How Basic Statistical Literacy Can Save You Money and Maybe Even Save Your Life!

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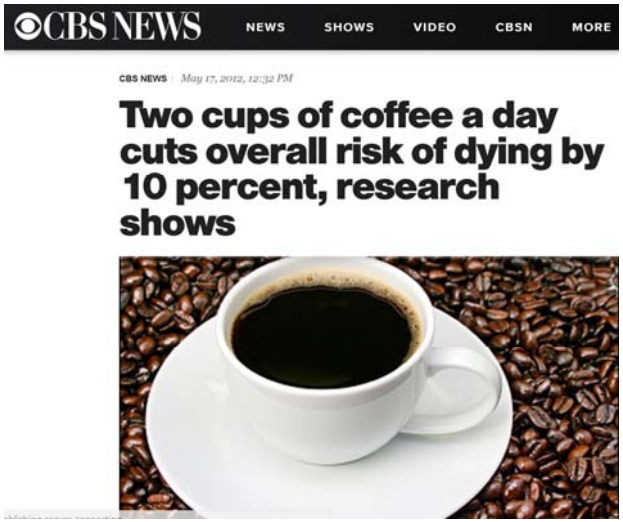
From My Abstract…

- A headline proclaims that coffee lovers live longer. Should you start drinking coffee?
- You test positive for a disease. How likely is it that you actually have the disease?
- Are there ways to increase your chance of winning the lottery?
- Should you buy an extended warranty?
- Should you pay the advance purchase, non-refundable cost for a hotel room, or wait and pay more when you arrive?

All of these are questions that can be answered with a little understanding of statistics and probability. This talk will discuss these and other examples of how statistics and probability permeate our lives, and how a little knowledge can help us make better decisions.

Do coffee lovers live longer?



Or does coffee trigger heart attacks?

HEART DISEASE HOME

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Coffee May Trigger Heart Attack

Attacks After Single Cup, Light Drinkers Most at Risk

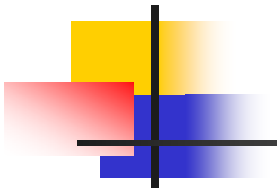
FROM THE WEBMD ARCHIVES

Aug. 15, 2006 -- That cup of coffee you're craving might not be such a good idea.

Research in the September issue of *Epidemiology* suggests coffee can trigger a heart attack within an hour in some people.

What do you think of these (real) headlines?

- 6 cups a day? Coffee lovers less likely to die, study finds
- Oranges, grapefruits lower women's stroke risk
- Yogurt reduces high blood pressure, says a new study
- Breakfast cereals prevent overweight in children
- Joining a choir boosts immunity
- Walk faster and you just might live longer
  - Researchers find that walking speed can help predict longevity
  - The numbers were especially accurate for those older than 75

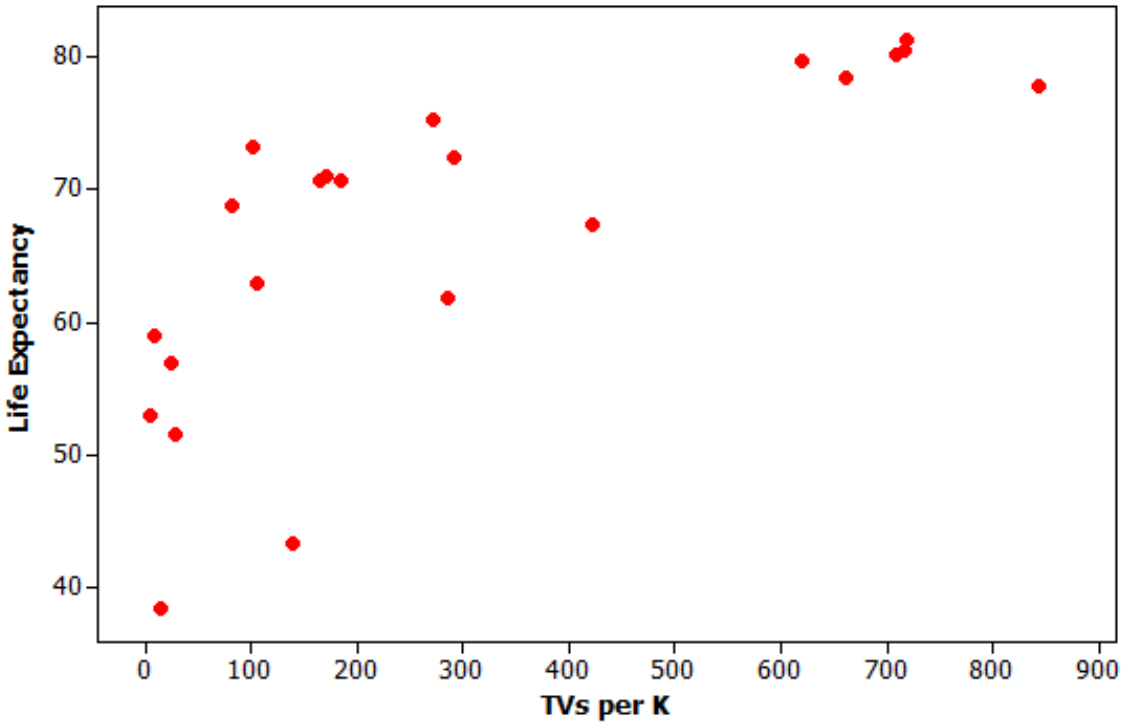


Notice that almost all imply *causal* connection!

- 6 cups a day? Coffee lovers less likely to die, study finds
- Oranges, grapefruits lower women's stroke risk
- Yogurt reduces high blood pressure, says a new study
- Breakfast cereals prevent overweight in children
- Joining a choir boosts immunity
- Walk faster and you just might live longer
  - Researchers find that walking speed can help predict longevity
  - The numbers were especially accurate for those older than 75

Correlation does not imply causation!

Televisions and life expectancy across countries (from Allan Rossman)



Cause and effect?

