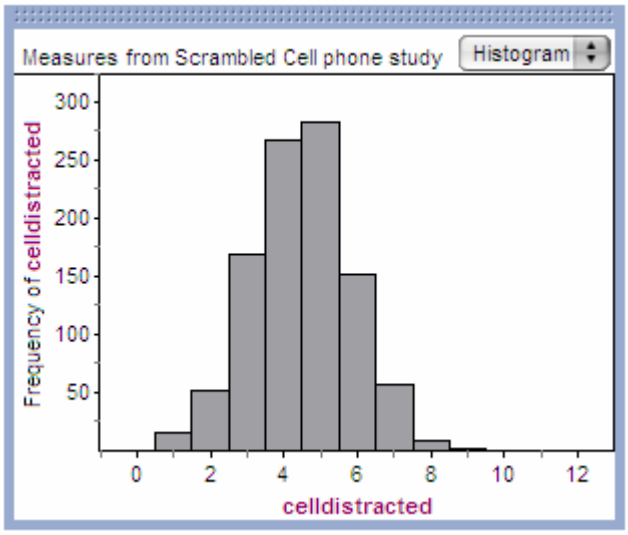
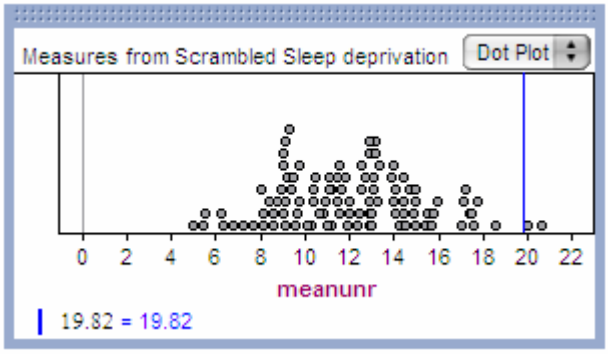
Inference: Early and often





Daren Starnes
The Lawrenceville School
dstarnes@lawrenceville.org

2008 TCM Conference
NCSSM

Comparing two proportions in a randomized experiment Distracted driving

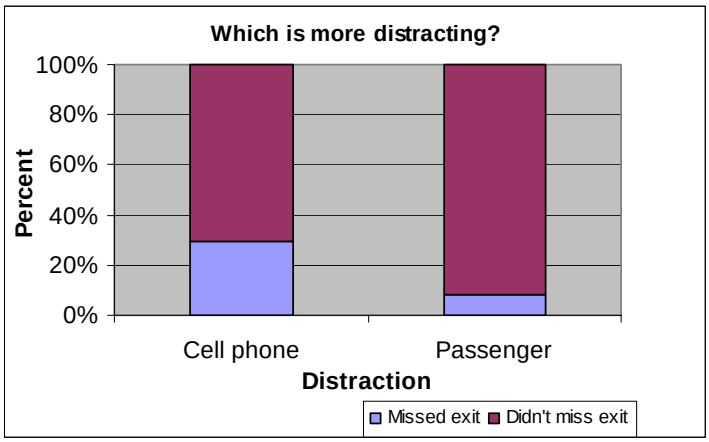
(from the 2007 AP Statistics Exam, question 5)

Researchers want to determine whether drivers are significantly more distracted while driving when using a cell phone than when talking to a passenger in the car. In a study involving 48 people, 24 people were randomly assigned to drive in a driving simulator while using a cell phone. The remaining 24 were assigned to drive in the driving simulator while talking to a passenger in the simulator. Part of the driving simulation for both groups involved asking drivers to exit the freeway at a particular exit. In the study, 7 of the 24 cell phone users missed the exit, while 2 of the 24 talking to a passenger missed the exit.

Research Question: Are drivers more distracted while driving when using a cell phone than when talking to a passenger in the car?

Data production:

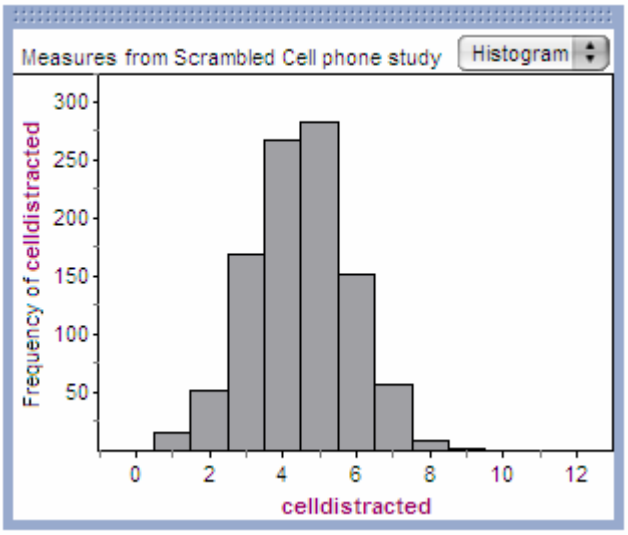
Data analysis: Here is a comparative bar graph of the data.



If there was <u>no</u> "treatment effect", i.e. no difference in driver distraction when talking on a cell phone or when talking to a passenger, then each driver's result (in terms of missing the exit) would be the same no matter which group (s)he was in. How likely is it that we would observe as large a difference as the one in this study simply as a result of the chance involved in the random assignment of subjects to groups? Put another way, how likely is it that we would observe 7 or more drivers in the cell phone group missing the exit just by the luck of the random assignment?

