOUT

- Find best defenses of both sides **and** compare them.
- Consider your existing background knowledge **and** endeavor to acquire more of it.
- Rely on facts and evidence, **not** assumptions.
- **Update** your beliefs when evidence goes against them.
- Restate your beliefs as (rough) **probabilities**; then justify those probabilities (or change them if you can't).

IT STARTS WITH EPISTEMOLOGY





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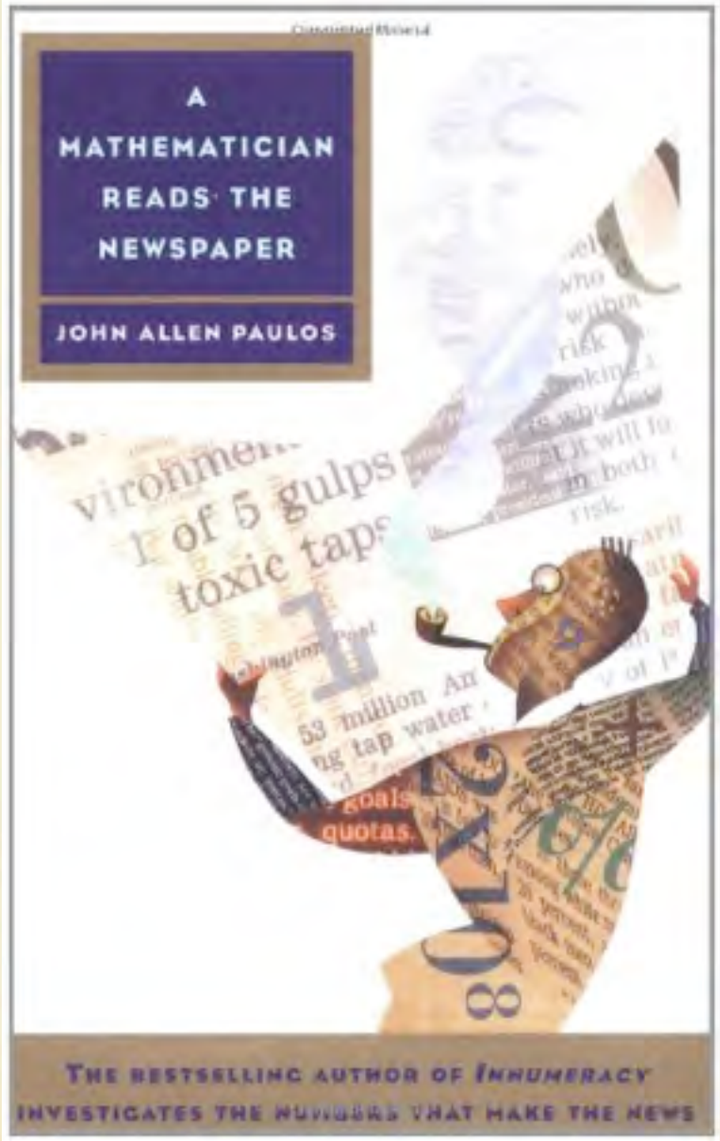