- There appears to be a relationship between number of televisions (per thousand people) in a country and life expectancy of the country
- Would you conclude that sending more TVs to Bangladesh would cause people there to live longer?
- Can you suggest a “confounding variable” that might be *related* to number of TVs, and also *affect* life expectancy?
- Is it reasonable to draw a cause-and-effect conclusion after observing a strong association between two variables?

When can cause and effect be concluded?

Randomized experiment

Researchers:

- ***Create*** differences in groups
- *Observe* differences in response

Example:

Randomly assign post-menopausal women to take hormones or not, observe and compare heart disease rates

Observational study

Researchers:

- ***Observe*** differences in groups
- *Observe* differences in response

Example:

Ask women if they take hormones or not, observe and compare heart disease rates

Example of an observational study: Yogurt reduces high blood pressure, says a new study

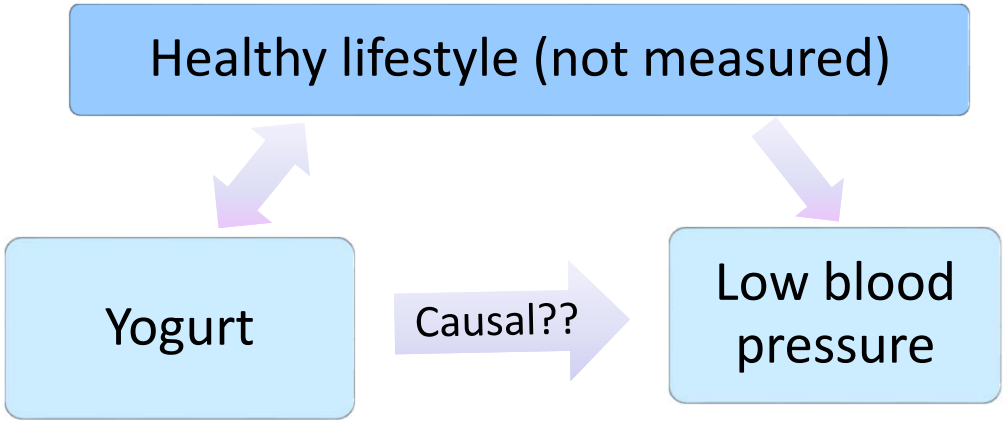
- Study tracked 2100 people for 14 years, participants recorded what they ate
- Those who ate yogurt were 31% less likely to develop high blood pressure
- Those who ate 2% or more of daily calories from yogurt "significantly" reduced their risk of high blood pressure
- Clearly, *not* randomly assigned to eat yogurt or not!
- What else might explain the difference in high blood pressure?

Some definitions:
Explanatory, Response and Confounding Variables

- **Explanatory variable** defines the groups or conditions
  - Whether the person reported eating yogurt regularly or not
- **Response variable** is the outcome of interest
  - Whether the person developed high blood pressure or not
- **Confounding variables**
  - Are *related* to the explanatory variable [eating yogurt], *and*
  - Might *affect* the response variable [high blood pressure].
- **Possible confounding variables:**
  - How health conscious the person is, general diet
  - Amount of fat in the person's diet
  - Amount of exercise, general quality of medical care, etc.

Can we conclude yogurt reduces blood pressure?

- In observational studies *confounding variables* can't be separated from the explanatory variable in affecting the outcome. So we cannot conclude that changes in the explanatory variable *cause* a change in the response.
- We cannot conclude that yogurt *causes* lower blood pressure



A more detailed example

- Headline: ***"Breakfast Cereals Prevent Overweight in Children"***

- The article continues:

"Regularly eating cereal for breakfast is tied to healthy weight for kids, according to a new study that endorses making breakfast cereal accessible to low-income kids to help fight childhood obesity."

Some Details about the Study

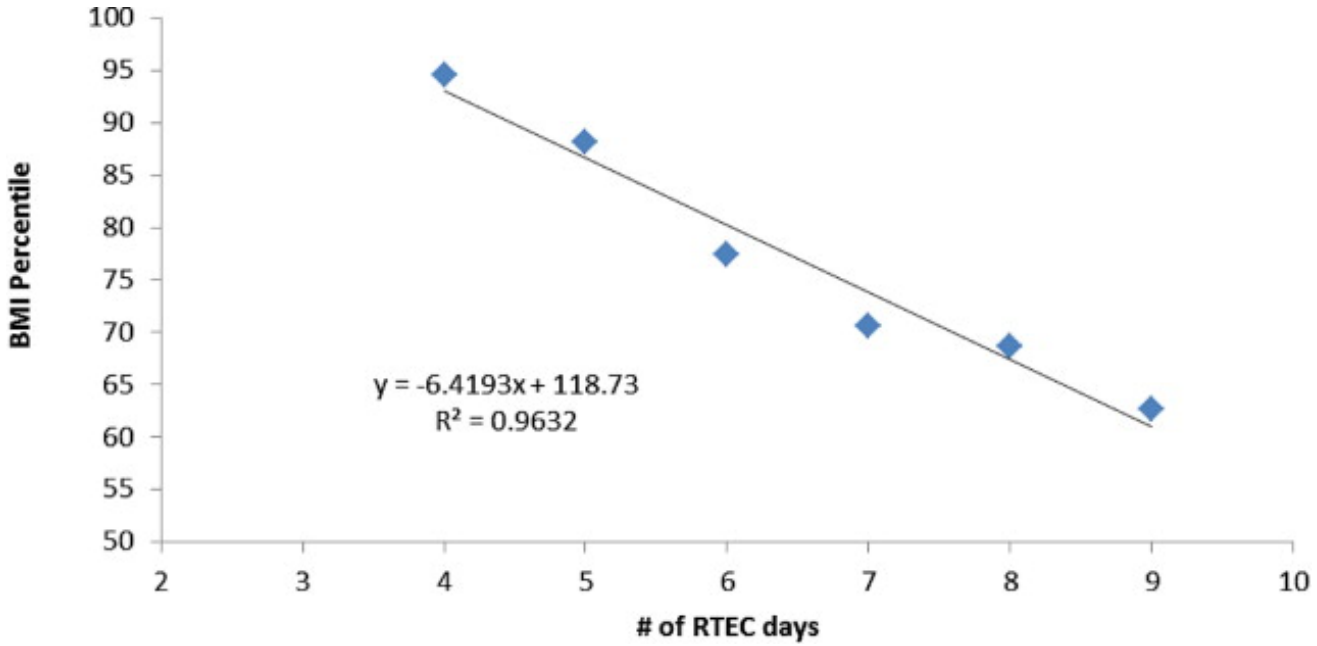
- This was an observational study
  - Children were asked what they ate, not randomly assigned
- 1024 children, only 411 with usable data
  - Mostly low-income Hispanic children in Austin, TX
  - Control group for a larger study on diabetes
- Asked what foods they ate for 3 days, in each of grades 4, 5, 6 (same children for 3 years)
- Study looked at number of days they ate cereal = 0 to 3 each year, so total of 0 to 9

