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Statistical Literacy

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May 15, 2012
Slides at www.StatLit.org/pdf/2012Schield1Keene6up.pdf

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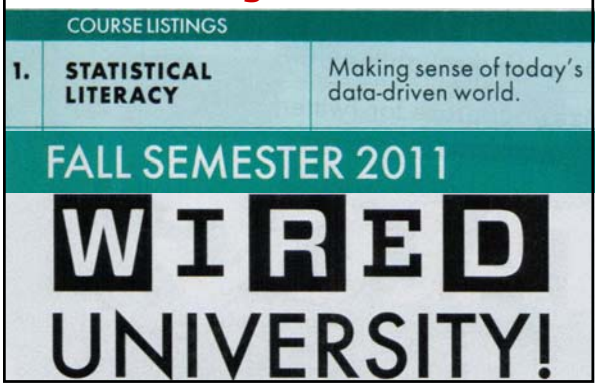
Wired Magazine: Oct 2010



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Importance of Statistical Literacy

I've been increasingly impressed by how important statistical literacy has become for all of us around the globe.

Statistical literacy has risen to the top of my advocacy list, right alongside numeracy, and perhaps even ahead of "algebra for all."

J. Michael Shaughnessy, NCTM President
www.StatLit.org/pdf/2010Shaughnessy-StatisticsForAll-NCTM.pdf

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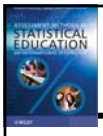
Statistical Literacy: Growing Rapidly

19% of US four-year colleges reported offering a course titled "Statistical Literacy" in 2009.

87% have college-wide quantitative requirement, 68% have a quantitative support center, 43% can satisfy QR requirement outside math, 32% have a pre/entry QR assessment and 20% have a post/exit QR assessment.

Schield (2009). **Quantitative Graduation Requirements at US Four-Year Colleges.** www.statlit.org/pdf/2010SchieldJMM.pdf



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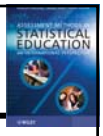
Statistical Literacy



Statistical literacy is the ability to **read and interpret** summary statistics in the everyday media: in graphs, tables, statements and essays.

Statistical literacy is needed by 'data consumers.'

About 40% of all US college students graduating in 2003 had non-quantitative majors.

Schield (2010) in *Assessment Methods in Statistical Education*

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Statistical Literacy: Take CARE

Associations may be useful in
- identifying causation
- making a prediction, a generalization or a specification.

Statistical associations may be influenced by:
- Context: what is (and is not) taken into account
- Assembly: how things are defined or measured
- Randomness: coincidence or margin of error
- Error/bias: Subject, research or sampling bias

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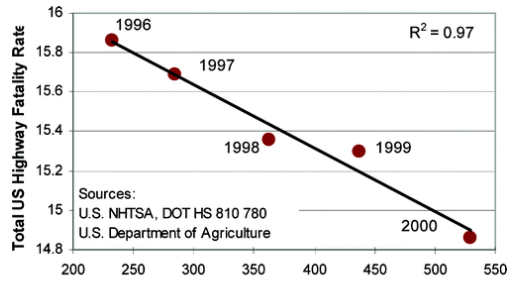
1a. Association is probably not Causation



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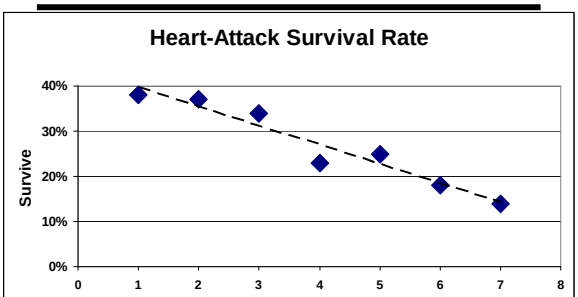
1b. Association is Probably Causation



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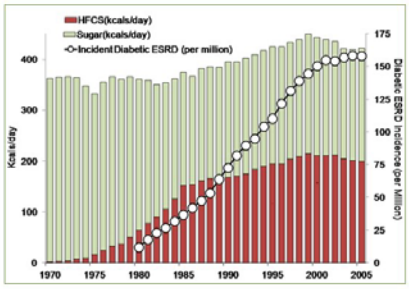
1c. Association is possibly a sign of Causation



U.S. Trends in Total Sugar and High Fructose Corn Syrup (HFCS) availability, and Incident Diabetic End-Stage Renal Disease (ESRD)

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Statistical Literacy Describing & Comparing

"Literacy" is a big idea in statistical literacy

Must be able to describe and compare percentages and rates presented in tables and graphs.

