



CAUSALITY

Timothy L. Lash

Rollins School of Public Health

Emory University



Four stem questions

- How is causality determined?
- Challenges to interpretation?
- Impact of confounders?
- How much could bias explain observations?

Four stem questions

- How is causality determined?
 - *It can't be*
- Challenges to interpretation?
 - *More on this later*
- Impact of confounders?
 - *All to none*
- How much could bias explain observations?
 - *All to none*

Six ways for X to be associated with Y

- Causation
- Reverse causation
- Chance
- Confounding
- Selection bias
- Information bias

Six ways for X to be associated with Y

- Causation
- Reverse causation
- Chance
- Confounding
- Selection bias
- Information bias

Reduce the potential for these five to explain $X \rightarrow Y$ by design and analysis

Confounding by Indication



Journal of Clinical Epidemiology 63 (2010) 64–74

**Journal of
Clinical
Epidemiology**

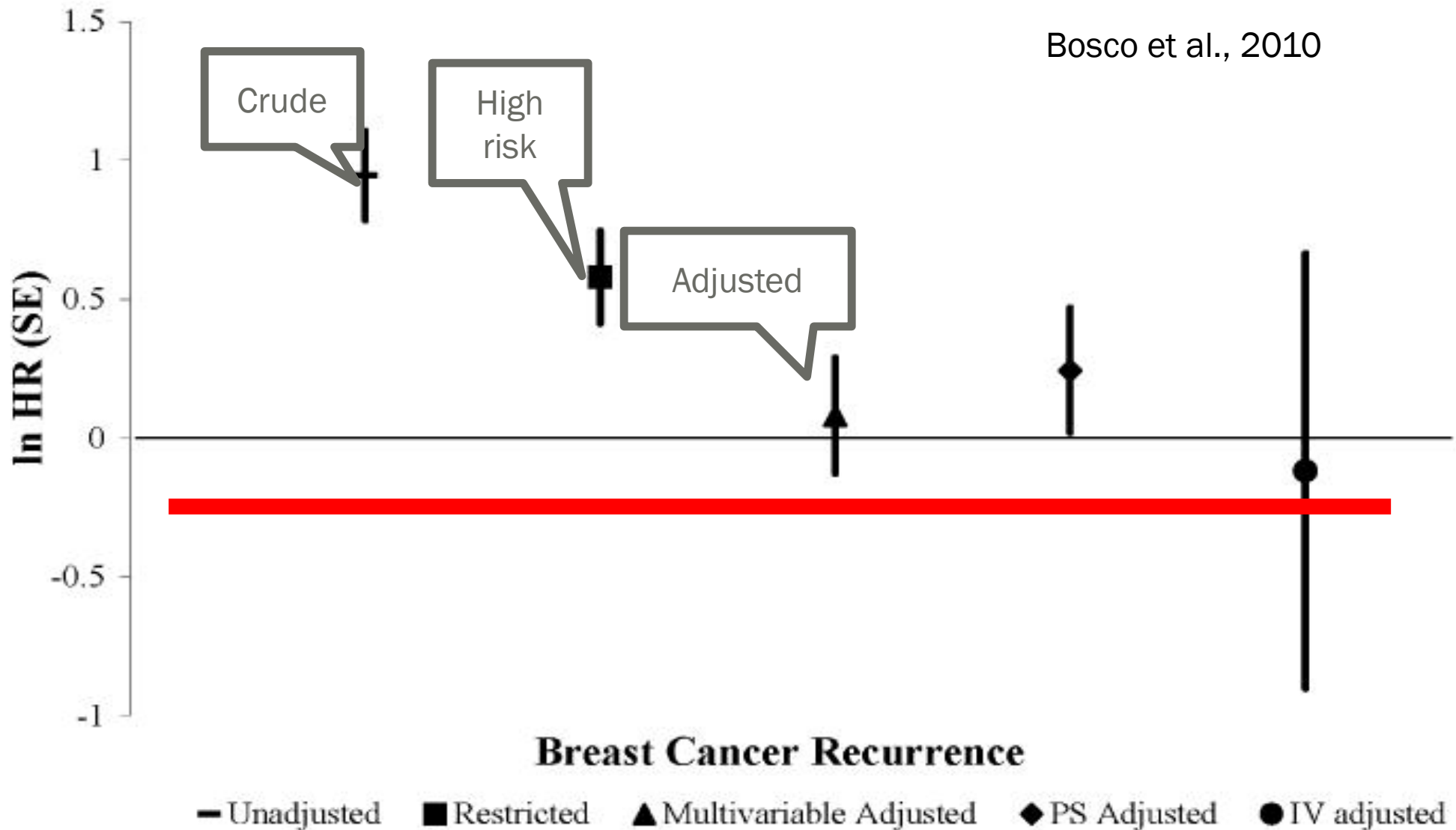
**A most stubborn bias: no adjustment method fully resolves
confounding by indication in observational studies**