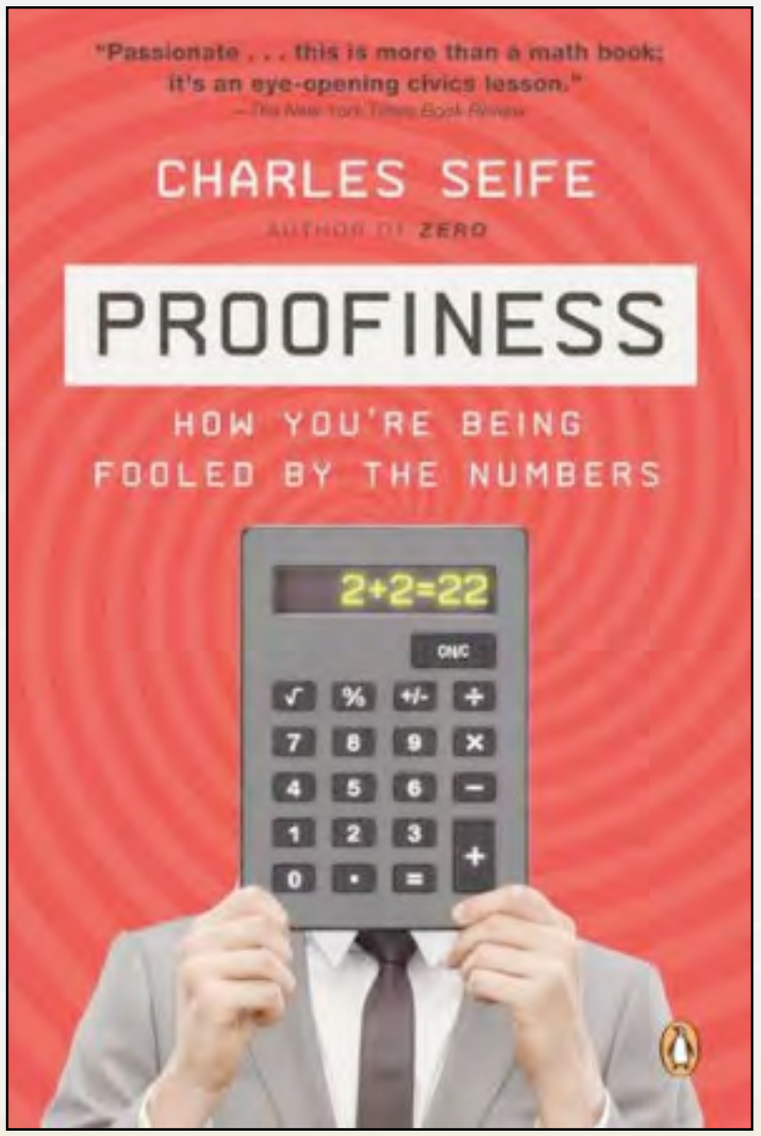

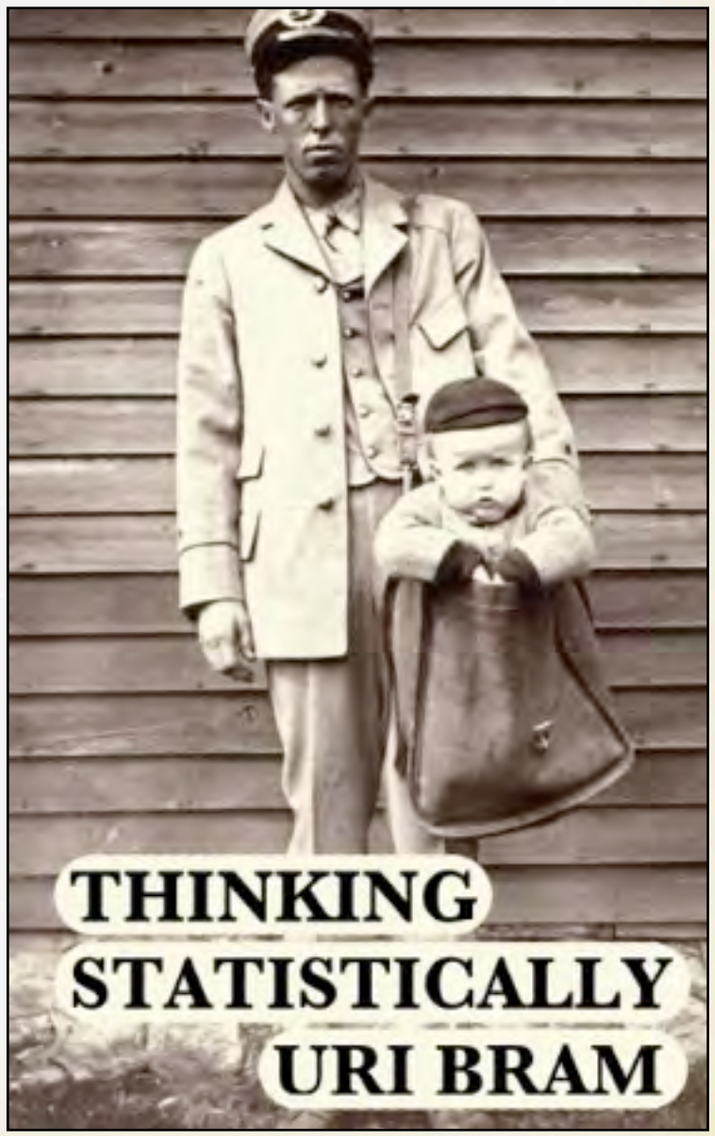

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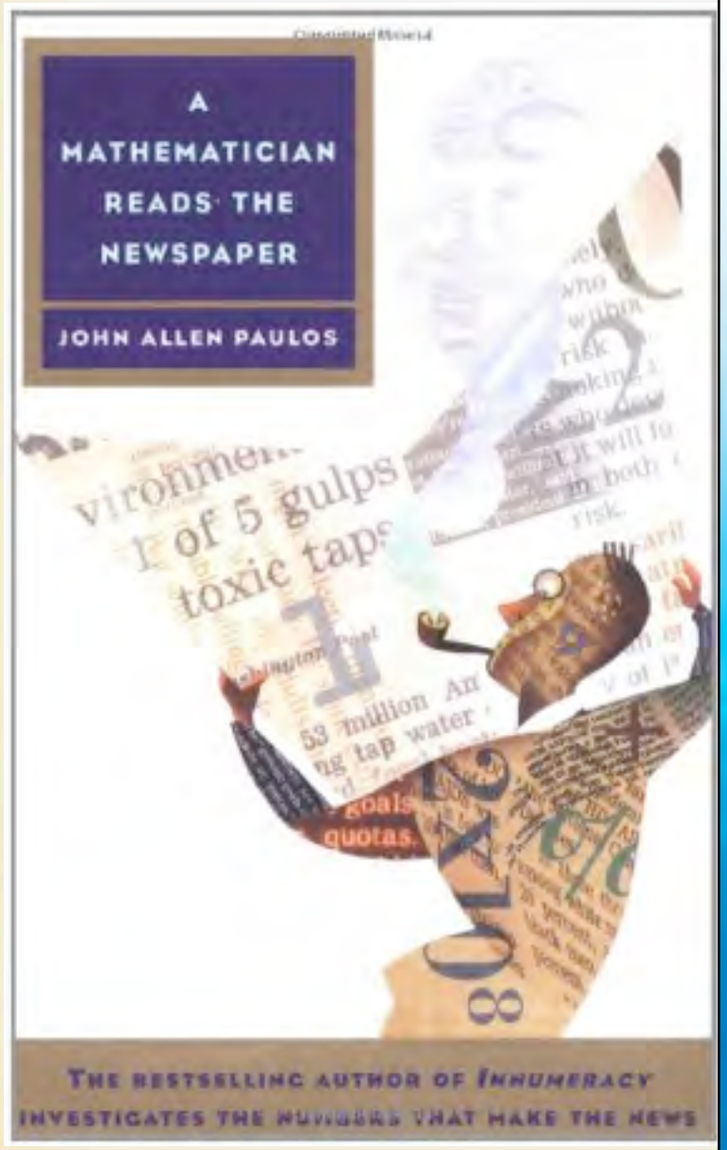
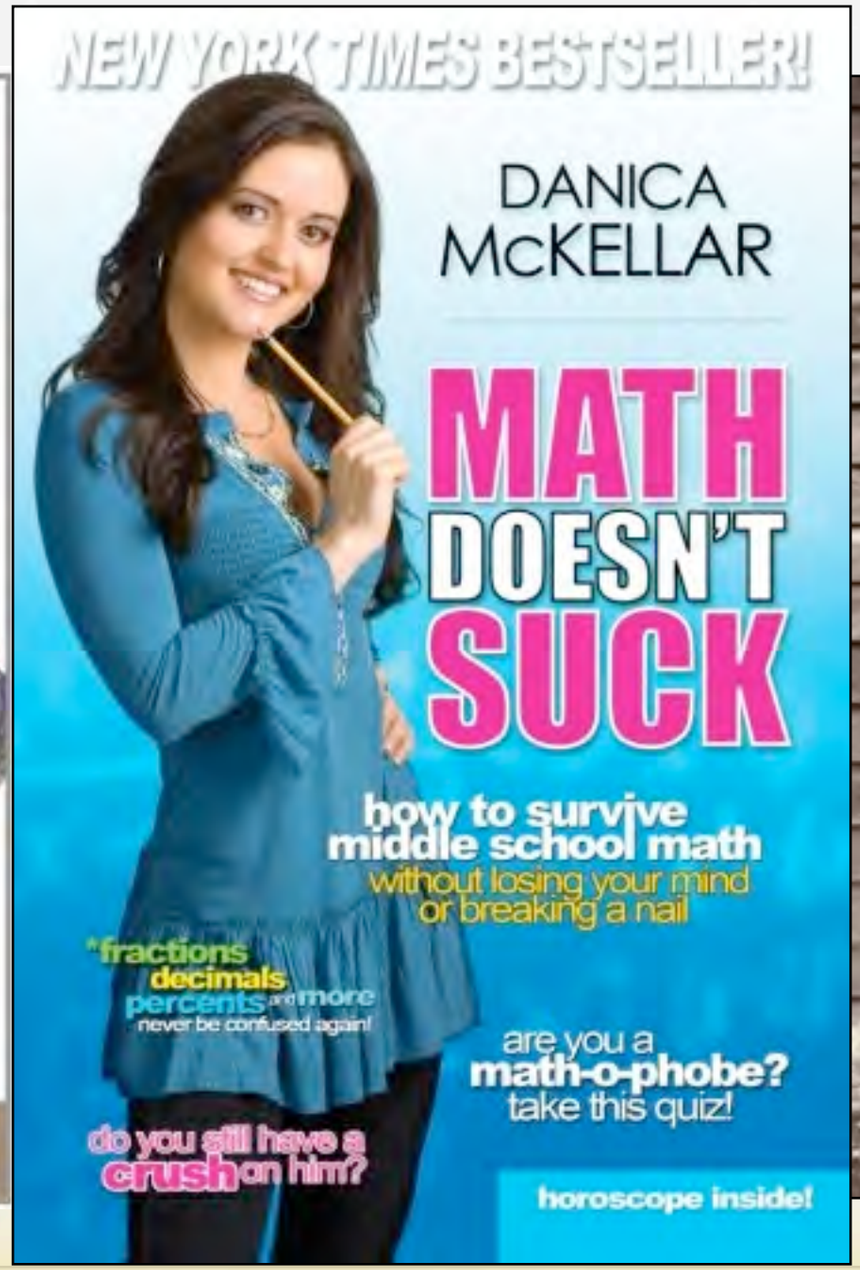
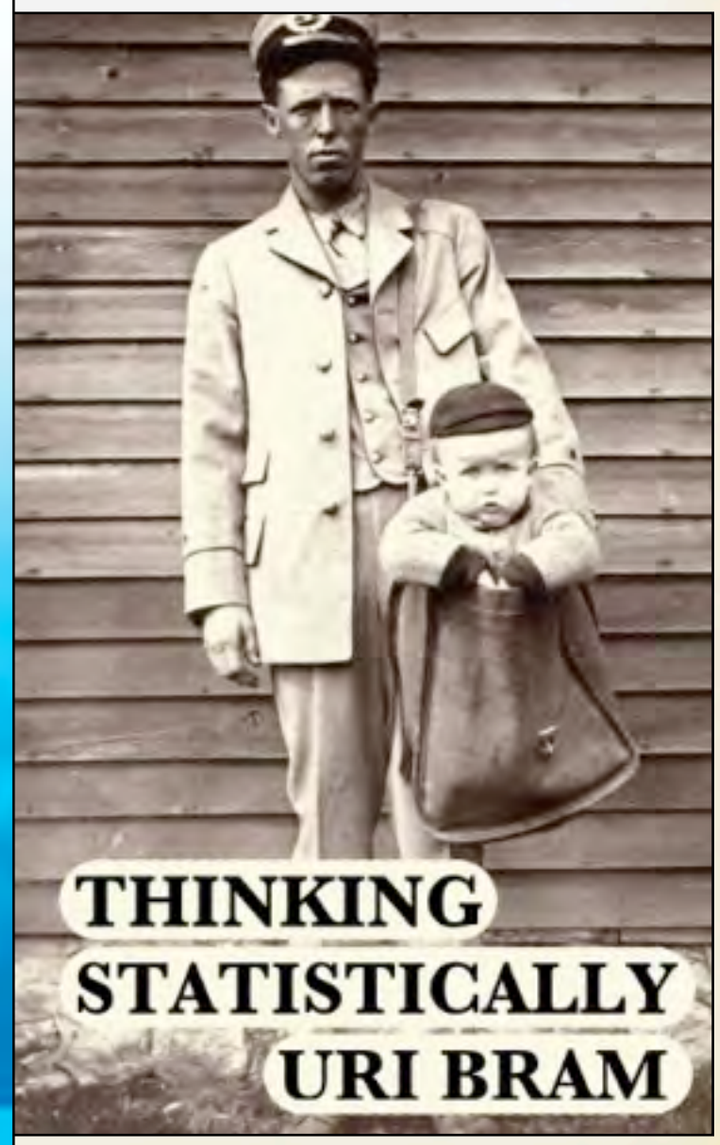