The Analysis

- Multiple regression:
  - Response variable = BMI percentile each year (BMI = body mass index), i.e. where does the child fall for their age group?
  - Explanatory variable = days of eating cereal in each year (0 to 3), modeled as linear relationship with BMI
- Did not differentiate between other breakfast or no breakfast (for days without cereal)
- Also included (adjusted for) age, sex, ethnicity and some nutritional variables

More Details: The analysis

- Multiple regression was used; simplistic (and possibly misleading) plot:



Confounding variables

What else could explain the relationship?

- Possible confounding variable is general quality of nutrition in the home
  - Unhealthy eating for breakfast (non-cereal breakfast or no breakfast), probably unhealthy for other meals too.
- High metabolism could cause low BMI and the need to eat breakfast. Those with high metabolism require more frequent meals.

Misleading headlines

"Breakfast Cereals Prevent Overweight in Children"

- The article continues:

"Regularly eating cereal for breakfast is tied to healthy weight for kids, according to a new study that endorses making breakfast cereal accessible to low-income kids to help fight childhood obesity."

- Notice that the *quote* does not imply cause and effect, but the headline does.
- Common in media – editors write the headlines

Other questions to ask:

- Who did the study?
  - Lead author = Vice President of Dairy MAX, a regional dairy council. (Fair disclosure: Study funded by NIH, not Dairy MAX)
- What was the size of the effect?
  - Reduction of just under 2% in BMI percentile for each extra day (up to 3) of consuming cereal (regression coefficient was -1.97)
- Has the study been replicated?

Replications?

Egg breakfast for kids can prevent childhood obesity

08 Feb 2016

Healthcare (Basel). 2017 Sep; 5(3): 49.
Published online 2017 Aug 30. doi: 10.3390/healthcare5030049

PMCID: PMC5618177
PMID: 28867765

Breakfast Cereal Consumption and Obesity Risk amongst the Mid-Age Cohort of the Australian Longitudinal Study on Women's Health

Angelica Quatela,[1] Robin Callister,[2,4] Amanda J. Patterson,[1,4] Mark McEvoy,[3,4] and Lesley K. MacDonald-Wicks[1,4,*]

Sampath Parthasarathy, Academic Editor

Abstract

Obesity affects 27.5% of Australian women. Breakfast cereal consumption has been proposed to be protective against obesity. This study investigated the association of breakfast cereal consumption with the risk of developing obesity (Body Mass Index (BMI) ≥ 30 kg/m^2) over 12 years among mid-age participants in the Australian Longitudinal Study on Women's Health (ALSWH). Dietary data were obtained at S3 and obesity incidence at S4–S7. Women were excluded if: dietary data were incomplete, energy intake was <4500 or >20,000 kJ/day, or they reported being overweight or obese at S3. Logistic regressions with discrete time survival analysis investigated the association between breakfast cereal intake and incident obesity and were adjusted for: area of residency, income, smoking, physical activity, hypertension, dietary intakes and a discrete measure of time. There were 308 incident cases of obesity. Any breakfast cereal intake was not associated with incident obesity (Odds Ratio (OR): 0.92; $p = 0.68$). Oat-based cereal (OR: 0.71; $p = 0.01$), muesli (OR: 0.57; $p = 0.00$) and All-Bran (OR: 0.62; $p = 0.01$) intakes were associated with a significant reduction in obesity risk. Among this cohort, muesli on its own, or as part of oat-based

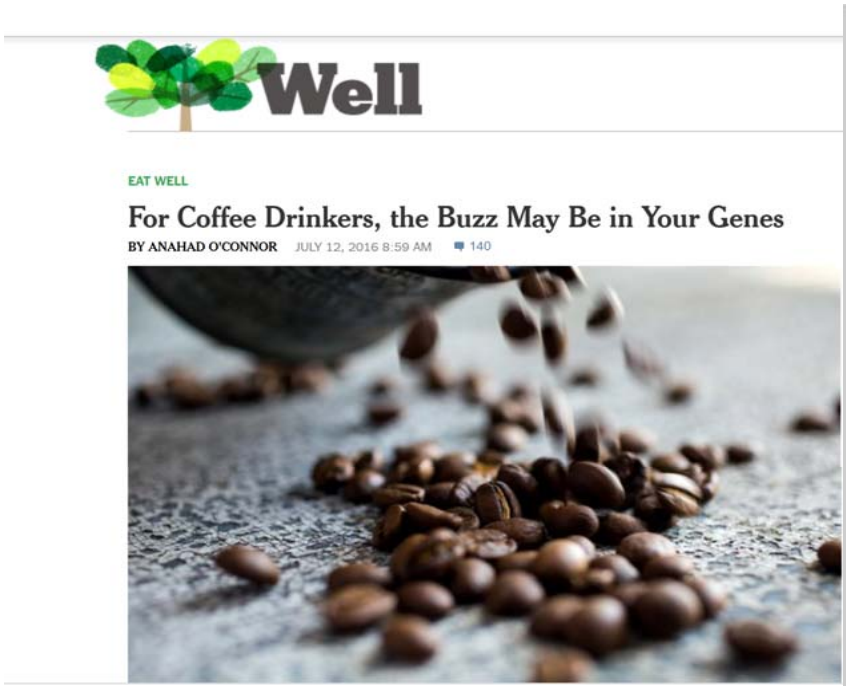
Assessing possible causation

Some features that make causation *plausible* even with observational studies:

- There is a reasonable explanation for how the cause and effect would work.
- The association is consistent across a variety of studies, with varying conditions.
- Potential confounding variables are measured and ruled out as explanations.
- There is a "dose-response" relationship.