<u>Simulation Activity:</u> Give each group a standard deck of playing cards. We need 48 cards to represent the 48 drivers in this study. Remove the 10, J, Q, and K of clubs from the deck. Since we are assuming that there is no treatment effect, that means there will be 9 drivers who miss the exit and 39 drivers who don't. Let the A through 9 of clubs represent missing the exit, and all other cards represent not missing the exit. "Shuffle up and deal" 24 cards representing the cell phone group. Count how many drivers miss the exit. Repeat this process 4 times. Pool results with your classmates.

Probability model: Here are the results of a computer simulation showing the number of drivers who missed the exit in the cell phone group in each of 1000 re-randomizations using Fathom software.



How often did the random assignment of subjects to the two groups result in 7 or more drivers in the cell phone group missing the exit? Do you think the results of this study could be simply the result of the random assignment under the assumption that there is no treatment effect?

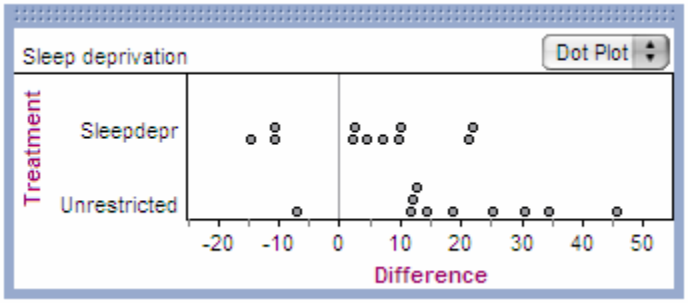
Inference:

For the full student activity and teacher notes, go to
http://courses.ncssm.edu/math/Stat_Inst/Stats2007/2007_statistics_institute.htm

Comparing two means in a randomized experiment Sleep deprivation
(from Rossman, Cobb, Chance, and Holcomb's NSF project shared at JMM 2008 in San Diego)

Researchers have established that sleep deprivation has a harmful effect on visual learning. But do these effects linger for several days, or can a person "make up" for sleep deprivation by getting a full night's sleep on subsequent nights? A recent study (Stickgold, James, and Hobson, 2000) investigated this question by randomly assigning 21 subjects (volunteers between the ages of 18 and 25) to one of two groups: one group was deprived of sleep on the night following training and pre-testing with a visual discrimination task, and the other group was permitted unrestricted sleep on that first night. Both groups were then allowed as much sleep as they wanted on the following two nights. All subjects were then re-tested on the third day. Subjects' performance on the test was recorded as the minimum time (in milliseconds) between stimuli appearing on a computer screen for which they could accurately report what they had seen on the screen. The sorted data and dotplots presented here are the improvements in those reporting times between the pre-test and post-test (a negative value indicates a decrease in performance):

Sleep deprivation (n = 11): −14.7, −10.7, −10.7, 2.2, 2.4, 4.5, 7.2, 9.6, 10.0, 21.3, 21.8
Unrestricted sleep (n = 10): −7.0, 11.6, 12.1, 12.6, 14.5, 18.6, 25.2, 30.5, 34.5, 45.6



(a) Does it appear that subjects who got unrestricted sleep on the first night tended to have higher improvement scores than subjects who were sleep deprived on the first night? Explain briefly.

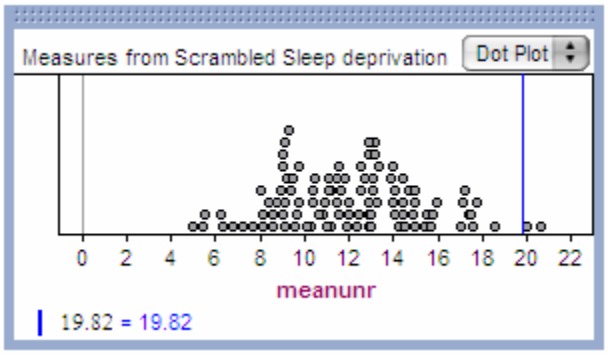
(b) Is it possible that there's really no harmful effect of sleep deprivation, and random chance alone produced the observed differences between these two groups?

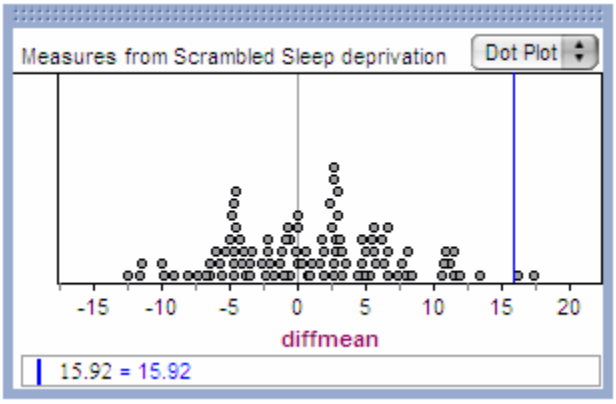
Simulation of the random assignment

- Place 21 cards (subjects) in a bag
- If no difference in treatment effects, then values same as in original study
- How large a difference in group means with different random assignments?
- Mix your cards and draw 10 to represent the unrestricted group.
- Compare your mean to 19.82. Report.

Computer simulation with Fathom

What's the difference in what these two displays are showing?





For George Cobb's article on a randomization-based approach to teaching inference, visit
http://repositories.cdlib.org/uclastat/cts/tise/vol1/iss1/art1/