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## Statistical Literacy: Errors Reading Graphs

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**The Kansas City Actuaries Club**  
5 December 2005  
[2005SchieldKCAC6Up.pdf](#)


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## Statistical LITERACY Focuses on Social Arguments

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Florence Nightingale

*“Seven times as many died after the battle as died in the battle.”*



Nurses save lives;  
We need more nurses!

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## Statistical Literacy

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To be literate about everyday arguments that use statistics as evidence

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*Statistics are man-made, socially constructed.*  
Motto: **“Take CARE!”**

- C = Context, Confounding (Tangled up)
- A = Assembly (Define/Choose/Present)
- R = Randomness (Chance)
- E = Error or Bias (Mistakes, Sampling bias)

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## Different Emphasis

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**Confounding:** Predictors are tangled up.

- ‘Take control of’ by random assignment.
- ‘Control for’ by standardizing (regression).

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**Assembly:**

- defining groups (bullying, heat-wave deaths)
- choosing statistics (centers, rates, percents)
- presenting statistics (graphs & comparisons).

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## Context and Assembly

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**Auto death rate in Hawaii vs. Arkansas**

- higher per mile of road
- lower per vehicle

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**Divorced men 35-44 are more likely to remarry**

- than divorced men of any other age-group.
- than divorced women 35-44.
- than non-divorced men 35-44.

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## ASSEMBLY Lies vs. Prevarication

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*“Lies, Damned Lies and Statistics.”*

“Lying is dumb. If you get caught, you look stupid.”

**Prevarication** is not lying. Prevarication is **assembly!**

Children & adults learn to prevaricate: to straddle, to equivocate, to omit, to tell a half-truth.

Prevarication can be

- \* unintentional – result of ignorance or enthusiasm.
- \* deliberate and even malicious.

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### Everyday Prevarication: "99.9% Accurate"

- Greater Than 99.9% Accurate  
*Reliable as Tests Used by Doctors and Hospitals*
- Confidential and Anonymous
- Results 24 Hours a Day
- One Spot™ Technology

**HIV-1 TEST SYSTEM**  
*for the Detection of Antibodies to HIV-1*

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### Accuracy Prevarication Prediction or Confirmation

**Prediction:** 99.9% of positives have HIV. **No!**  
**Confirmation:** 99.9% of HIVs test positive. **Yes!**

**Prediction:** 50% of positives have HIV.\*  
 \* If only 0.1% of those tested have HIV.

- Greater Than 99.9% Accurate  
*Reliable as Tests Used by Doctors and Hospitals*

**HIV-1 TEST**

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### Tax Cut for the Rich: Modest or Extravagant?

**Republicans: 3% Cut for Rich**

Minimum Income (\$1,000)	Tax Cut (%)
0	2.5
10	3.5
20	4.0
30	4.5
50	4.5
75	4.0
100	3.5
200	3.0

**Democrats: 28% of Cut for Rich**

Minimum Income (\$1,000)	Share of Tax Cut (%)
0	1
10	2
20	3
30	12
50	16
75	15
100	23
200	28

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### Assembly Using Charts and Graphs

**Percentage of what? What is/are the whole/s?**

**Pie charts:** Usually obvious; pie is 100%  
 Slices must be exclusive: favorite, best, most  
 Distinct-part comparison!

**Bar charts:** Not always obvious!

- Can be distinct-part pie chart (100% sum).
- Can be a common-part "half-table".  
 Slices have distinct wholes

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### Pie Chart 100% Whole is Visible

OK with national IDs?

