

# Confounding Issues: Why do Birds Fly South?

*Data exist to show a relationship between temperature and bird population density: population decreases as temperature decreases.*

Quotation from *TAKING SIDES: Clashing Views in Science and Technology*

- What are other possible underlying variables/confounding issues here?
- What makes good experiments on this issue difficult?

# Correlation versus Causation: Why do Birds Fly South?

*no experiment has conclusively established that temperature is a causative factor of bird migration. If sufficiently controlled experiments could rule out alternative hypotheses, the cause/effect statement could be made. As it is, a simple correlation (statement of coincidence) is all that remains.*

Quotation from *TAKING SIDES: Clashing Views in Science and Technology*



<http://www.seppo.net/cartoons/displayimage.php?&pid=802>



# Marijuana and Cognition?

Studies have found that college students who used marijuana regularly had impaired skills related to attention, memory, and learning 24 hours after the last use. What are some confounding issues?

## *When are We Convinced?*



<https://efherne.wordpress.com/2012/09/08/countdown-to-disorder/seek-truth-final/>

💡 Does **smoking** cause cancer?

## When are We Convinced?

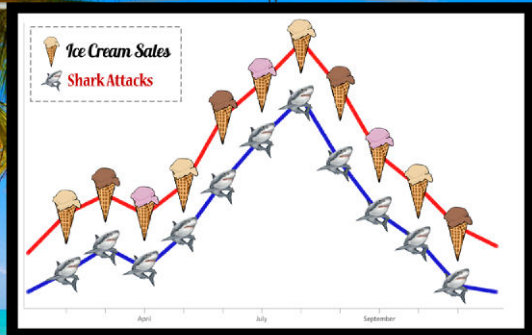


<https://efherne.wordpress.com/2012/09/08/countdown-to-disorder/seek-truth-final/>

- 💡 Does **smoking** cause cancer?
- 💡 Does **cell phone use** cause cancer?
  - contested assumptions and intellectual debates across the globe
  - analyze a single issue from multiple perspectives

*Such tests can, and should, remind us of the effects that the play of chance can create... Beyond that they contribute nothing to the proof of our hypothesis. [Bradford Hill]*

Correlation is not Causation

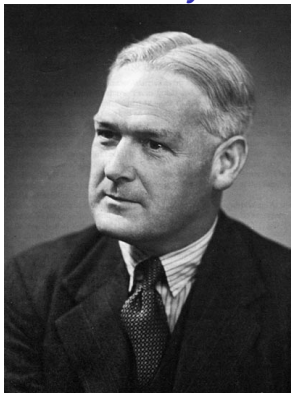


**WARNING!**

Restricting the number of ice creams sold reduces the likelihood of shark attack.

<http://onlineinsider.tumblr.com/post/7351752849/correlation-is-not-causation>  
[http://news.bbc.co.uk/2/hi/uk\\_news/magazine/7592579.stm](http://news.bbc.co.uk/2/hi/uk_news/magazine/7592579.stm)

## *Reasonable Certainty without Proof?*



Austin Bradford Hill (1897-1991)

1965 formalised methodology for clinical trials via 9 criteria

Bradford Hill Criteria/ Hill's criteria for causation

"The Environment and Disease: Association or Causation?"

*Proceedings of the Royal Society of Medicine*, 58, 295–30

## *Strength, Consistency and Biological Gradient*

Strength of the association, including diverse studies. Does increased exposure result in a greater response?

*The death rate from cancer of the lung in cigarette smokers is nine to ten times the rate in non-smokers and the rate in heavy cigarette smokers is twenty to thirty times* [Bradford Hill]

*the Advisory Committee to the Surgeon General... found the association of smoking with cancer of the lung in 29 retrospective and 7 prospective inquiries... The lesson here is that broadly the same answer has been reached in quite a wide variety of situations and techniques* [Bradford Hill]