Is "*the percentage of men who smoke*" the same as "*the percentage of men among smokers*"? No

If "*Smoking is more likely among women than men*" does this mean that "*Smokers are more likely to be women than men*"? No

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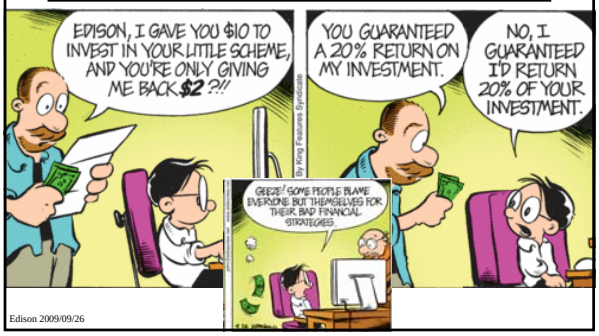
Small Change in Syntax; Big Change in Semantics



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Statistical Literacy #1: Context & Confounding

"Confounding" is a big idea in Statistical Literacy.

Controlling for a confounder can influence:

- the size of rates, percentages and relative risks
- the percentage or # of cases attributed to X
- whether a difference is statistically Significant

Statistically-significant differences can become *statistically **in**significant* (and vice versa).

Intro statistics textbooks do NOT mention this!

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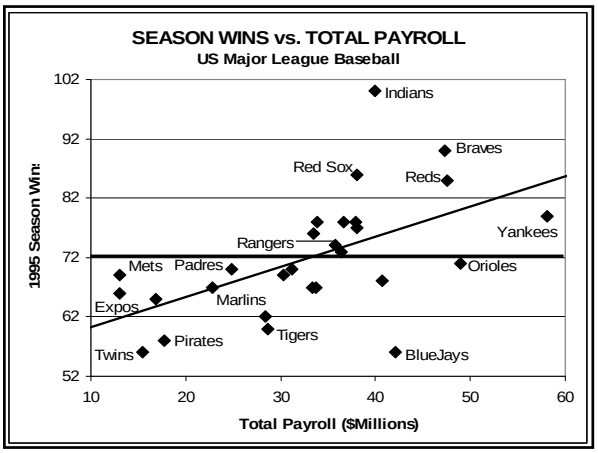
Size of a statistic depends on what is "taken into account"

State Prison Expense (1996)

State	Total	Compare	Inmates	Per Inmate	Compare
MN	$184M	27% more	4,865	$37,825	56% more
IA	$144M	12% less	5,929	$24,286	36% less

State	Total	Compare	Inmates	per Inmate	Compare
CA	$2.9B	50% more	136K	$21,385	25% less
NY	$1.9B	34% less	69K	$28,426	33% more



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US SAT-VERBAL SCORES

Average SAT-V	1981	2002	Change	1981	2002
All Test-Takers	504	504	0	100%	100%
White	519	527	8	85%	65%
Black	412	431	19	9%	11%
Asian	474	501	27	3%	10%
Mexican	438	446	8	2%	4%
Puerto Rican	437	455	18	1%	3%
American Indian	471	479	8	0%	1%

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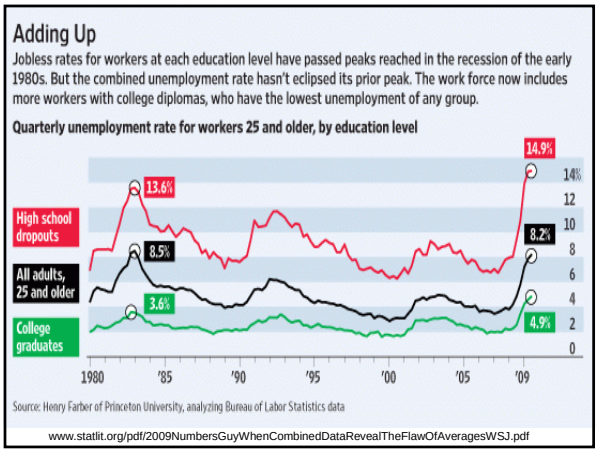
Death Rates per 10,000 Auto Accidents

People in auto accidents are less likely to die if their car has an air bag.