Not sure 17%  
 No 33%  
 Yes 50%

Name: Jane Doe  
 ID #: 5555-5555

By Anne R. Carey and Chad Palmer, USA TODAY  
 Source: TNS for truste.org

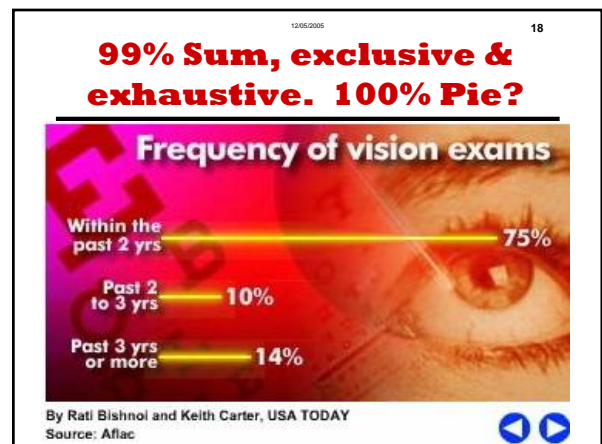
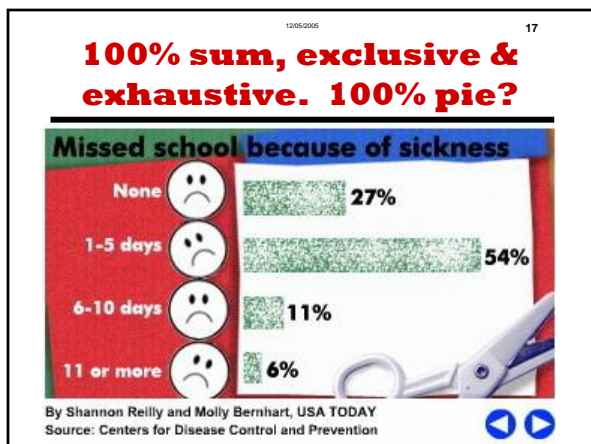
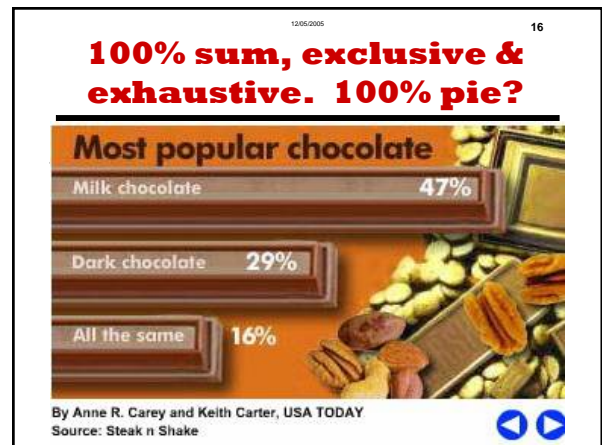
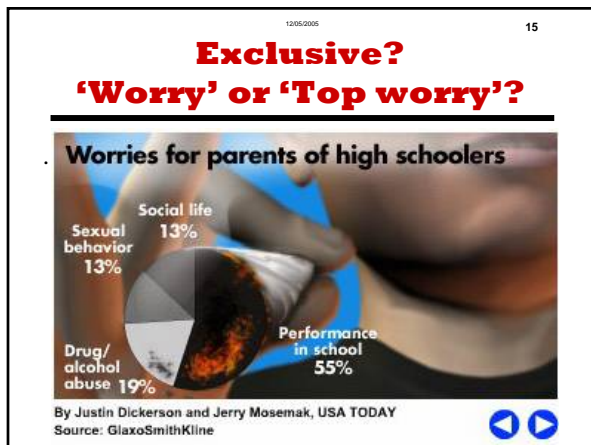