Coffee, revisited

Beware of unknown additional factors!

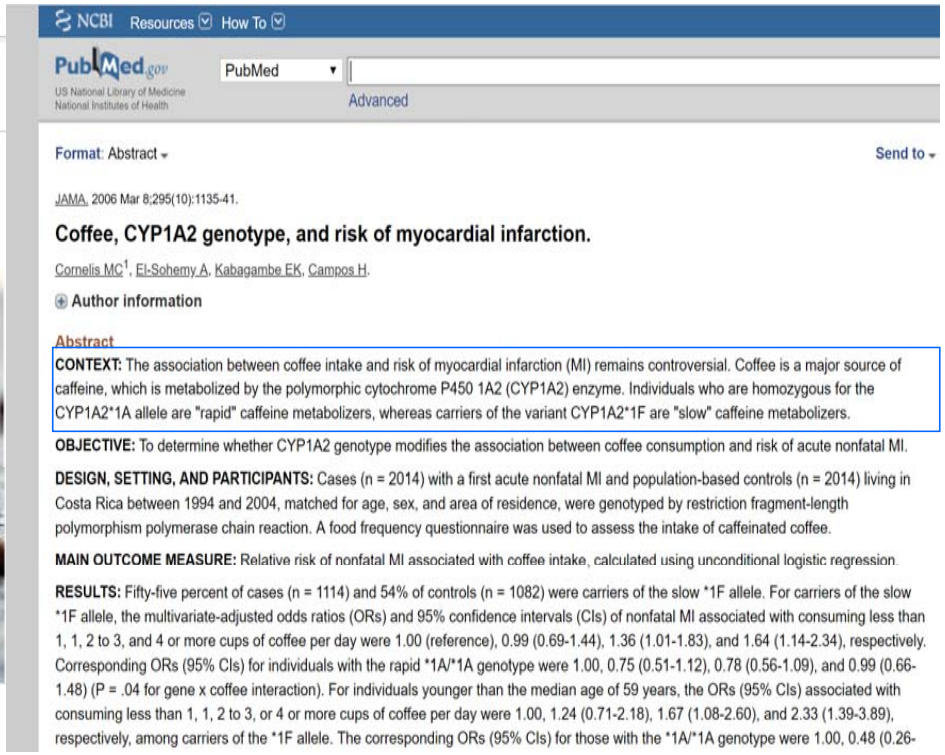


Well

EAT WELL

For Coffee Drinkers, the Buzz May Be in Your Genes

BY ANAHAD O'CONNOR JULY 12, 2016 8:59 AM 140



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JAMA. 2006 Mar 8;295(10):1135-41.

Coffee, CYP1A2 genotype, and risk of myocardial infarction.

Cornelis MC[1], El-Sohemy A, Kabagambe EK, Campos H.

Author information

Abstract

CONTEXT: The association between coffee intake and risk of myocardial infarction (MI) remains controversial. Coffee is a major source of caffeine, which is metabolized by the polymorphic cytochrome P450 1A2 (CYP1A2) enzyme. Individuals who are homozygous for the CYP1A2*1A allele are "rapid" caffeine metabolizers, whereas carriers of the variant CYP1A2*1F are "slow" caffeine metabolizers.

OBJECTIVE: To determine whether CYP1A2 genotype modifies the association between coffee consumption and risk of acute nonfatal MI.

DESIGN, SETTING, AND PARTICIPANTS: Cases (n = 2014) with a first acute nonfatal MI and population-based controls (n = 2014) living in Costa Rica between 1994 and 2004, matched for age, sex, and area of residence, were genotyped by restriction fragment-length polymorphism polymerase chain reaction. A food frequency questionnaire was used to assess the intake of caffeinated coffee.

MAIN OUTCOME MEASURE: Relative risk of nonfatal MI associated with coffee intake, calculated using unconditional logistic regression.

RESULTS: Fifty-five percent of cases (n = 1114) and 54% of controls (n = 1082) were carriers of the slow *1F allele. For carriers of the slow *1F allele, the multivariate-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) of nonfatal MI associated with consuming less than 1, 1, 2 to 3, and 4 or more cups of coffee per day were 1.00 (reference), 0.99 (0.69-1.44), 1.36 (1.01-1.83), and 1.64 (1.14-2.34), respectively. Corresponding ORs (95% CIs) for individuals with the rapid *1A/*1A genotype were 1.00, 0.75 (0.51-1.12), 0.78 (0.56-1.09), and 0.99 (0.66-1.48) (P = .04 for gene x coffee interaction). For individuals younger than the median age of 59 years, the ORs (95% CIs) associated with consuming less than 1, 1, 2 to 3, or 4 or more cups of coffee per day were 1.00, 1.24 (0.71-2.18), 1.67 (1.08-2.60), and 2.33 (1.39-3.89), respectively, among carriers of the *1F allele. The corresponding ORs (95% CIs) for those with the *1A/*1A genotype were 1.00, 0.48 (0.26-

Genetics! Slow vs fast caffeine metabolizers

- **CONTEXT:** The association between coffee intake and risk of myocardial infarction (MI) remains controversial. Coffee is a major source of caffeine, which is metabolized by the polymorphic cytochrome P450 1A2 (CYP1A2) enzyme. Individuals who are homozygous for the CYP1A2*1A allele are "rapid" caffeine metabolizers, whereas carriers of the variant CYP1A2*1F are "slow" caffeine metabolizers.
- **CONCLUSION:** Intake of coffee was associated with an increased risk of nonfatal MI only among individuals with slow caffeine metabolism, suggesting that caffeine plays a role in this association.