	Seatbelt		
Airbag	No	Yes	Total
Yes	125	20	40
No	102	30	50
Total	115	25	45

After controlling for the use of a seat belt (compare in a column), airbags make almost no difference in survival compared to seat belts (compare in a row)



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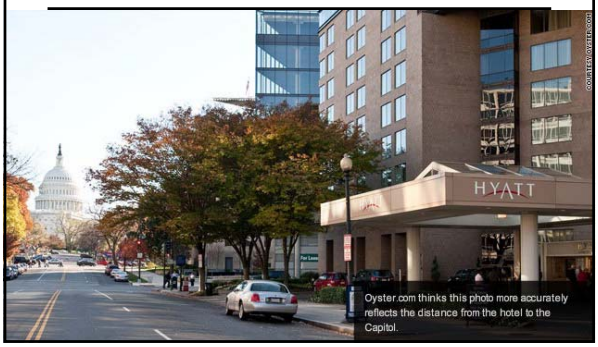
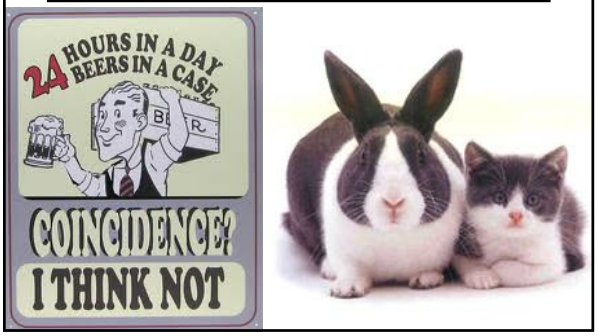
Assembly: Making small things big

7 nanograms per gram = 7 parts in a billion

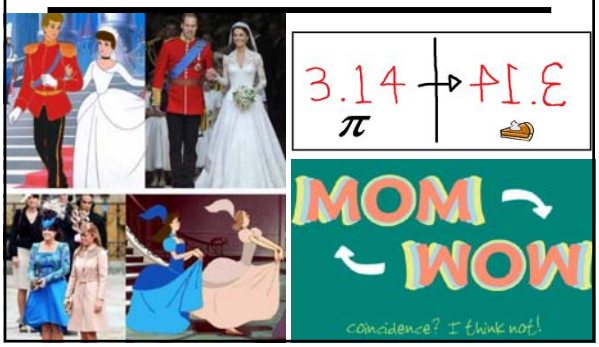
Hyatt: Close to the US Capital



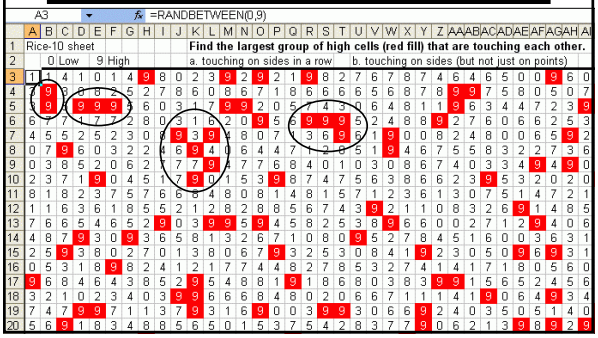
Randomness: Coincidence



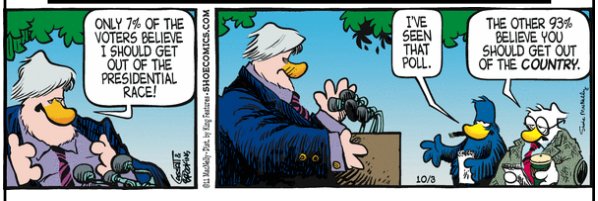
Randomness: Coincidence?



Seeing Coincidence



Error/Bias



Error/Bias

Suppose that men make a third more income than women for the same job.

How much of this difference is due to bias?

- Lying or "reaching" by men. Rounding up. Including anticipated bonus/raise.
- Conservatism by women. Rounding down. Quoting regular pay or even take-home pay.

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Conclusion #1
Most students are statistically illiterate

They don't believe that taking into account a related factor can change an association.

They can't see why coincidences are common. They can't read tables or graphs. They can't describe and compare rates and percentages.

They can't think hypothetically about what might have influenced an association.

They don't see how definitions affect numbers.

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Conclusion #2

Graduates in non-quantitative majors are most likely to be the journalists, policy makers and politicians who influence decisions on funding for science, technology, engineering and math (STEM).

The less value they see in STEM, the harder it is to get their support for STEM.

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Conclusion #3

Colleges must commit to graduating students that are statistically literate.

They must

•identify the principles involved.

•educate faculty on these principles.

•get faculty committed to this project

•get those principles embedded in courses.

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References

Schield (1999). Simpson's Paradox and Cornfield's Conditions. www.StatLit.org/pdf/1999SchieldASA.pdf

Schield, Milo (2006). Presenting Confounding and Standardization Graphically. *STATS Magazine*, See www.StatLit.org/pdf/2006SchieldSTATS.pdf.