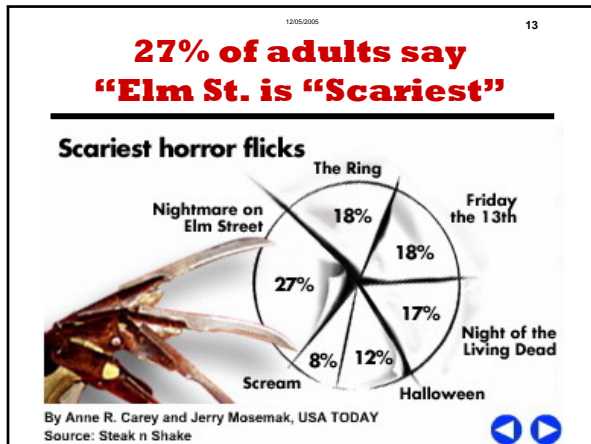
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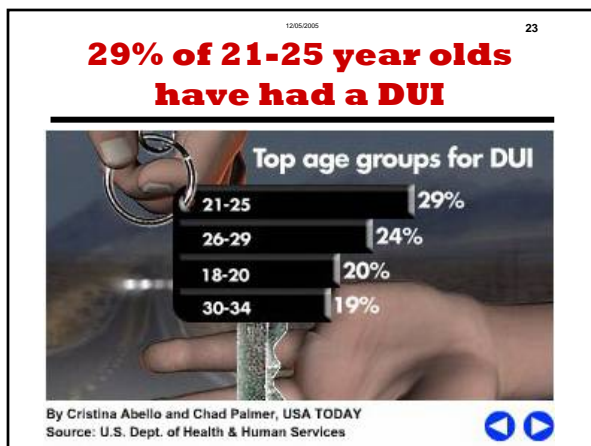
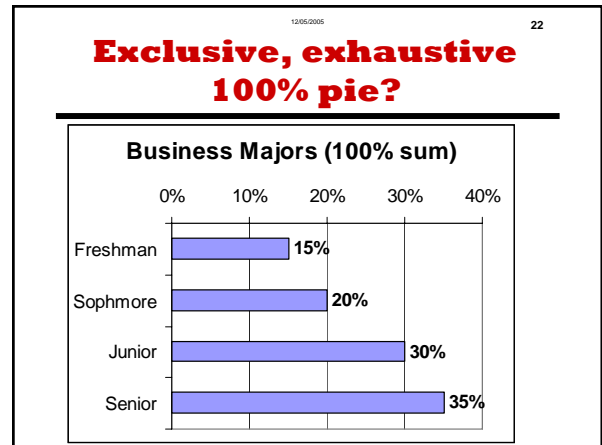
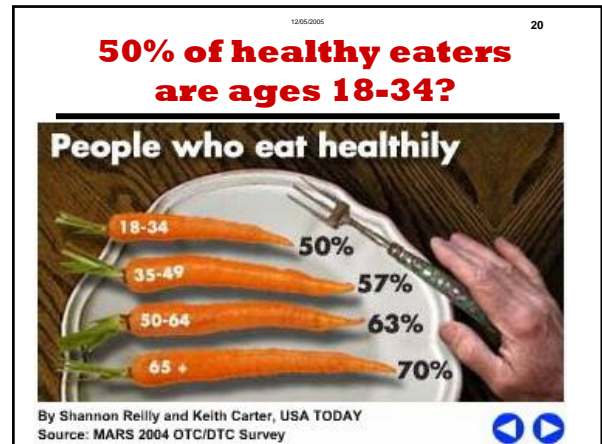
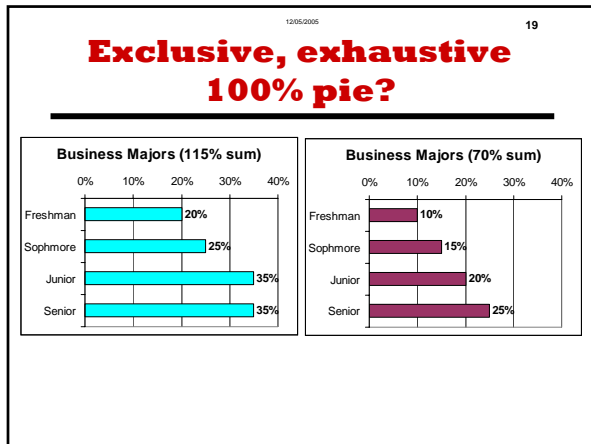
### Pie Chart 100% Whole is Visible