Jaclyn L.F. Bosco^{a,b,*}, Rebecca A. Silliman^{a,b}, Soe Soe Thwin^a, Ann M. Geiger^c,
Diana S.M. Buist^d, Marianne N. Prout^b, Marianne Ulcickas Yood^e,
Reina Haque^f, Feifei Wei^g, Timothy L. Lash^{a,b}

Confounding by Indication

Characteristic	Cohort* (n=1798)			
	Chemo		No Chemo	
	N	%	N	%
Node positivity				
None	43	26	1308	80
1 to 3 nodes	64	38	262	16
4+ nodes	60	36	62	3.8
Not determined	1	0.6	336	21

Confounding by Indication



Overview of causal interpretation

■ Models of causation

- *Causal web*
- *Potential outcomes*
- *Exchangeability*
- *Causal graphs*
- *Sufficient component cause*
- *etc*

■ Inferential paradigms

- *Criteria (e.g., Hill's)*
- *Refutationist*
- *Bayesian*
- *Best explanation*
- *Precautionary principle*
- *etc*

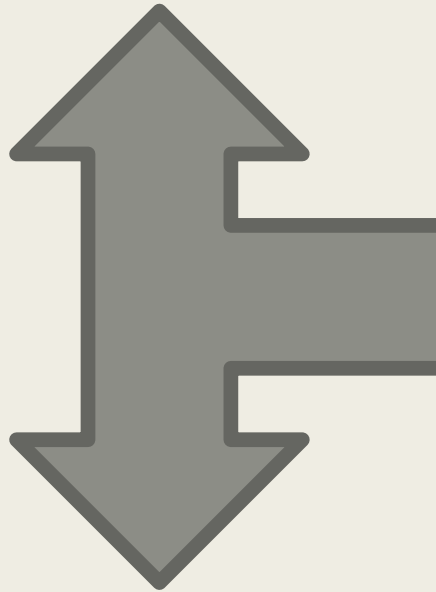
Models of
causation



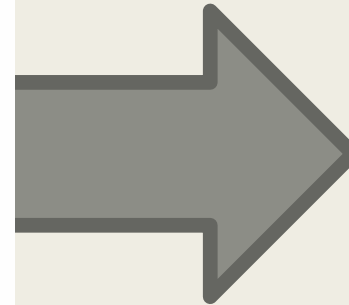
Inferential
paradigms

Causal
interpretation

Models of
causation

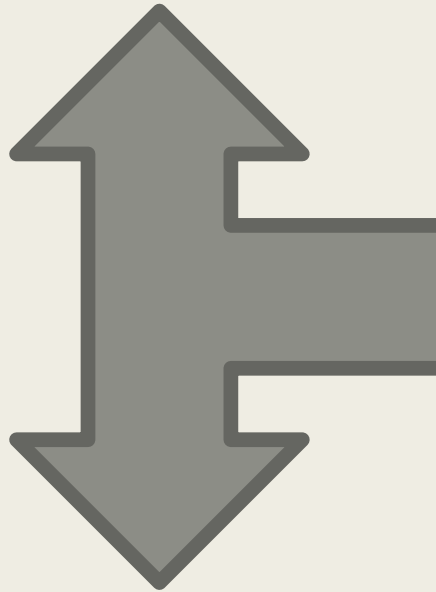


Inferential
paradigms

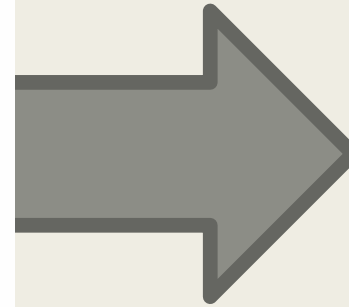


Causal
interpretation

Models of
causation



Inferential
paradigms



Causal
interpretation

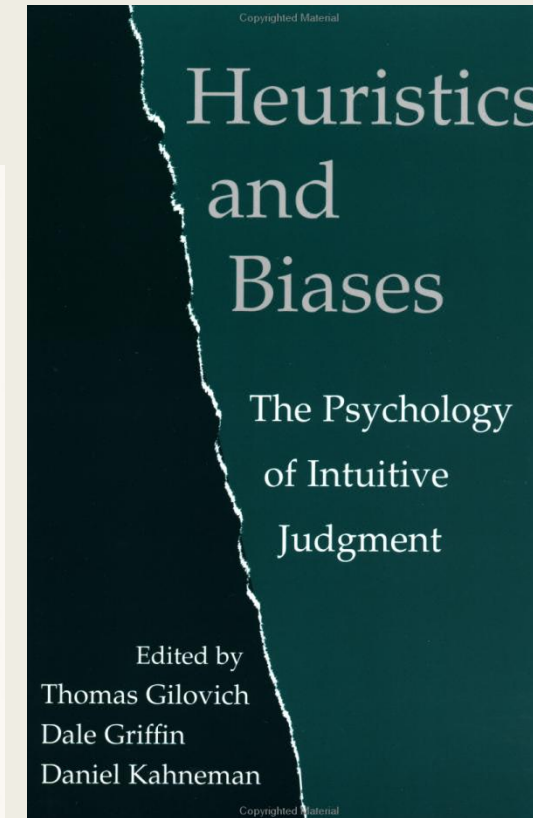
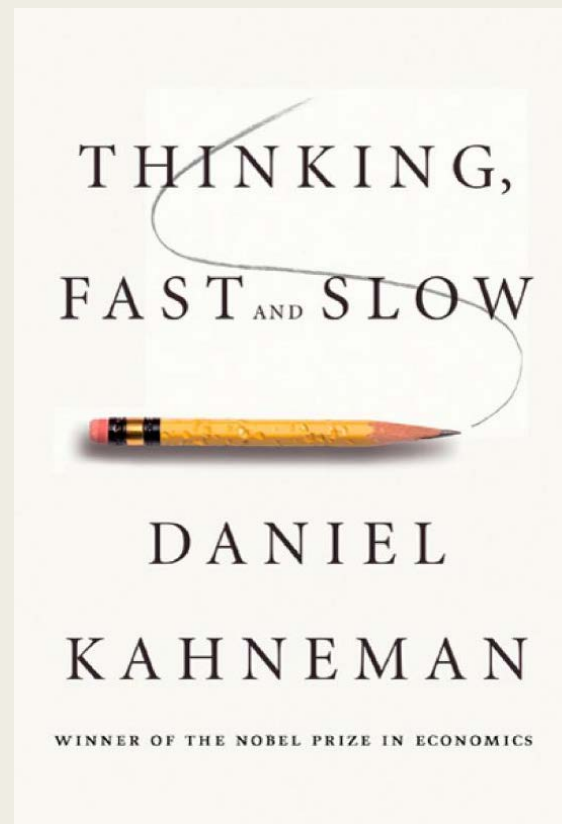
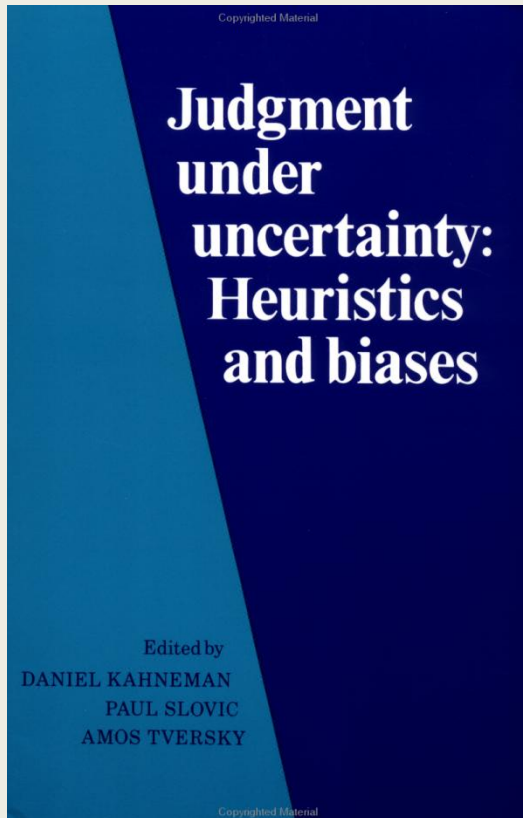
Challenges to
interpretation