TRADITIONAL CT

- **Defense Against the Dark Arts:** Understanding argument & persuasion: **ChangingMinds.org**.

- **Software Patch 1.0:** Understanding fallacies and how to detect & avoid them: **Wikipedia** (List of Fallacies); **The Fallacy Files** (Taxonomy); Bo Bennett's ***Logically Fallacious***.

- **Logic 101:** "Syllogisms" at ChangingMinds.org (under "Argument") and Bennett's book.

IMPROVED CT

- **Software Patch 2.0:** Understanding the cognitive science of human reasoning, error, and belief-formation.

- *You need to control, correct, or compensate for your own cognitive biases, and learn to detect them in others.*

- **Updating Your Firmware:** Understanding Bayes' Theorem and how it underlies all sound thinking.

- *You need to know how to use Bayes' Theorem as a tool to improve your own reasoning and evaluate the reasoning of others.*

GETTING WITH COGNITIVE SCIENCE

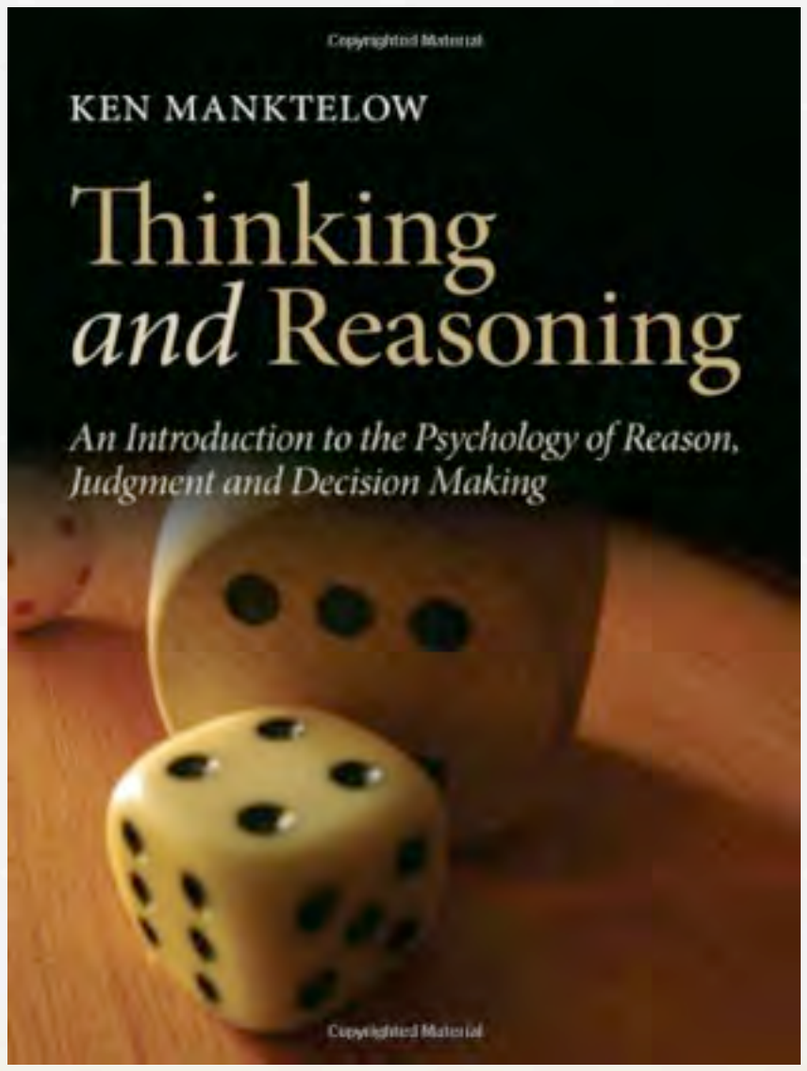
- **It's the 21st Century:** We now know how badly built our brains are for the purpose of reasoning.

