Statistical Hypothesis Testing

Stat 120

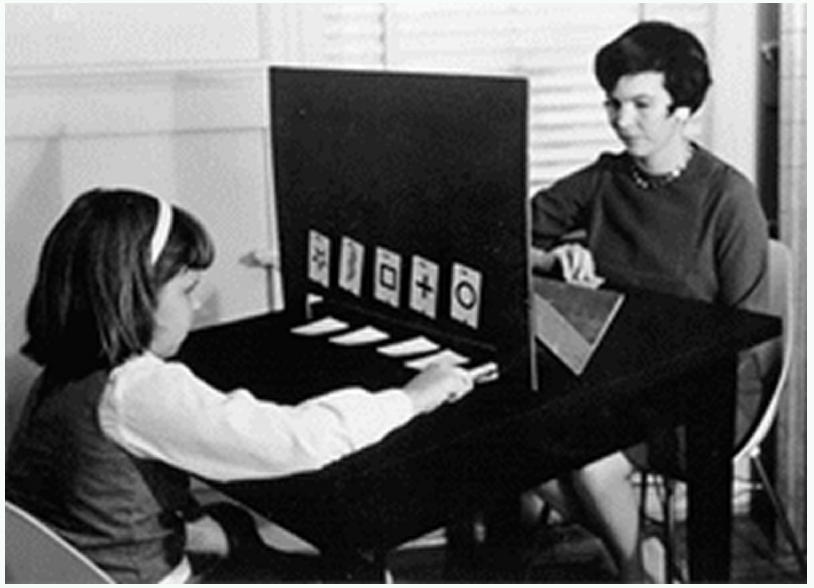
April 17 2023

Extrasensory Perception

SOURCE: Americans' Belief in Psychic and Paranormal Phenomena Is up Over Last Decade (8 June 2001), http://www.gallup.com/poll/4483/Americans-Belief-Psychic-Paranormal-Phenomena-Over-Last-Decade.aspx

Extrasensory Perception

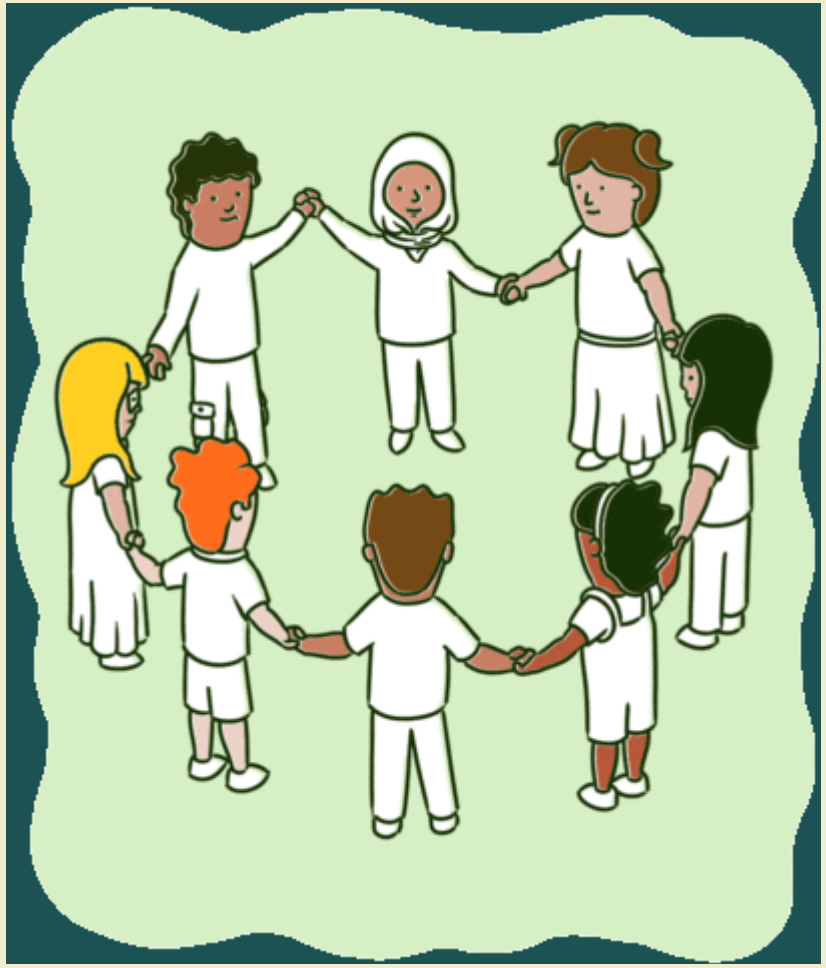
One way to test for ESP is with Zener cards:



Subjects draw a card at random and telepathically communicate this to someone who then guesses the symbol

YOUR TURN 1

10:00



- Randomly choose a letter from A B C D E and write it down (don't show anyone!)
- Find a partner, telepathically communicate your letter (no auditory or visual clues!) and have them guess your letter.
- Repeat a couple of times then switch roles.

How often did you guess correctly?

Suppose you did this 10 times and guessed correctly 3 times. Is this evidence that you have ESP abilities?

Extrasensory Perception

There are five cards with five different symbols. If there is no such thing as ESP, what proportion p of guesses should be correct?

1. $\mathrm{p} = 0$
2. $\mathrm{p} = 1/4$
3. $\mathrm{p} = 1/5$
4. $\mathrm{p} = 1/2$

▶ Click for answer

Extrasensory Perception

Let $\hat{p}$ denote the sample proportion of correct guesses. Which of the statistics below would give the strongest evidence for ESP?

