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Statistical Literacy and Mathematics

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February 24, 2012
Slides at www.StatLit.org/pdf/2012Schield-Lehman6up.pdf

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Stat Lit IS NOT Mathematics

Statistical literacy, quantitative reasoning, quantitative literacy and numeracy:

1. have NO solid or rigorous definitions
2. are NOT centered on any algebraic or quantitative expressions.
3. are NOT defined like any other part of mathematics – by unique mathematics topics.

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Stat Lit IS NOT Mathematics

Statistical literacy, quantitative reasoning, quantitative literacy, numeracy:

- are NOT mathematics because …….. [Audience suggestions]

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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, surveys and studies.

Statistical literacy is needed by data consumers – students in non-quantitative majors.

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

Statistical literacy studies all the influences on statistics.

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Statistical Literacy Is a part of Mathematics

Compared to QR, Quantitative Literacy or Numeracy, Statistical Literacy focuses

- Focuses more on chance
- Focuses more on what is taken into account

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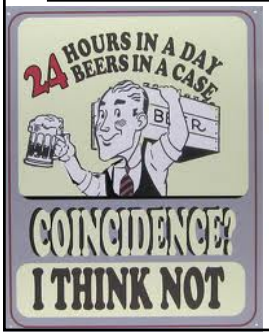
Coincidence



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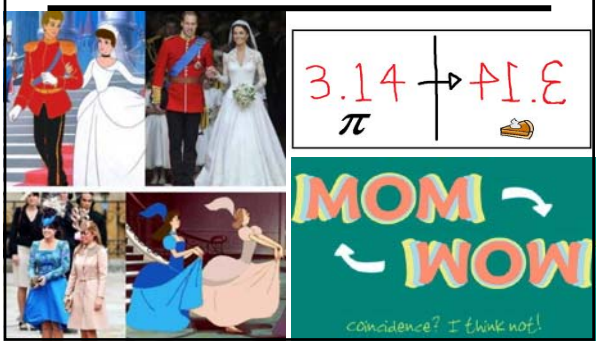
Coincidence?



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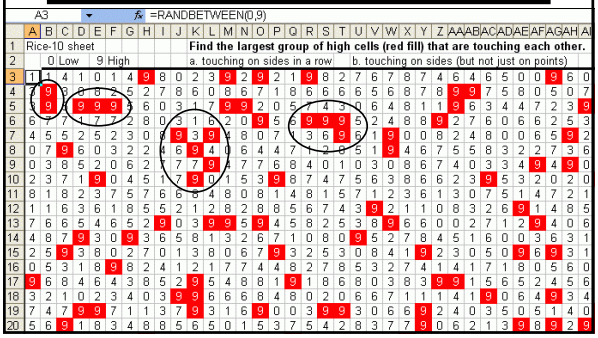
Seeing Coincidence



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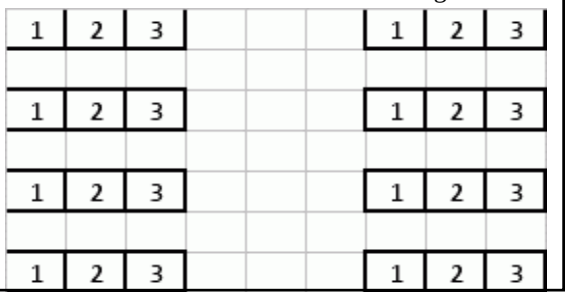
Flip 8 sets of 3 coins each [24 flips]; A run of three heads is "expected"

Chance of 3 heads: one chance in eight.



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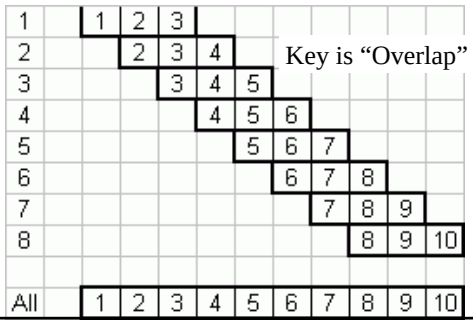
Run of at least three heads: "Expected" in 10 flips of fair coin



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Coincidence: Mathematical Principle

Seen: unlikely conjunction

Unseen: # ways to generate that unlikely conjunction.

Mathematics reveals hidden connections.