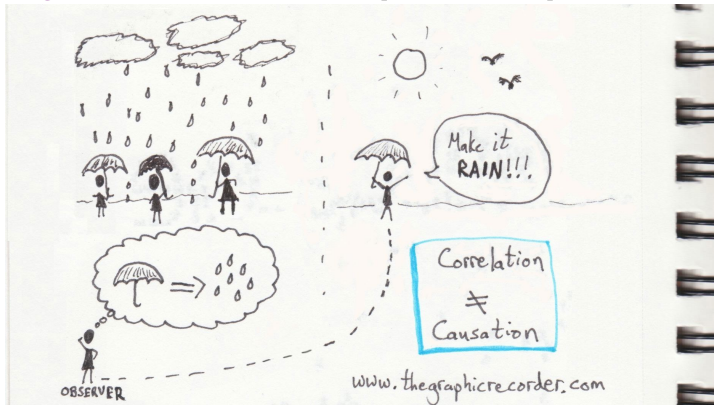
*the death rate from cancer of the lung rises linearly with the number of cigarettes smoked daily* [Bradford Hill]



## Specificity and Temporality

Other likely explanations? Does the effect occur afterward?

*investigations ... have been criticized ... But... If other causes of death are raised 10, 20 or even 50% in smokers whereas cancer of the lung is raised 900–1000% we have specificity... in the magnitude of the association [Bradford Hill]*



## *Plausibility, Coherence and Analogy*

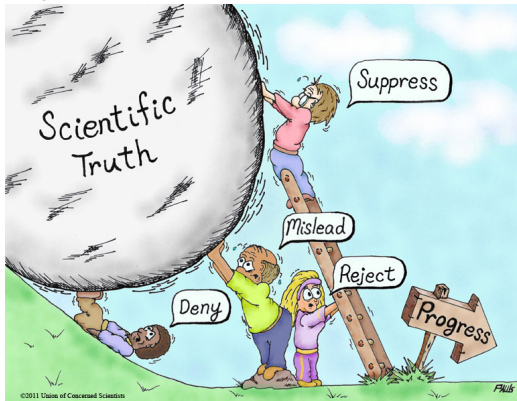
Make sense? Conflict with current knowledge? Or tie-in with similar associations?

[Bradford Hill] *association with cigarette smoking [is] coherent with the temporal rise that has taken place... over the last generation and with the sex difference in mortality...*

[Bradford Hill] *With the effects of thalidomide... before us we would surely be ready to accept slighter but similar evidence*

# Experiments

[Bradford Hill] *Occasionally it is possible to appeal to experimental, or semi-experimental, evidence. For example, because of an observed association, some preventative action is taken... Here the strongest support for the causation hypothesis may be revealed.*

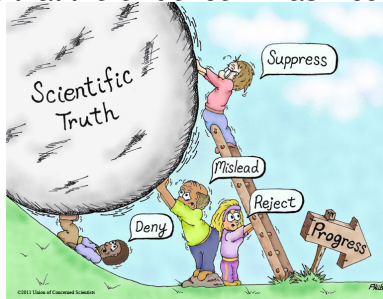


©2011 Union of Concerned Scientists

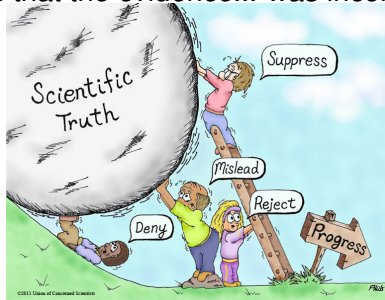
PAUL



*In 1994, heads of the major U.S. tobacco companies testified before Congress that the evidence... was inconclusive...*

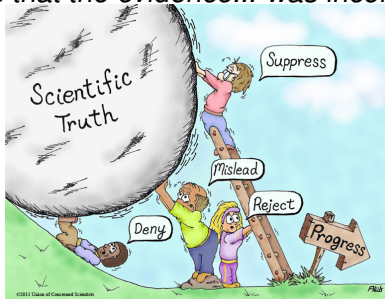


*In 1994, heads of the major U.S. tobacco companies testified before Congress that the evidence... was inconclusive...*