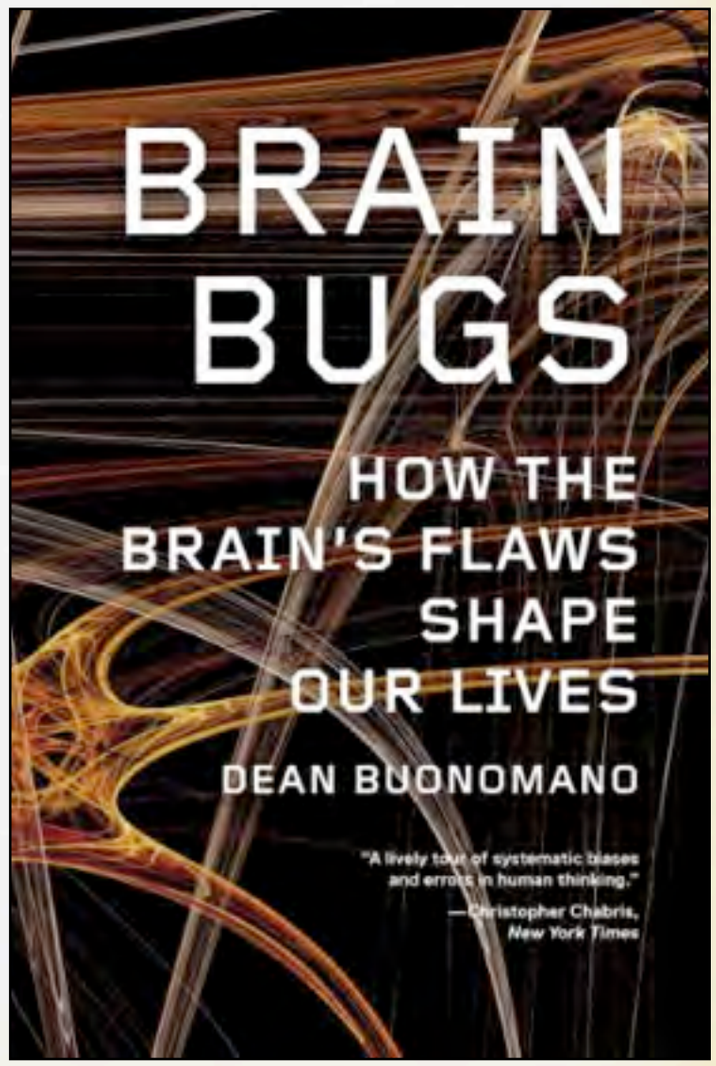
- Natural inborn tools of thought and cognition are clunky, ad hoc, prone to well-documented errors.

- You are as much subject to them as anyone else.

- Start with Wikipedia's **List of Cognitive Biases**.

INSTRUCTION MANUALS FOR YOUR BRAIN





THE FUTURE OF CT

- The Center for Applied Rationality (CFAR)
  Rationality.org

- **LessWrong.com** : "refining the art of human rationality"

EXAMPLES...

- Confirmation Bias
- Illusory Correlation / Agency Over-detection
- Expectation Bias
- Availability Heuristic (*and other errors in probability*)
- Backfire Effect
- vs. Bandwagon Effect & Persistent Cognitive Dissonance

PERSONALITY-BASED COGNITIVE ERROR

- Dogmatism
- Ambiguity Intolerance
- Uncertainty Avoidance
- Low Openness to Experience

THE "OVERT 5D" OF PERSONALITY

- **Openness to Experience** *[curiosity / exploration]*
- **Conscientiousness** *[discipline / carefulness]*
- **Extraversion** *[little effect on cognition]*
- **Agreeableness** *[compassion / cooperativeness]*
- **Neuroticism** *[emotionally reactive]*

BAYES' THEOREM

$$\mathbf{P}(h \mid e.b) = \frac{\mathbf{P}(h \mid b) \times \mathbf{P}(e \mid h.b)}{[\mathbf{P}(h \mid b) \times \mathbf{P}(e \mid h.b)] + [\mathbf{P}(\sim h \mid b) \times \mathbf{P}(e \mid \sim h.b)]}$$

The Probability of...

Your Theory [**H**] = [*add the above to...*] (How Typically is **H** True? X How Likely is the Evidence on **H**?) / (How Typically is **H** False? X How Likely is the Evidence Otherwise?)

The Probability of...

Your Theory [**H**] =

How Typically is **H** True? X How Likely is the Evidence on **H**?

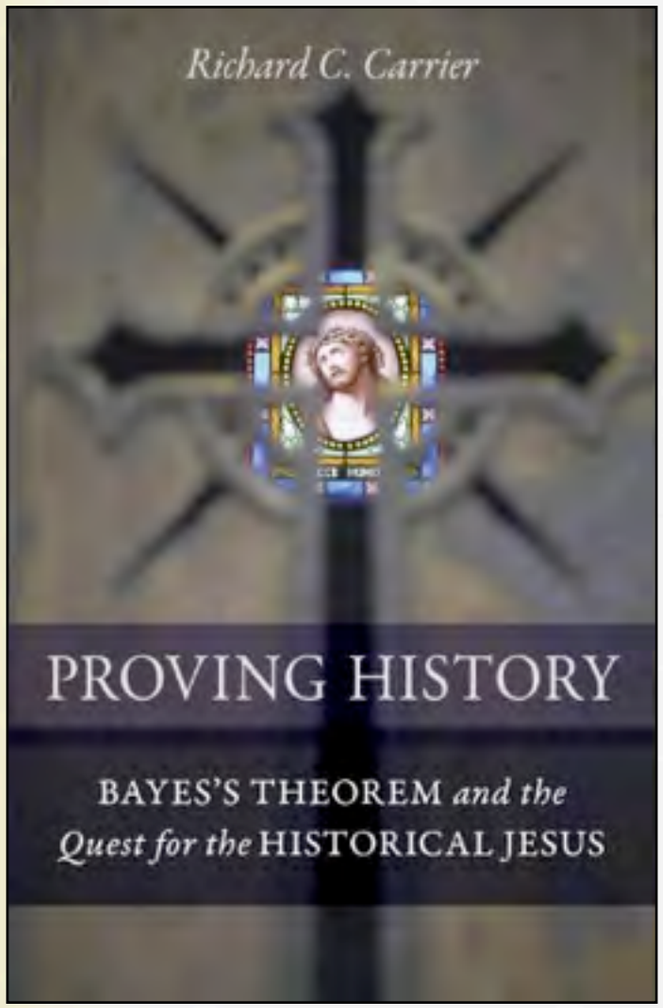
[*add the above to...*]