Do you take a multivitamin?

2% Don't know  
 44% Every day  
 33% Never  
 21% Not every day

By Anne R. Carey and Juan Thomassie, USA TODAY  
 Source: Opinion Research for Viactiv





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**53% sum. Exhaustive?  
100% Pie? Other slice?**

**Football is the USA's favorite sport**

Football	53%
NFL	23%
MLB	13%
NBA	10%
College football	7%

By Ellen J. Horrow and Gia Kereselidze, USA TODAY  
Source: ESPN Sports Poll, a service of TNS Intersearch

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**80% sum. 100% pie?  
Main Concern?**

**Parents' concerns in youth sports**

Injuries	39%
Aggression	16%
Drug use	15%
Competitiveness	10%

By Ellen J. Horrow and Chad Palmer, USA TODAY  
Source: Blue Cross Blue Shield Association

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**99% Sum. 100% pie?  
Favorite = exclusive?**

**Favorite tailgating food**

Hamburgers	38%
Hot dogs	35%
Chicken	26%

By Anne R. Carey and Chad Palmer, USA TODAY  
Source: Impulse for Johnsonville Sausage

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**172% sum. 100% pie?  
Most Favorite?**

Among a list of popular food combinations, 50% of adults say their favorite is spaghetti and meatballs.

**Favorite food duos**

Spaghetti & meatballs	50%
Mac & cheese	45%
Cereal & milk	42%
Peanut butter & jelly	35%

By Anne R. Carey and Gia Kereselidze, USA TODAY  
Source: NOP World for Mr. Clean

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**Bars add to 30%  
30% have B-stickers?**

**Types of bumper stickers we have**

Promotional	9%
University-related	9%
Political	6%
Humorous	6%

By Justin Dickerson and Rod Coddington, USA TODAY  
Source: Roper for Mercedes-Benz

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**Assembly  
More/Most**

**Incomplete (Null) comparatives.**

- More doctors like Crest than any other toothpaste than nurses liked Crest.

**Superlatives (Majority vs. Plurality)**

- Most doctors like Crest.
- Most girls were named Emily\* in 2004.
- \* Most common girl's name was Emily (1.24%)

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### Prevarication Today (Assembly)

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**No matter how much statistical prevarication there is in the news by**

- Special interest groups,
- Politicians and
- Journalists

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the financial prevarication by CPAs using **Actuarial data** may be of greater significance.

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### CPA Prevarication: State WC Reinsurance

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<b>Assets</b>		<b>2004</b>
Investments, at market value		1,437,902
Uncollected reinsurance premiums		
Deferred funded premiums		2,531
<b>Deferred for unfunded losses</b>		<b>160,000 CPA</b>
<b>Total assets</b>		<b>1,600,433</b>
<b>Liabilities</b>		
Losses and loss expenses		
Funded		1,159,143
<b>Unfunded</b>		<b>Actuary 160,000</b>
Other payables		290,981
<b>Total liabilities</b>		<b>1,610,124</b>

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### CONTEXT Standardizing

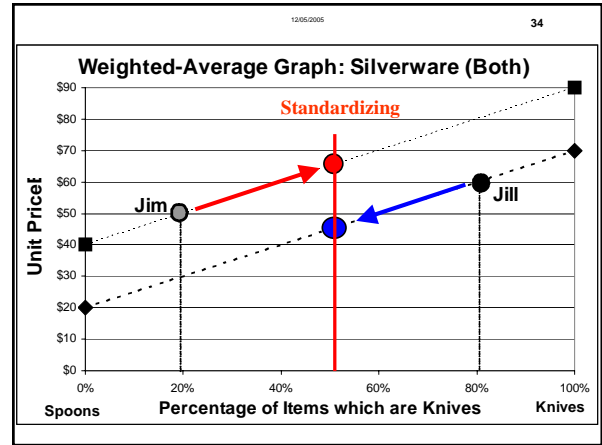
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Once you have ratios (percentages, rates or averages) or comparisons of ratios, many students mistakenly think no more can be done.