Overconfidence

Cognitive dissonance

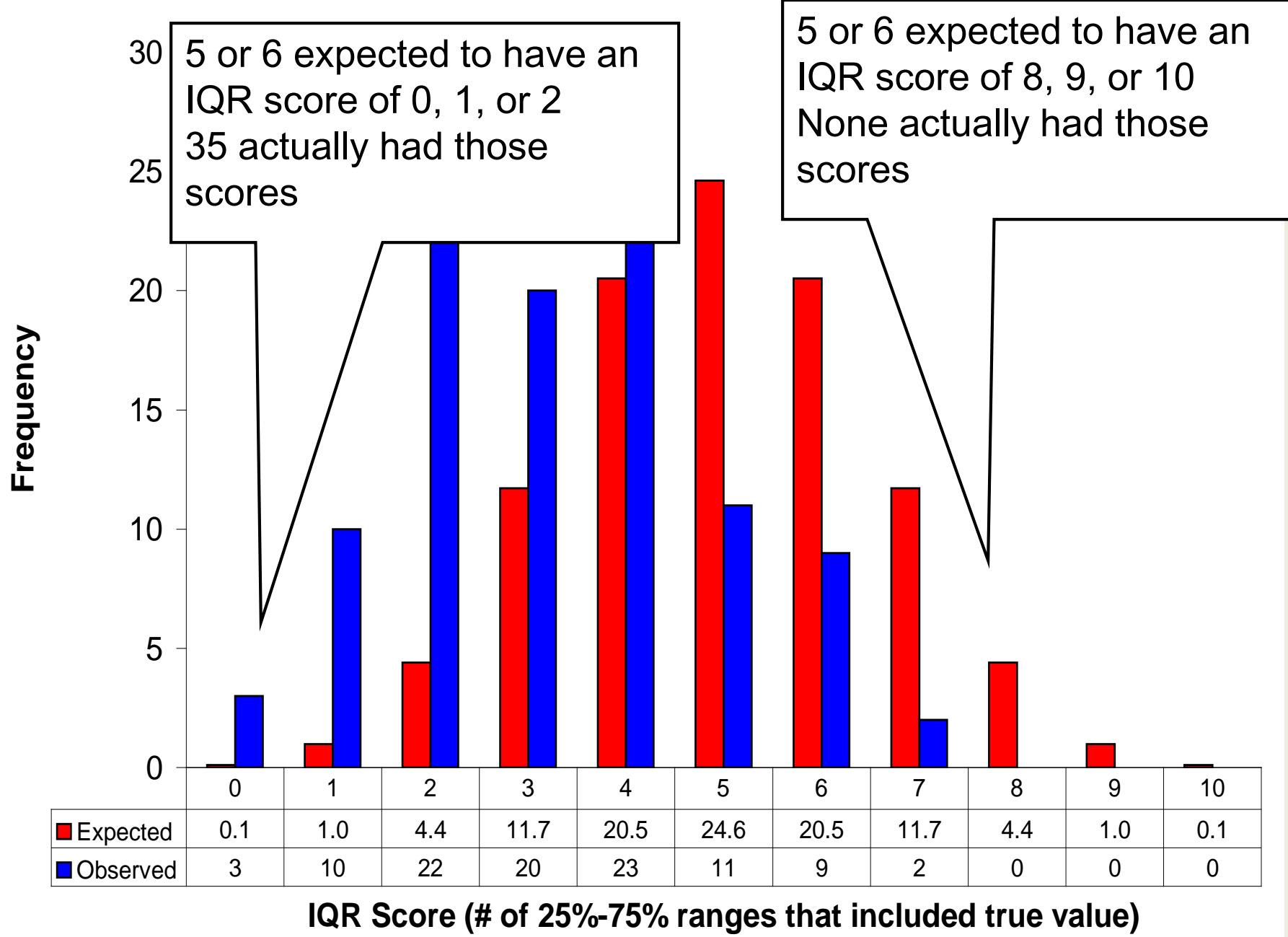
Conflicts of interest

Reasoning under uncertainty: heuristics and biases



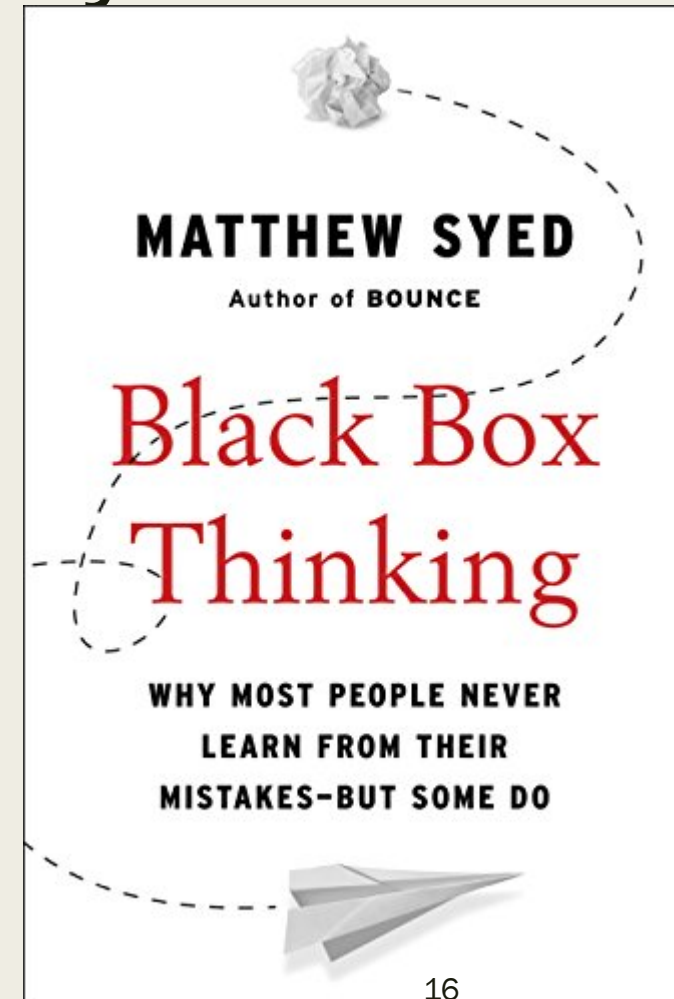
Overconfidence—we overestimate our certainty

- Experiment—Ask 100 students to give numeric estimates for 10 uncertain quantities. For each estimate give 25%, 50%, 75%.
- For a well calibrated estimator, truth should fall inside the IQR (25%–75%) as often as outside.
- IQR score equals the number (of 10) for which truth fell in the IQR (expect 5).



Cognitive dissonance—admitting to mistakes threatens our identity

- Progress depends on willingness to learn from failure
- Reframing mistakes to preserve identity destroys the opportunity
- We seldom realize that we are doing it
- Ambiguity of failures heightens the potential





REVIEWS AND COMMENTARY

When Genius Errs: R. A. Fisher and the Lung Cancer Controversy

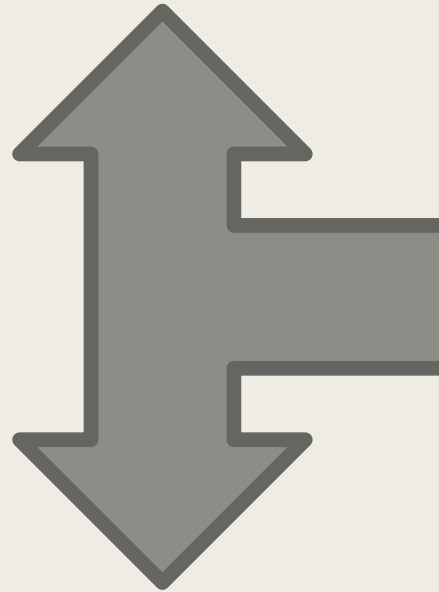
Paul D. Stolley

