



UNIVERSITY OF MINNESOTA

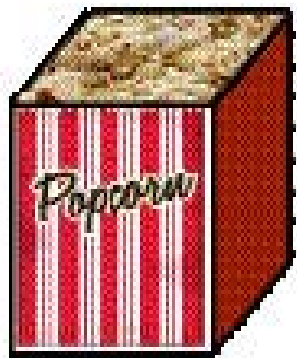
September 2009

Stat 1001 Popcorn

Sandy Weisberg
University of Minnesota
School of Statistics



How Much Would You Pay for Each of These Boxes of Popcorn?



Small
(24 oz, \$1.50)

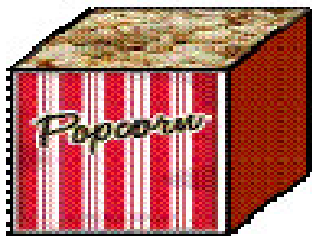
Medium

Large

Extra large



How About These?



Small
(24 oz, \$1.50)



Medium



Large



Extra large



Goals of this Study...

- Can people estimate relative sizes of things accurately? Who cares?
- Is there a difference between 3D rendering and 1D rendering?
- Make everyone hungry for popcorn



Describing this study

- Experiment or observational study?
- Subjects? Representative?
- Randomization?
- Measurement?



Biases in questions/design

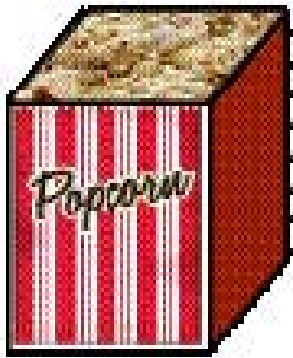
- Deliberate bias
- Unintentional bias
- Desire to please
- Asking the uninformed
- Unnecessary complexity
- Ordering of questions/conditions
- Confidentiality and anonymity and protection of subjects



What was wrong with the study we just did in class?

- Order effect
- Wrong measurement
- No context for the subjects
- No informed consent/Institutional Review Board approval





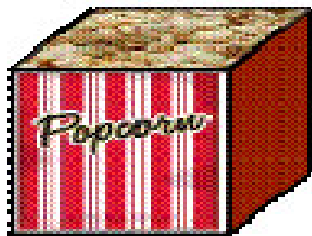
Small
(24 oz, \$1.50)

Medium
(40 oz, \$2.50)

Large
(67 oz, \$4.20)

Extra large
(112 oz, \$7.00)





Small
(24 oz, \$1.50)



Medium
(40 oz, \$2.50)



Large
(67 oz, \$4.20)



Extra large
(112 oz, \$7.00)



Volume Estimation

➤ Data from Tierney Lab Blog readers:

	True volume	1D mean estimate	3D mean estimate
Small	24	24	24
Medium	40	40	38
Large	67	62	60
XL	112	100	94



Price Estimation

	Actual Value	1D mean price	3D mean price
Small	\$1.50	\$1.50	\$1.50
Medium	\$2.50	\$2.34	\$2.22
Large	\$4.20	\$3.42	\$3.17
XL	\$7.00	\$4.75	\$4.27



Lanarkshire Milk Experiment

- Question (1930): Does supplementing diet with milk in school improve growth of children with poor diets?
- Study group 20,000 age 5 to 12 children in public schools in one county in Scotland