**Standardizing** takes into account the influence of confounders on ratios.

**Standardizing** links mathematics, confounding and context in ways that everyone should know.

**Standardizing** involves multivariate thinking.



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### Numbers in Context: Multivariate Thinking

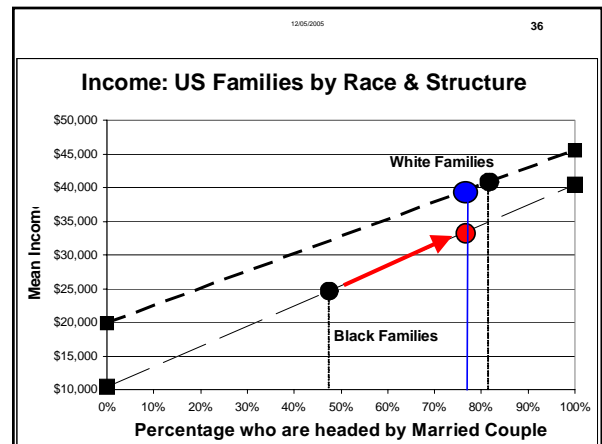
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Let's try an example in Public Affairs:

Average family income:

- \$41,000 for US white families
- \$25,000 for US black families
- \$16,000 is the black-white income gap

*Is this evidence of structural racism in America?*



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## Support Needed

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Educators in math/stats are leery of statistical literacy because it focuses on inductive arguments about causes. Each year, ~50% of incoming freshman take remedial algebra while ~70% of college grads study statistics. Does either help them make better decisions?

Support for Statistical Literacy is needed from those professions using numbers as evidence. E.g., Actuaries, Insurers, Epidemiologists, Operations Researchers, Financial Analysts, Investment Advisors and Bankers.

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## Thanks

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To Michael Round, President of the Kansas City Actuaries Club, for his kind invitation.

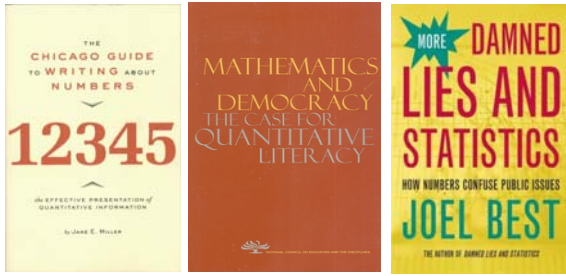
To the W. M. Keck Foundation for their grant to Augsburg College “to support the development of statistical literacy as an interdisciplinary curriculum in the liberal arts.”

To Joel Best, *Damned Lies & Statistics*, for seeing statistics as “social constructs.”

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## Statistical Literacy: Books

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## Suggestions

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1. Read overview articles on Statistical Literacy [www.StatLit.org/pdf/2004SchieldAACU.pdf](http://www.StatLit.org/pdf/2004SchieldAACU.pdf)
2. Buy *Damned Lies & Statistics* by Joel Best
3. Read article on statistical prevarication. [www.StatLit.org/pdf/2005SchieldIASE.pdf](http://www.StatLit.org/pdf/2005SchieldIASE.pdf)
4. Support Statistical Literacy
5. Encourage CPAs to be more responsible with actuarial data involving unfunded losses.

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## Recent Articles at

[www.Augsburg.edu/StatLit](http://www.Augsburg.edu/StatLit)

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Schield, Milo (2004). *Statistical Literacy and Liberal Education at Augsburg College*. AAC&U Peer Review

Schield, Milo (2005). *Information Literacy, Statistical Literacy and Data Literacy*. IASSIST IQ Quarterly.

Schield, Milo (2005). *Statistical Prevarication: Telling Half Truths Using Statistics*. IASE conference Sydney

Schield, Milo (2005). *Statistical Literacy: An Evangelical Calling for Statistical Educators*. ISI Au.

Terwilliger, Jim and Milo Schield (2004). *Frequency of Simpson's Paradox in NAEP Data*. AERA