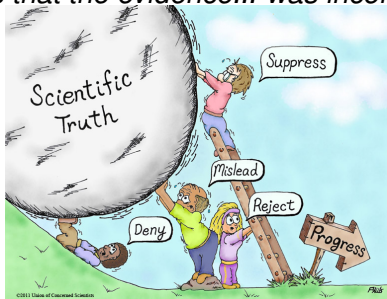
*Less than 1 month after... a box containing confidential documents... [with]*

*In 1994, heads of the major U.S. tobacco companies testified before Congress that the evidence... was inconclusive...*



*Less than 1 month after... a box containing confidential documents... [with] evidence that the tobacco industry had for decades known and accepted the fact that cigarettes caused premature death... [and worse they]*

*In 1994, heads of the major U.S. tobacco companies testified before Congress that the evidence... was inconclusive...*



*Less than 1 month after... a box containing confidential documents... [with] evidence that the tobacco industry had for decades known and accepted the fact that cigarettes caused premature death... [and worse they] helped manufacture the smoking controversy by funding scientific research that was intended to obfuscate and prolong the debate about smoking and health. ["The cigarette controversy" by Cummings KM, A Brown & R. O'Connor. *Cancer Epidemiol Biomarkers Prev.* 2007 Jun 16(6):1070–6]*

# Direct DNA Evidence

## Science News

*from research organizations*

### Smoking a pack a day for a year causes 150 mutations in lung cells

Genetic damage caused by smoking measured in different organs of the body

*Date:* November 3, 2016

*Source:* Wellcome Trust Sanger Institute

*Summary:* Scientists have measured the catastrophic genetic damage caused by smoking in different organs of the body and identified several different mechanisms by which tobacco smoking causes mutations in DNA. Researchers found smokers accumulated an average of 150 extra mutations in every lung cell for each year of smoking one packet of cigarettes a day.

<https://www.sciencedaily.com/releases/2016/11/161103140559.htm>



## *Local to Global Connections*

*Seeing the local to global connections were really cool and usually surprising in one way or another.*

*Comparing local math and global math was interesting because you could compare something small and seemingly insignificant to something that can change the world.*

- local regions—global regions
- statistics and probability from here and abroad

Review and write down a few local to global connections from our statistics and probability segment.

## *Role of chance, probability and truth*

...helped bring mathematics into a more tangible thought process for me and gave further insight to how conceptual ideas connect to the world around us and our personal lives.

- quantitative measure of the likelihood of an event
- mathematical foundation of common sense and judgment
- 0 to 1 (or 0% to 100%)
- law of large numbers
- experimental error provides an estimate of the inherent uncertainty associated with experimental procedures
- The probability of event E occurring =  $\frac{\text{number of different outcomes in E}}{\text{total number of equally likely outcomes}}$
- probability that an event will happen = 1 - it won't
- independent events have probabilities that multiply
- expected value—weighted average of probabilities
- x% confidence interval gives likelihood of obtaining true population response within a range of margin of error

## *Ways that people succeed in and impact mathematics*

*The diverse ways people succeed in mathematics theme was interesting for me because it actually put a face to math and showed me that you don't have to be genius to impact mathematics.*

Review and write down a few people and their impacts from our statistics and probability segment.

## *Ways that people succeed in and impact mathematics*

*The diverse ways people succeed in mathematics theme was interesting for me because it actually put a face to math and showed me that you don't have to be genius to impact mathematics.*

Review and write down a few people and their impacts from our statistics and probability segment.

David Blackwell, Florence Nightingale, George Gallup, Nate Silver, Leonardo da Vinci, Ronald Fisher, Austin Bradford Hill, psychics/stock wiz...

# *What mathematics is, has to offer, and how it is useful*

*I always found the question what is mathematics very interesting.*

Review and write down a few ideas relating to what mathematics is and has to offer from our statistics and probability segment.

I care about you and your success!



Write down as many items, scenarios, equations, visualizations, and more that we covered and are related to each of the following (i.e. use these as a way to review what we covered):



Problem solving at the heart of mathematics: visualization, generalization, making decisions