N logical events (k at a time) map onto n physical events

n = N + k - 1. n << N*k; n ~ N

10 = 8 + 3 – 1. 10 << 24 [8*3]; 10 ~ 8

Analogous to combinations vs. permutations.

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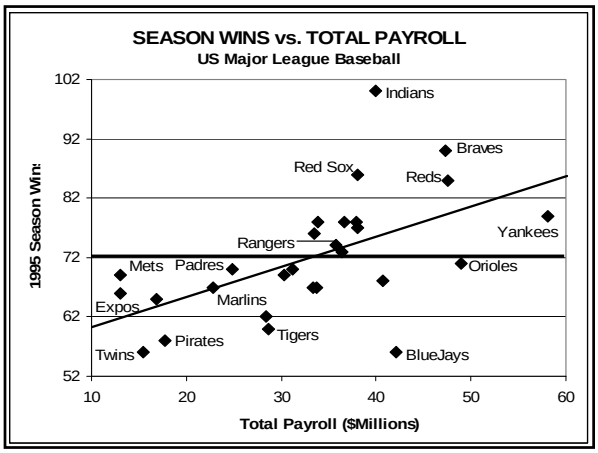
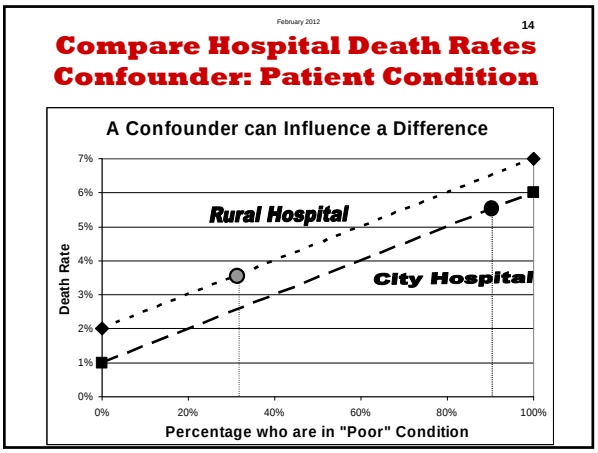
Size of a statistic depends on what is "taken into account"