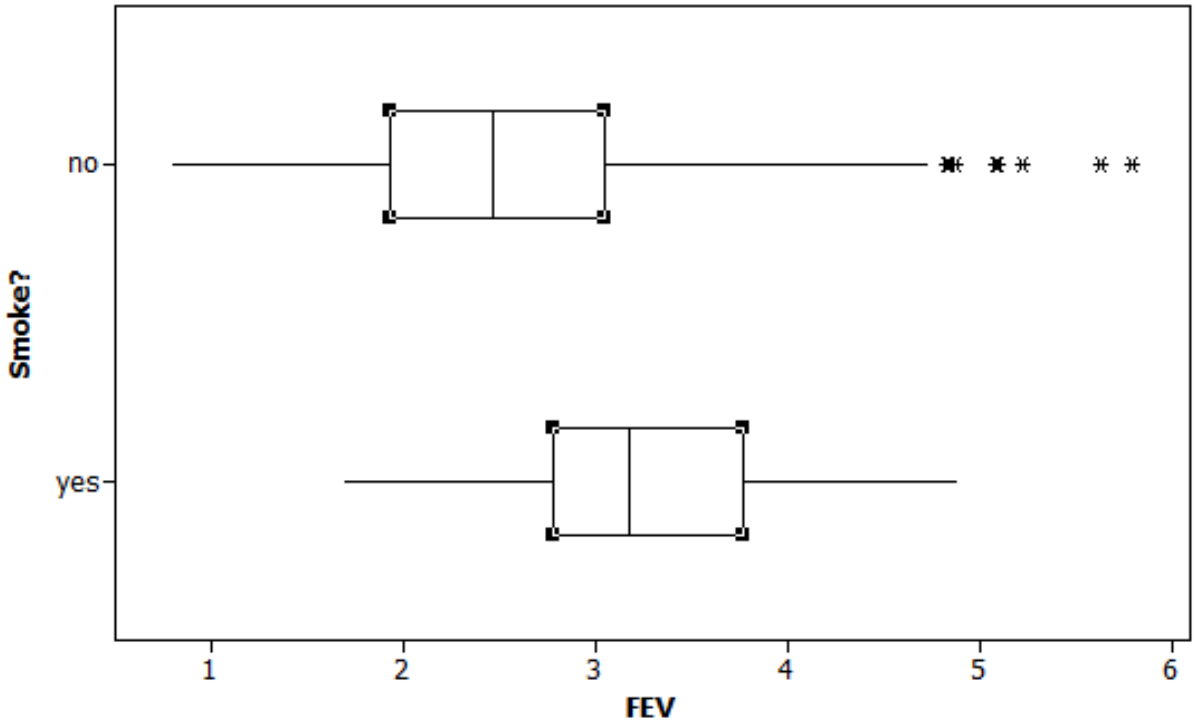
Replications and confusions

- Multiple studies have found a relationship between drinking *coffee* and lower risk of death from multiple causes (but not cancer)
- However, not much difference was found between *caffeinated* and *decaffeinated* coffee
- Other studies examined relationship of *caffeine* to heart issues
- Recent students showed major differences between genetic fast and slow caffeine metabolizers for heart, and for effect of caffeine on enhancing exercise performance. In other words, different genes = different benefits of caffeine!
- But coffee does not equal caffeine in most of the studies

Multivariable Thinking

Example:

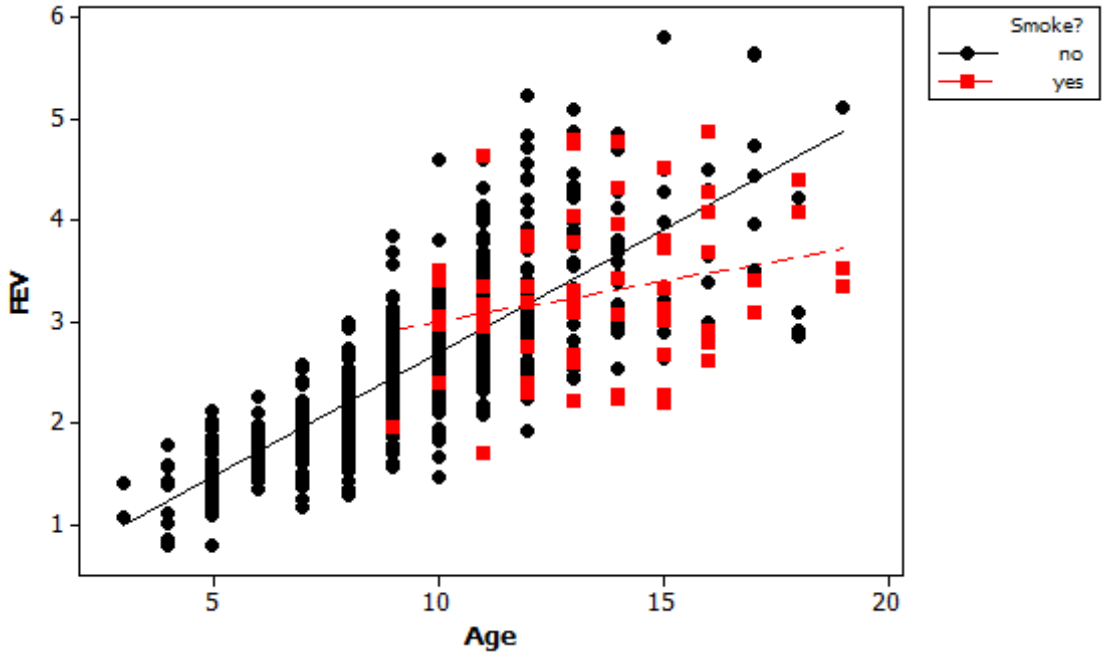
Lung capacity (FEV = forced expiratory volume) in children



Higher for smokers??

Adding a 3rd variable changes the picture!

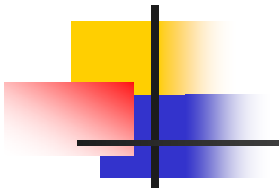
Example: Lung capacity and smoking



Third variable, age, needs to be considered.