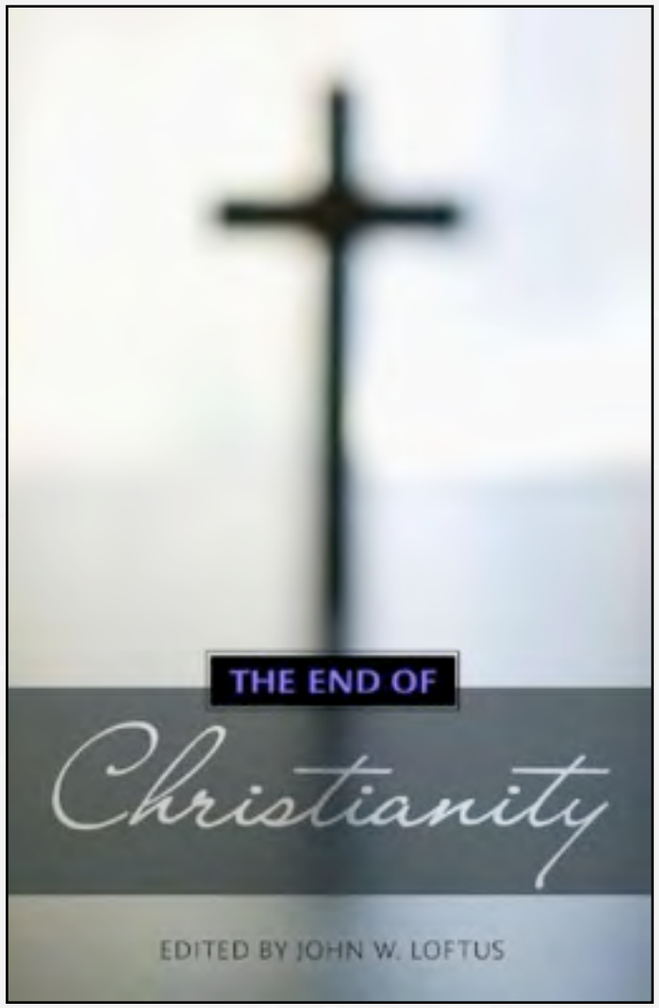
How Typically is **H** False? X How Likely is the Evidence Otherwise?

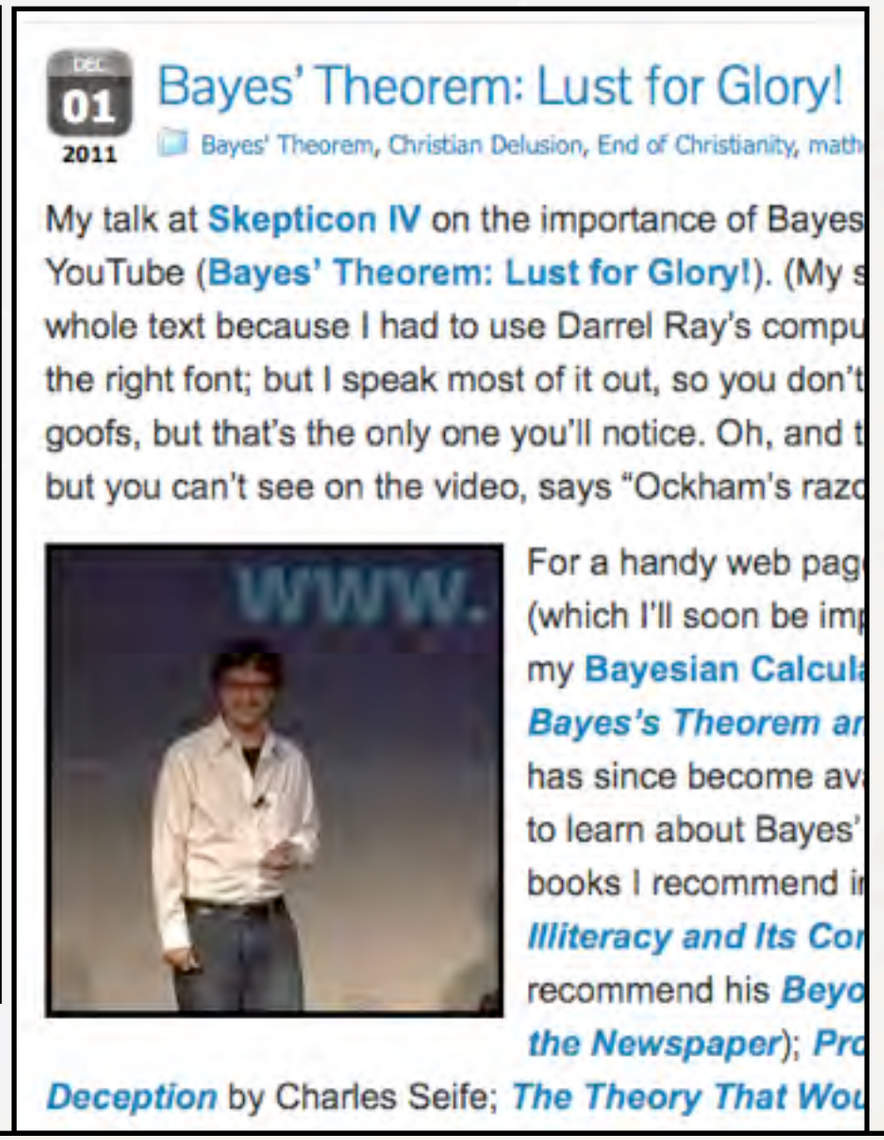
BAYES' THEOREM

- Mathematical model of all sound empirical reasoning
- ...whether you are aware of it or not
- ...whether you use it or not
- But the more aware of it you are / the more you use it correctly, the more reliable your reasoning will be
- **Deductively valid** formula for **inductive logic**