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


SEASON WINS vs. TOTAL PAYROLL
US Major League Baseball
1995 Season Wins
Total Payroll ($Millions)
Indians
Braves
Red Sox
Reds
Yankees
Rangers
Mets
Padres
Orioles
Expos
Marlins
Tigers
Pirates
Twins
BlueJays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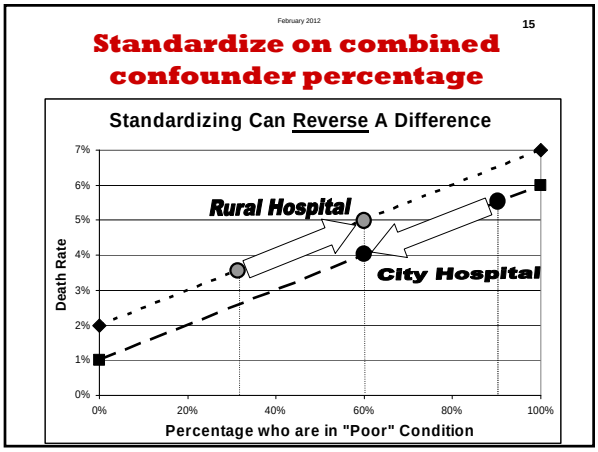
Compare Hospital Death Rates
Confounder: Patient Condition
A Confounder can Influence a Difference
Rural Hospital
City Hospital
Death Rate
Percentage who are in "Poor" Condition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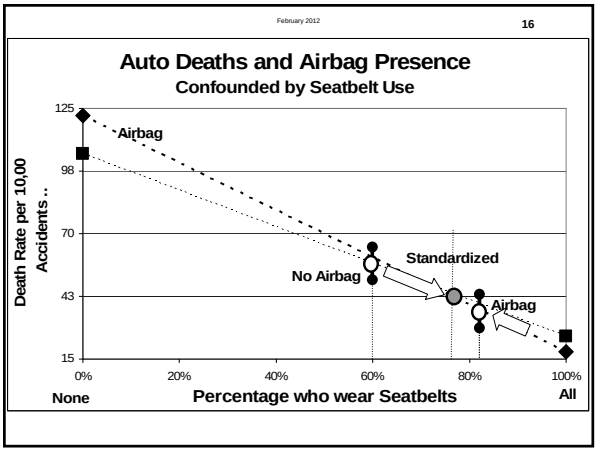
Standardize on combined confounder percentage
Standardizing Can Reverse A Difference
Rural Hospital
City Hospital
Death Rate
Percentage who are in "Poor" Condition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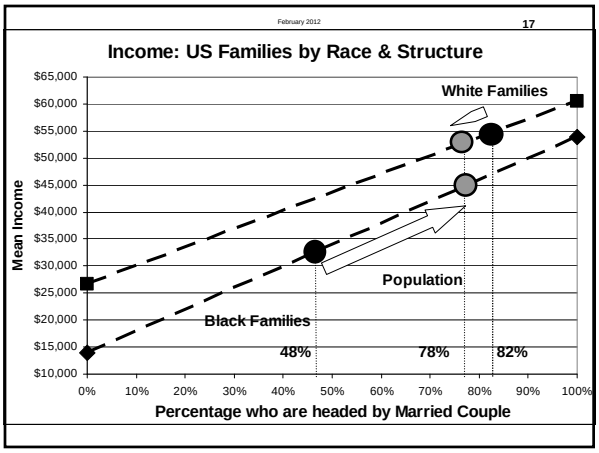
Auto Deaths and Airbag Presence
Confounded by Seatbelt Use
Airbag
Standardized
No Airbag
Airbag
Death Rate per 10,00 Accidents...
None
Percentage who wear Seatbelts
All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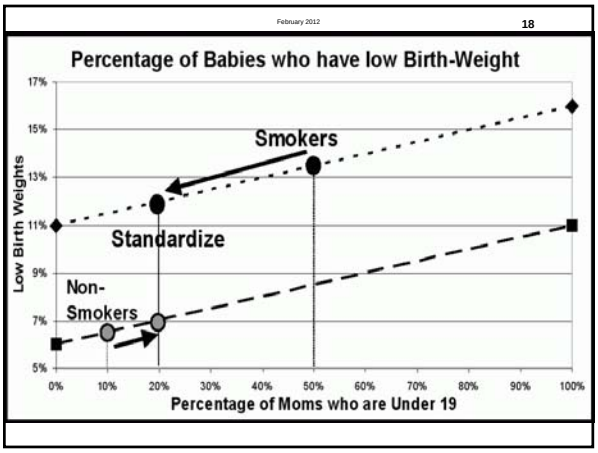
Income: US Families by Race & Structure
White Families
Population
Black Families
48%
78%
82%
Mean Income
Percentage who are headed by Married Couple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Percentage of Babies who have low Birth-Weight
Smokers
Standardize
Non-Smokers
Low Birth Weights
Percentage of Moms who are Under 19

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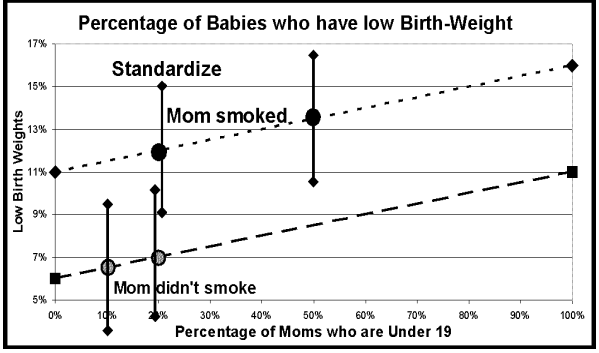
Controlling Can Change Statistical Significance



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Ratios: influenced by confounders Math-Stat Principles

Partial derivative can have
a different magnitude and
a different sign
than a total derivative.

Statistical significance can be influenced by what is taken into account

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Conclusion

If courses or programs involving numeracy, quantitative literacy or statistical literacy are to survive – much less to thrive –

they must be strongly supported by mathematics and statistics departments and faculty.

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Recommendation

Mathematics departments should give strong support for quantitative literacy courses and programs

provided they embody high-level principles that are taught in upper-level math and stat courses – even if those principles are taught in an introductory manner.

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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.

Schield, Milo (2012). Coincidences. MAA Boston. See
www.StatLit.org/pdf/2012SchieldMAA.pdf
www.StatLit.org/Excel/2012Schield-Runs.xls
www.StatLit.org/Excel/2012Schield-Rice.xls
www.StatLit.org/Excel/2012Schield-Bday.xls