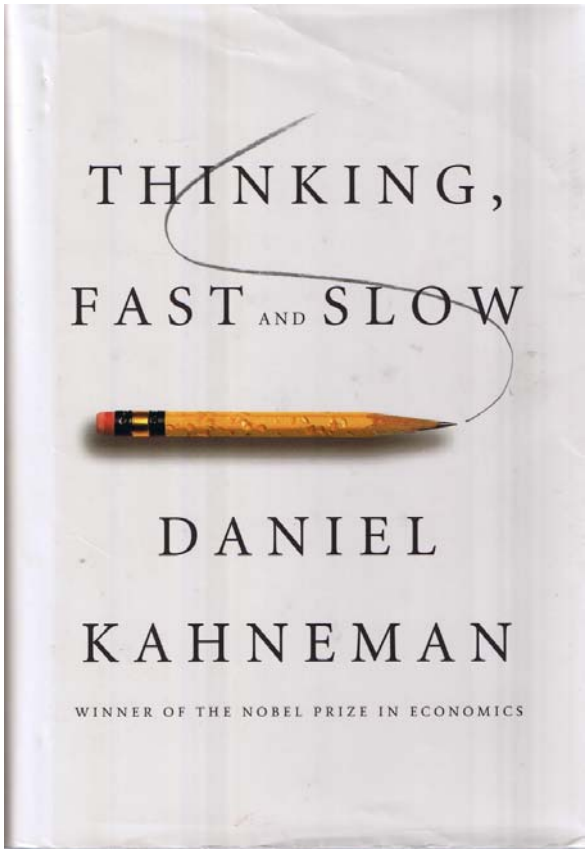
The lesson about additional variables

- A relationship between two variables might *depend* on the value of a 3rd variable:
  - Effect of caffeine on heart health and exercise performance *depends* on whether you are a fast or slow metabolizer
  - Lung capacity in children increases with age – but much more slowly for smokers
  - How much does adding a pool or a fireplace to a home increase (or decrease!) the value when selling? It *depends* on where the house is located.

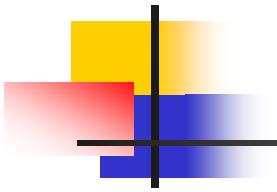


New topic:
Poor intuition about probability and risk

- William James was first to suggest that we have an *intuitive* mind (works fast) and an *analytical* mind (works more slowly), and that they process information differently.
- Example: People feel safer driving than flying, when probability suggests otherwise.
- Psychologists have studied many ways in which we have poor intuition about probability assessments.
  - Recommended reading: *Thinking, Fast and Slow* by Daniel Kahneman



Daniel Kahneman

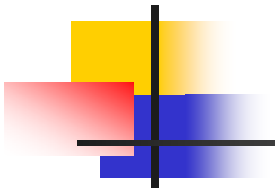


Example: Confusion of the Inverse

Gigerenzer gave 160 gynecologists this scenario:

- About 1% of the women who come to you for mammograms have breast cancer
- If a woman has breast cancer, 90% chance of positive test
- If she does not have breast cancer, there is only a 9% chance of positive test (false positive)

A woman tests positive. What should you tell her about the chances that she has breast cancer?



Answer choices he gave them: Which is best?

- The probability that she has breast cancer is about 81%.
- Out of 10 women with a positive mammogram, about 9 have breast cancer.
- Out of 10 women with a positive mammogram, about 1 has breast cancer.
- The probability that she has breast cancer is about 1%.

Answer choices and % who chose them

- 13% chose “The probability that she has breast cancer is about 81%.”
- 47% chose “Out of 10 women with a positive mammogram, about 9 have breast cancer.” [Note that this is 90%.]
- 21% chose “Out of 10 women with a positive mammogram, about 1 has breast cancer.” [Note that this is 10%.]
- 19% chose “The probability that she has breast cancer is about 1%.”

What is the Correct Answer?

Let's look at a hypothetical 100,000 women.

Only 1% have cancer, 99% do not.

	Test positive	Test negative	Total
Cancer			1,000 (1%)
No cancer			99,000
Total			100,000

Let's see how many test positive

90% who have cancer test positive.

9% of those who don't have it test positive.

	Test positive	Test negative	Total
Cancer	900 (90%)		1,000
No cancer	8910 (9%)		99,000
Total	9810		100,000

Complete the table for 100,000 women:

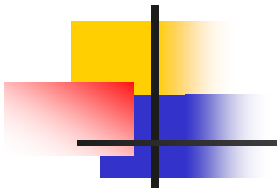
	Test positive	Test negative	Total
Cancer	**900**	100	1,000
No cancer	8910	90,090	99,000
Total	**9810**	90,190	100,000

Correct answer is 900/9810, just under 10%!

Physicians confused two probabilities:

P(positive test, given cancer) = .9 or 90%

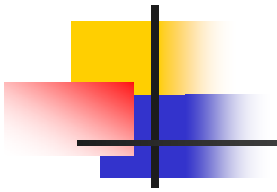
P(cancer, given positive test) = 900/9810 = .092 or 9.2%



Confusion of the inverse: Other examples

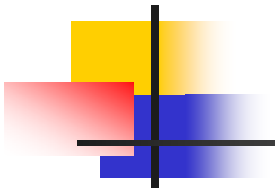
Cell phones and driving (2001 study):

- *Given* that someone was in an accident:
  - Probability that they were using cell phone was .015 (1.5%)
  - Probability that they were distracted by another occupant was .109 (10.9%)
  - Does this mean other occupants should be banned while driving, but cell phones are okay??
- What we really want is probability of being in an accident, *given* that someone is on a cell phone, much harder to find!



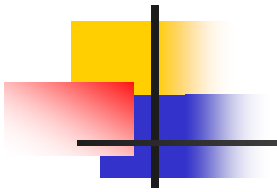
Confusion of the inverse: DNA Example

- Dan is accused of crime because his DNA matches DNA at a crime scene (found through database of DNA). Only 1 in a million people have this specific DNA.
- Suppose there are 6 million people in the local area, so about 6 have this DNA. Only one is guilty!
- Is Dan almost surely guilty??



DNA Example continued

- Remember, only 6 people with this DNA out of 6 million people
- P(DNA match | Dan is innocent)
  ≈ 5 out of 6 million, extremely low!
  - *Prosecutor would emphasize this*
- But... P(Dan is innocent | DNA match) ≈ 5 out of 6, fairly high!
  - *Defense lawyer should emphasize this*
- Jury needs to understand this difference!