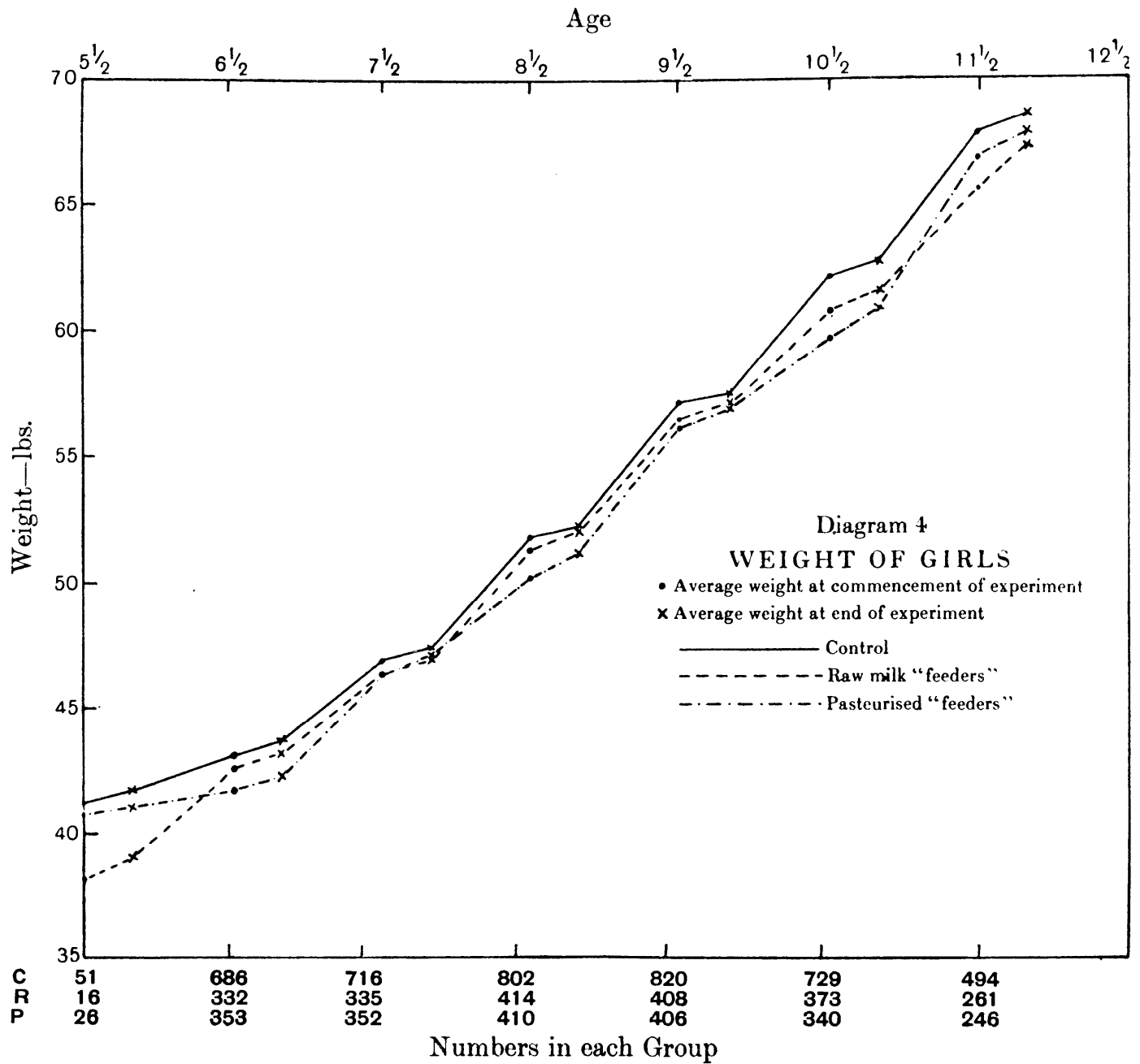


Protocol

- Weigh everybody in February
- Divide into 3 groups: 10,000 controls, 5,000 raw milk; 5,000 pasteurized milk.
- Weigh in June.
- Response = **Weight gain**

- Results...

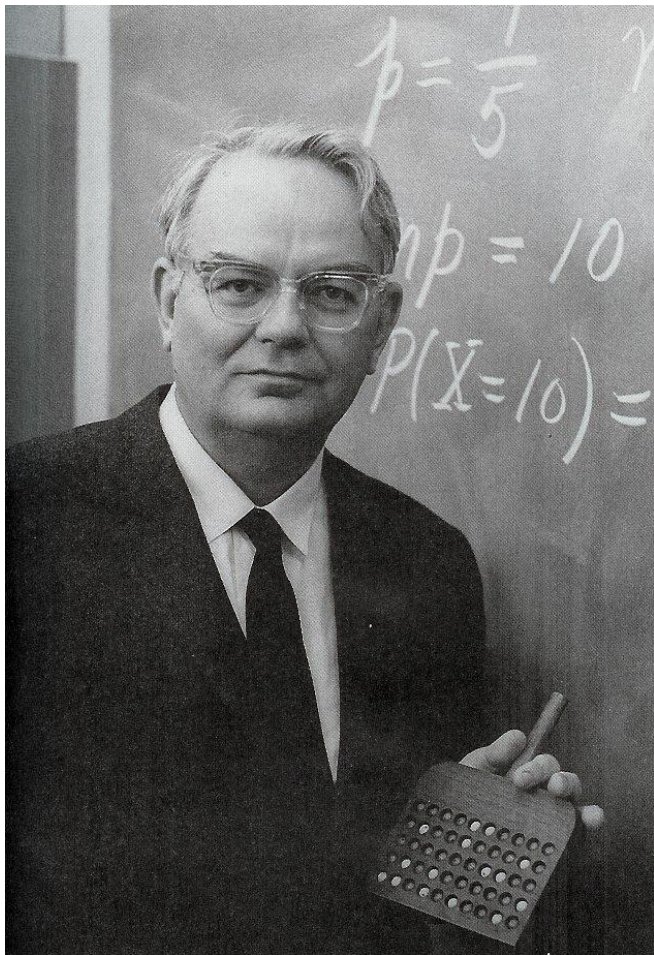




Controls did better than feeders, but...

- Selection bias: teachers were told to “balance” assignment of milk/control within class
- Measurement bias: It’s colder in Scotland in Feb. than in June, so children, especially well-fed ones, wear more clothes





“...[W]e often do not know which is the best of several possible policies and, worse yet, that we may not know if any of them betters what we are now doing.”

---J. Gilbert, R. J. Light and
Frederick Mosteller



References

- Utts, J. (2005). *Seeing Through Statistics*, 3rd Ed., Chapter 3.
- Popcorn:
<http://tierneylab.blogs.nytimes.com/2008/12/05/how-supersizing-seduces/>
- Student (1931). The Lanarkshire milk experiment, *Biometrika*,
<http://www.jstor.org/stable/2332424?origin=JSTOR-pdf>