BAYESIAN REASONING







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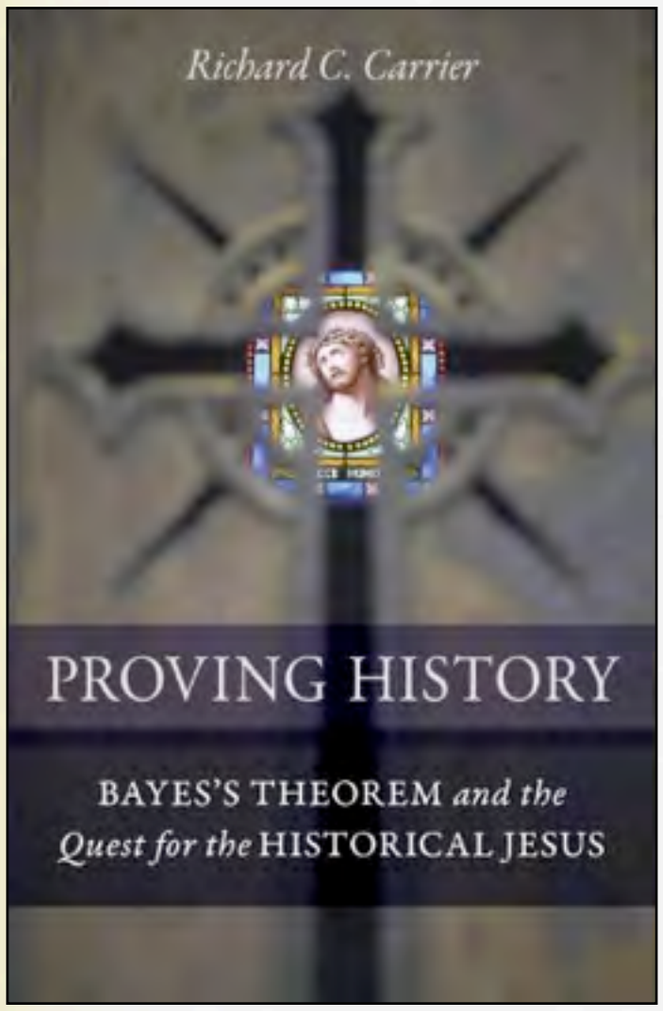
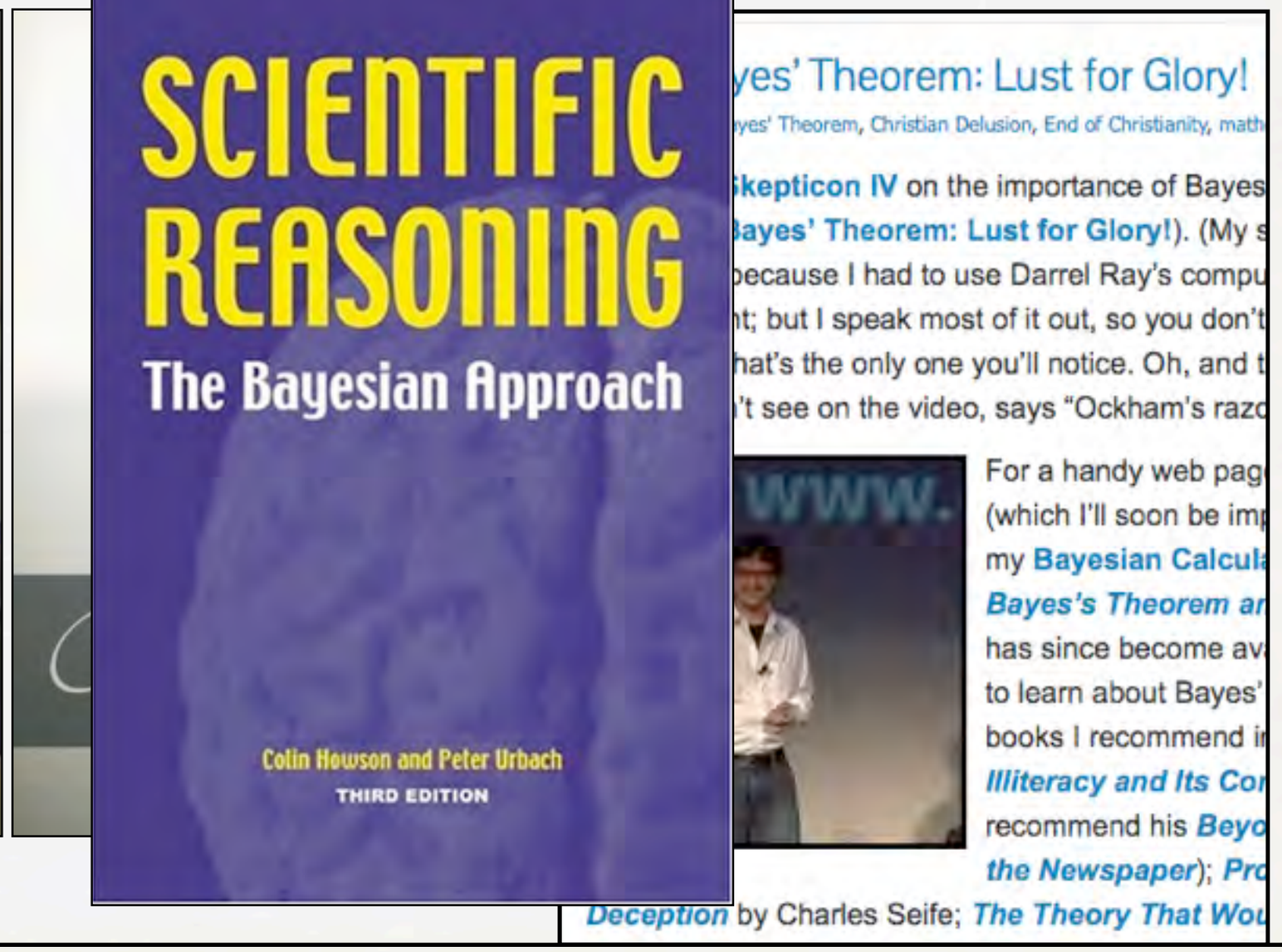
BAYESIAN REASONING