New topic: Expected Values

Suppose you decide to go to Minneapolis to a concert and don't know if you will spend the night there. If the weather is bad or you are very tired, you will stay at a hotel. You look at hotels and find a room with the following:

- Pay $170 now, nonrefundable *OR*
- Pay $200 when you arrive, but only if you need the hotel

- What should you do? What additional information would help you decide?

The concept of "expected value"

- Expected value = average over the long run or a large group
- Example:
  - Simple lottery game costs $1 to play.

Prize	$0	$2	$50
Probability	79/100	20/100	1/100

Expected value = 0(79/100) + $2(20/100) + $50(1/100) = $90/100

  - On average, "win" $0.90 (90 cents) for each dollar spent.

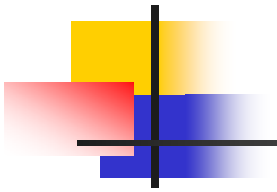
Expected value for hotel decision

- Suppose p = probability you will need the hotel.
- Expected value of the cost for each decision:
  - Advance purchase, Expected value of cost = $170
  - If you don't pay in advance

    Expected value of cost = $200(p) + $0(1 – p) = $200p

    Example: p = ½, Expected value of cost = $100
- Which is lower?

  $200p < $170 when p < (170/200) = 0.85.
- Decision: Pay advance purchase if p > 0.85, but not otherwise.
- Over the long run, you come out ahead if you use that rule.



Insurance, lottery, extended warranty

Should you buy an extended warranty? What about insurance? (e.g. earthquake?)

- *On average* the company wins
- But *some* consumers will be winners, and some will be losers.
- You can use knowledge of your own circumstances to assess which is likely for you.

A quick note about lottery strategy

- The expected value for amount won is generally (much!) lower than the cost of a ticket.
- However, occasionally the jackpot gets so high that the expected value is higher than the ticket cost.
- *But* that assumes there is only one winning ticket.
- Because the jackpot is shared by all winners, the best strategy is to avoid commonly selected numbers, for instance numbers above 31 wouldn't be chosen if someone is using birthdays to choose numbers.

Understanding Expected Value: Survey Question (my class)

Which one would you choose in each set?
(Choose either A or B and either C or D.)

A. A gift of $240, guaranteed
B. A 25% chance to win $1000 and a 75% chance of getting nothing.

C. A sure loss of $740
D. A 75% chance to lose $1000 and a 25% chance to lose nothing

Survey Question Results

Which one would you choose in each set?
(Choose either A or B and either C or D.)

85%	**A.** A gift of $240, guaranteed	E.V. = $240
15%	**B.** A 25% chance to win $1000 and a 75% chance of getting nothing.	E.V. = $250
30%	**C.** A sure loss of $740	E.V. = -$740
70%	**D.** A 75% chance to lose $1000 and a 25% chance to lose nothing	E.V. = -$750

The Amount Makes a Big Difference

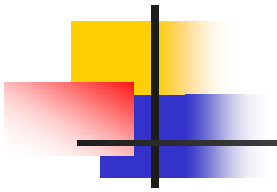
Which one would you choose in each set?

A. A gift of $5, guaranteed
B. A 1/1000 chance to win $4000
Now 75% chose B.
This is like buying lottery tickets.

C. A sure loss of $5
D. A 1/1000 chance of losing $4000
Now 80% chose C.
Like buying insurance or extended warranty.

We under-estimate risk of bad things

We over-estimate chance of good things



The "Linda Story"

Linda is thirty-one years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Which alternative is more probable?

- *Linda is a bank teller.*
- *Linda is a bank teller and is active in the feminist movement.*

Which do you think is more probable?

- A massive flood somewhere in North America next year, in which more than 1,000 people drown.
- An earthquake in California sometime next year, causing a flood in which more than 1,000 people drown.

The Representativeness Heuristic and the Conjunction Fallacy

- **Representativeness heuristic:** People assign higher probabilities than warranted to scenarios that are *representative* of how they *imagine* things would happen.
- This leads to the **conjunction fallacy** … when detailed scenarios involving the conjunction of events are given, people assign *higher* probability assessments to the *combined event* than to statements of one of the simple events alone.
- But *P(A* and *B) = can't exceed P*(*A*)

Other Probability Distortions

- Coincidences have higher probability than people think, because there are so many of us and so many ways they can occur.
  - UCI Statistics Department story of 13s
  - The one in a million event
- Low risk, scary events in the news are perceived to have *higher* probability than they have (readily brought to mind).
- High risk events where we think we have control are perceived to have *lower* probability than they have.

Probability, Intuition, Expected Value

Examples of Consequences in daily life:

- Assessing probability when on a jury

  Lawyers provide detailed scenarios – people give higher probabilities, even though *less* likely.

- Extended warranties and other insurance

  "Expected value" favors the seller

- Gambling and lotteries

  Again, average "gain" per ticket is negative

- Poor decisions (e.g. driving versus flying)

Avoiding Risk May Put You in Danger

- In 1995, UK Committee on Safety of Medicines issued warning that new oral contraceptive pills "increased the risk of potentially life-threatening blood clots in the legs or lungs by twofold – that is, by 100%" over the old pills
- Letters to 190,000 medical practitioners; emergency announcement to the media
- Many women stopped taking pills.

Clearly there is increased risk, so what's the problem with women stopping pills?

Probable consequences:

- Increase of 13,000 abortions the following year
- Similar increase in births, especially large for teens
- Additional $70 million cost to National Health Service for abortions alone
- Additional deaths and complications probably *far exceeded* pill risk.

Actual Risk versus Relative Risk

- "Twofold" risk of blood clots:
  - 1/7000 to 2/7000, not a big change in *absolute* risk, and still a *small risk*.
- *Absolute* risk is what is important:
  - 2/7000 likely to have a blood clot
  - Compare to other risks of pregnancy
- But *relative* risk (2 in this case) is what makes news!