R. A. Fisher's work on lung cancer and smoking is critically reviewed. The controversy is placed in the context of his career and personality. Although Fisher made invaluable contributions to the field of statistics, his analysis of the causal association between lung cancer and smoking was flawed by an unwillingness to examine the entire body of data available and prematurely drawn conclusions. His views may also have been influenced by personal and professional conflicts, by his work as a consultant to the tobacco industry, and by the fact that he was himself a smoker. *Am J Epidemiol* 1991; 133:416-25.

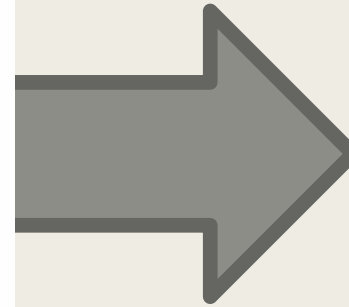
Common elements of biases and heuristics

- General \Rightarrow majority of humans.
- Systematic \Rightarrow tendency always in the same direction.
- Independent of intelligence and education \Rightarrow experts make the same mistakes as novices with only slightly harder problems.
- In fact, accuracy increases with expertise, but overconfidence increases faster.

Models of
causation



Inferential
paradigms



Causal
interpretation

Challenges to
interpretation

- Overconfidence
- Cognitive dissonance
- Conflicts of interest