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PRIOR Probability

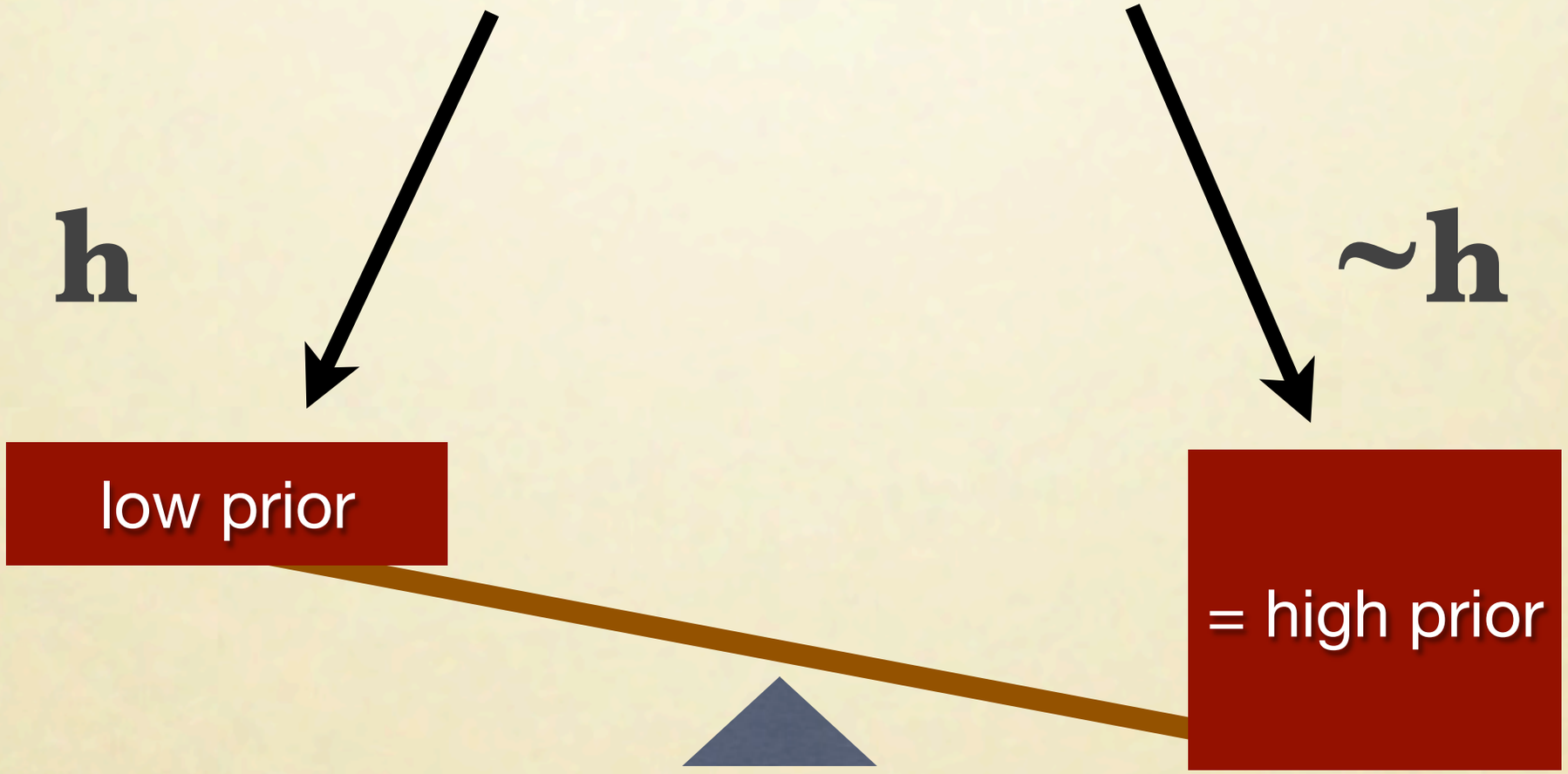
What has usually happened before?
(to cause the kind of evidence we have)

CONSEQUENT Probability

How expected is the evidence we have?
(if our claim is true, and if our claim is false)

AKA "Likelihood"

Unusual Claims Require **Unusual** Evidence



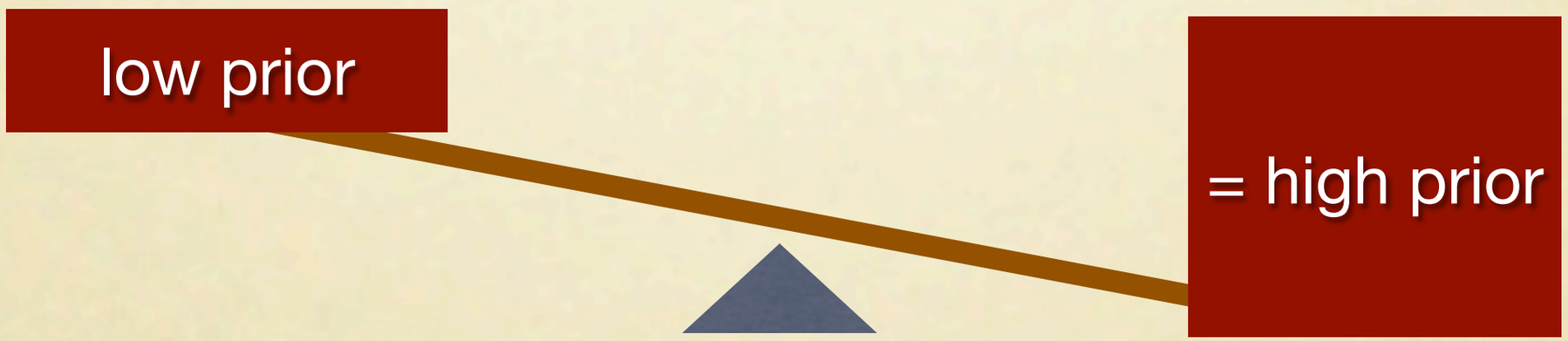
Unusual Claims Require **Unusual** Evidence

Evidence must be more likely on **h** than...

...it is on **~h**

h

~h



- What evidence would we normally expect to have for the claimed fact?
- ...and for the claimed phenomenon in general if it existed in general?
- Unexpected evidence is improbable evidence
- Improbable evidence = evidence **against**
- Evidence that's improbable on every *other* explanation = evidence **for** what's claimed

- W… …expect to h…

No evidence = Prior probability very low
Some = Prior is relative frequency

- …and for the claimed phenomenon in general if it existed in general?
- Unexpected evidence is improbable evidence
- Improbable evidence = evidence **against**
- Evidence that's improbable on every *other* explanation = evidence **for** what's claimed

So what evidence is expected if the claim is false?

Is it the evidence we have?

If not, how unlikely is the evidence we have if claim is false?

As unlikely as the claimed phenomenon is generally?

If not, then the claim is probably false.

PRIORS & LIKELIHOODS

- **Prior Probability Reflects**
  - all available background experience
  - all the past findings of science
- **Likelihood Ratio (Consequent Probabilities)**
  - how expected the evidence we have is
  - or how unexpected it is

ARGUMENT FROM SILENCE

- Is the absence of certain evidence **unexpected**?
- Unexpected = unusual = infrequent = **improbable**
- That means a low probability of the evidence.
- BT entails if that is low, then **prior probability** must be high or else **h** is probably false.
- As long as this absence of evidence is **expected** if **h** is false (i.e. high probability of the evidence on ~h).
- Prior probability can't be high if no proven examples.

ARGUMENT FROM SILENCE

- Is the absence of certain evidence **unexpected**?
- Un… …ble
- Th…
- BT… …must be…
- As… …**h** is fal…
- Prior probability can't be high if no proven examples.