Reported Risk versus Your Risk

"Older cars stolen more often than new ones"
Davis (CA) Enterprise, 15 April 1994, p. C3

- Of the 20 most popular auto models stolen in California the previous year, 17 were at least 10 years old.
- Many factors determine which cars stolen:
  - Type of neighborhood.
  - Locked garages.
  - Cars not locked and/or don't have alarms.

Reported Risk versus Your Risk, continued

- The real question of interest is:

  If I were to buy a new car, would my risk of having it stolen increase or decrease over my old car?

- Article gives no information about that question.

Considerations about Risk

- Changing a behavior based on relative risk may *increase* overall risk of a problem. Trade-offs!
- Find out what the *absolute* risk is, and consider relative risk in terms of additional *number* at risk
- Suppose a behavior doubles risk of cancer

  Brain tumor: About 7 in 100,000 new cases per year, so adds about 7 cases per 100,000.

  Lung cancer: About 75 in 100,000 new cases per year, so adds 75 per 100,000, more than 10 times as many!
- Does the reported risk apply to you?
- Over what time period? (Per year? Per lifetime?)

New Topic: Cautions about "average" Beware when you hear…

"The average person…."

- Will live to be …
- Has 2.3 children…
- Makes $x per year…

Etc….

- What's missing?
  - Information about distribution and variability!

Usually average is not enough!

- Recent trip, I flew into Chicago Terminal 2, Concourse E, flight was delayed
- Needed to get to Concourse C, flight leaving in 35 minutes
- There is a shuttle! Sign says “Average wait time is 15 minutes.”
- What’s missing with this information??

How about maximum wait time?

Average is over-rated. Variability is more interesting and useful!

- The average temperature in Minneapolis (across all months) is 55 degrees.

- The average temperature in San Francisco (across all months) is 59 degrees.

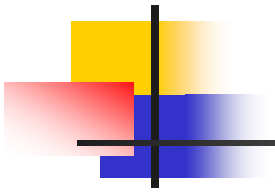
New Topic: More about Cereal
Does it Produce Boys?

- Headline in *New Scientist*: “Breakfast cereal boosts chances of conceiving boys” Numerous other media stories of this study.
- Study in *Proc. of Royal Soc. B* showed of pregnant women who ate cereal, 59% had boys, of women who didn’t, 43% had boys.
- Problem #1 revisited:

  Headline implies eating cereal *causes* change in probability, but this was an observational study. (Confounding variables???)

The Problem: Multiple Testing

- The study investigated 132 foods the women ate, at 2 time periods for each food = 264 possible tests! (Stan Young pointed this out in a published criticism.)
- By chance alone, *some* food would show a difference in birth rates for boys and girls.
- Main issue: Selective reporting of results when many relationships are examined, not adjusted for multiple testing. Quite likely that there are "false positive" results.

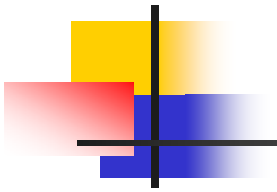


Common Multiple Testing Situations

- *Genomics*: Looking for genes related to specific disease, testing many thousands.
- *Diet and disease*: For instance, ask patients and controls about many dietary habits.
- *Interventions* (*e.g. Abecedarian Project*):
  - Randomized study gave low-income kids (infant to kindergarten) educational program (or not).
  - Kids in program were almost 4 times as likely to graduate from college. (Many other differences; too many to all be multiple testing.)

Multiple Testing: What to do?

- There are statistical methods for handling multiple testing. See if the research report mentions that they were used.
- See if you can figure out how many different relationships were examined.
- Was the main purpose of looking at the data to test *that* particular food or behavior?
- Was there a dose-response relationship?
- If *many* significant findings are reported (relative to those studied), it's *less likely* that the significant findings are false positives.



New Topic: Surveys and polls

Most of you probably know about common problems, such as:

- Biased wording posing as objective surveys
- Confusing wording and/or possible responses
- Problems with getting a representative sample, and getting people to respond
- Responses given with desire to please or give socially acceptable answers

Let's look at some subtle examples…

Wording is Important and Difficult to Get Right!

Small change of words can lead to big change in answers.

Example: How Fast Were They Going?

Students asked questions after shown film of car accident.

- About how fast were the cars going when they contacted each other?

  Average response = 31.8 mph
- About how fast were the cars going when they collided with each other?

  Average response = 40.8 mph

Ref: Loftus & Palmer, *Journal of Verbal Learning and Verbal Behavior*

Ordering of Questions

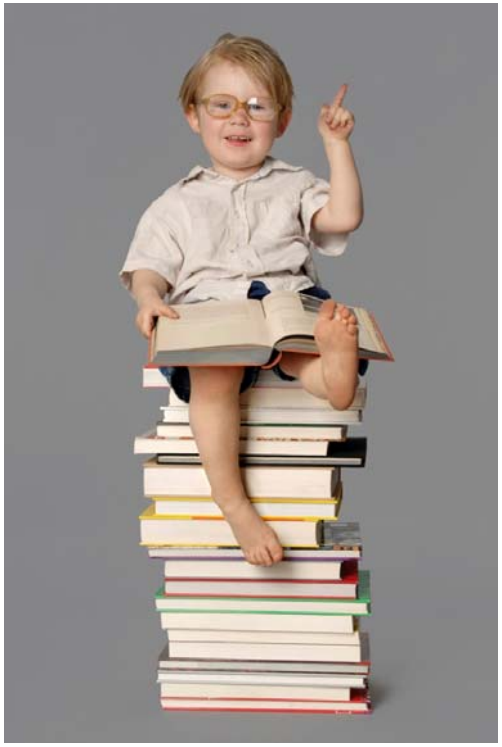
The order in which questions are presented can change the results.

Example:

1. How happy are you with life in general?
2. How often do you normally go out on a date?
   About _____ times a month.

Almost no correlation in answers. When order was *reversed*, there was a strong correlation! Respondents seem to think the happiness question was now, "Given what you just said about going out on dates, how happy are you?"

Ref: Clark and Schober, *Questions about Questions*, J. Tanur, Ed.



QUESTIONS?

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