Kooks & Quacks Intuitively Know This

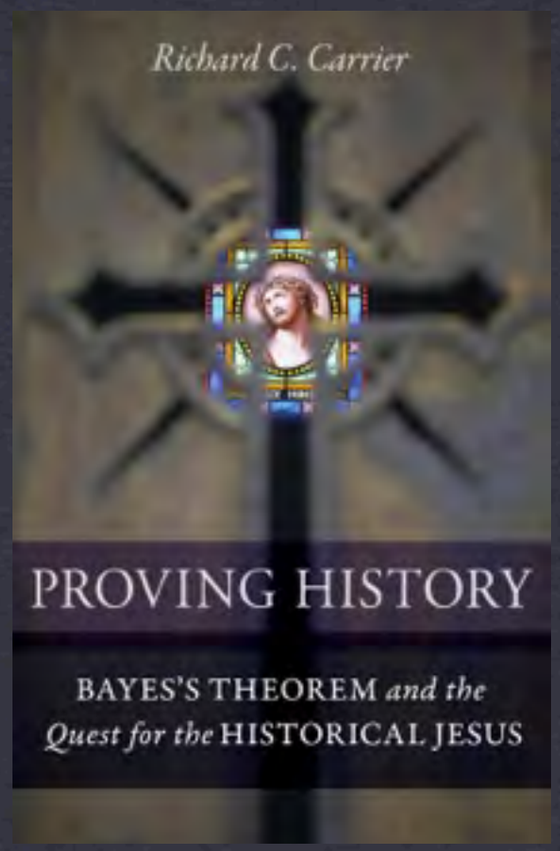
- That's why they try to make excuses for why the expected evidence isn't observed.
- But BT entails excuses that **aren't proven** actually **lower** the prior probability.

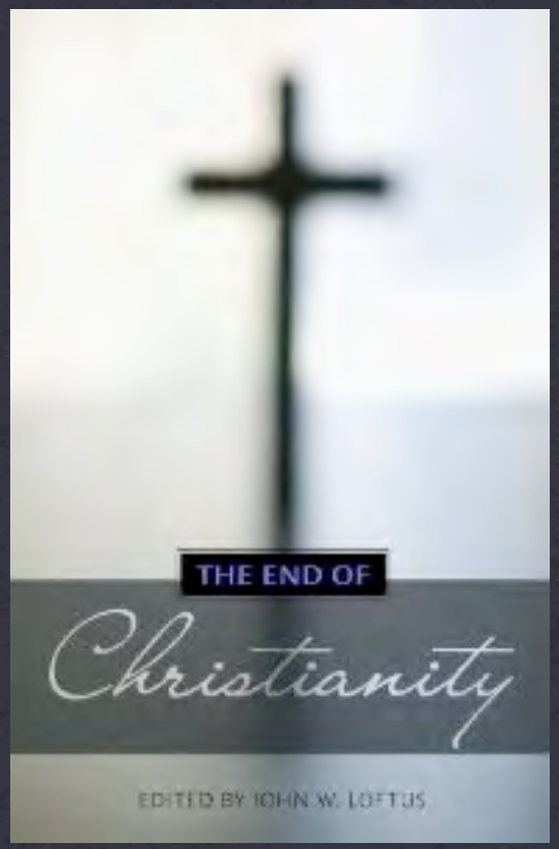
IT'S BAYES' THEOREM ALL THE WAY DOWN

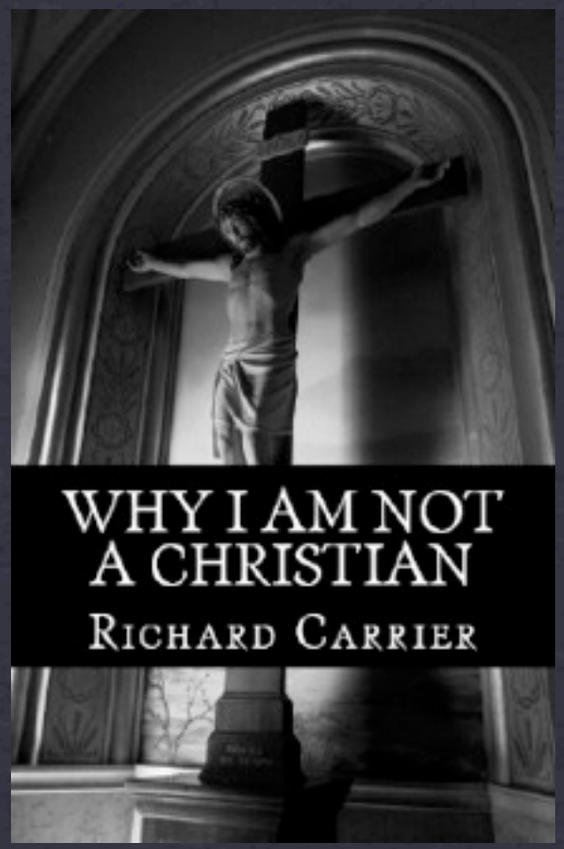
- Not only "Extraordinary Claims Require Extraordinary Evidence" and the Argument from Silence but also...
- The Hypothetico-Deductive Method (HDM)
- Inference to the Best Explanation (IBE)
- Ockham's Razor
- Etc.

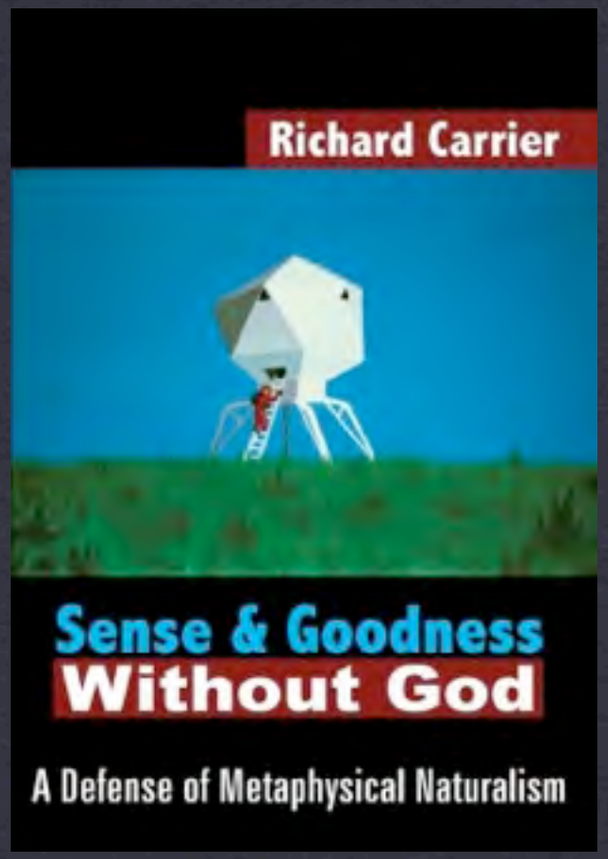
BAYESIAN REASONING

- Evidence expected even if **h** is false is not evidence for **h**.
- The more **improbable** the evidence is on any other explanation than **h**, the more **probable** it makes **h**.
- The more typically explanations like **h** turn out to be true, the more evidence you need against **h** to conclude it's false.
- The more typically explanations like **h** turn out to be false, the more evidence you need for **h** to conclude it's true.
- "More evidence" always means "evidence that's more improbable on any other explanation."









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