1. $\hat{\text{p}} = 0$
2. $\hat{\text{p}} = 1/5$
3. $\hat{\text{p}} = 1/2$
4. $\hat{\text{p}} = 3/4$

▶ Click for answer

Extrasensory Perception

- *As we've learned, statistics vary from sample to sample*
- *Even if the "population/true" proportion is* $\mathrm{p} = 1/5$*, not every sample proportion will be exactly* $1/5$

Extrasensory Perception

- ***As we've learned, statistics vary from sample to sample***
- ***Even if the "population/true" proportion is*** $\mathrm{p} = 1/5$***, not every sample proportion will be exactly*** $1/5$

How do we determine when a sample proportion is far enough above 1/5 to provide evidence of ESP?

Statistical Test

A statistical test uses data from a sample to assess a claim about a population or experiment

Null Hypothesis: (H_0) ***Claim that there is no effect or difference.***

Alternative Hypothesis: (H_a) ***Claim for which we seek evidence.***

Statistical Test

A statistical test uses data from a sample to assess a claim about a population or experiment

Null Hypothesis: (H_0) ***Claim that there is no effect or difference.***

Alternative Hypothesis: (H_a) ***Claim for which we seek evidence.***

Always claims about **population parameters.**

ESP Hypothesis

For the ESP experiment:

- $H_0 : p = 1/5$
- $H_a : p > 1/5$

Helpful hints

- H_0 usually includes $=$
- H_a usually includes $>, <$, or $\neq$
- The direction in H_a depends on the question being asked, not based on what the data shows!
- The data should be used as an evidence supporting or refuting H_a.

Sleep Vs. Caffeine

Students were given words to memorize, then randomly assigned to take either a 90 min nap, or a caffeine pill. $2\frac{1}{2}$ hours later, they were tested on their recall ability.

- ***Explanatory variable: sleep or caffeine***
- ***Response variable: number of words recalled***

Research Question: Is sleep or caffeine better for memory?

Mednick, Cai, Kanady, and Drummond (2008). "Comparing the benefits of caffeine, naps and placebo on verbal, motor and perceptual memory," Behavioral Brain Research, 193, 79-86.

Sleep Vs. Caffeine

What is the parameter of interest in the sleep versus caffeine experiment?

1. Proportion
2. Difference in proportions
3. Mean
4. Difference in means
5. Correlation

▶ Click for answer

Sleep Vs. Caffeine

Let μ_s and μ_c be the mean number of words recalled after sleeping and after caffeine.

Sleep Vs. Caffeine

Let μ_s and μ_c be the mean number of words recalled after sleeping and after caffeine.

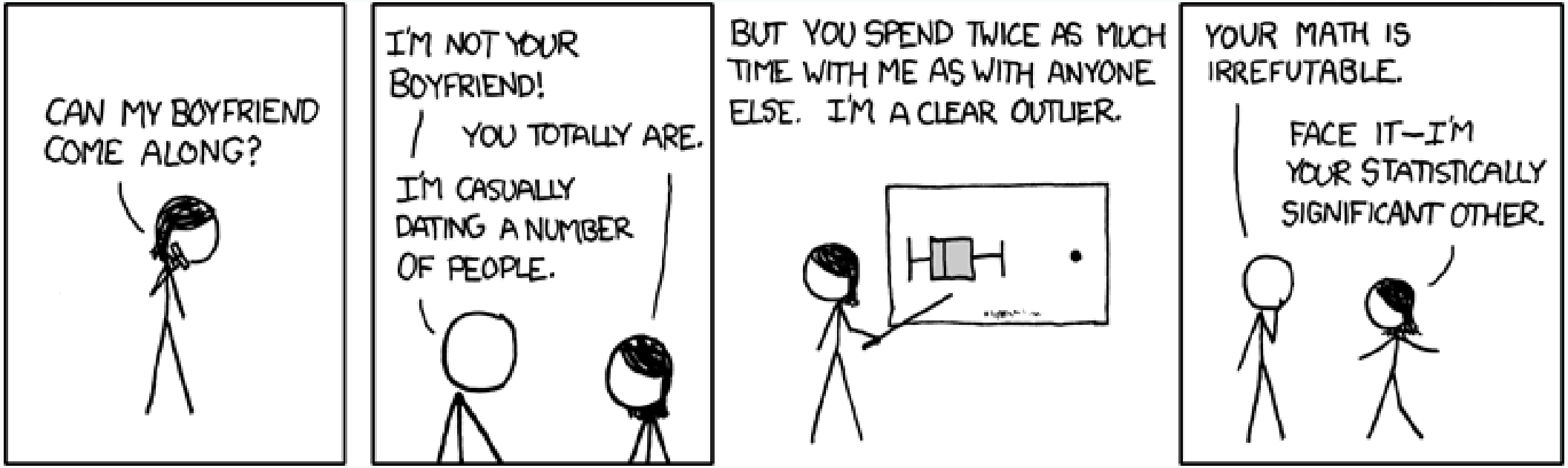
- ***Is there a difference in average word recall between sleep and caffeine?***

Sleep Vs. Caffeine

- *What are the null and alternative hypothesis?*

1. $H_0: \mu_s \neq \mu_c$, $H_a: \mu_s = \mu_c$
2. $H_0: \mu_s = \mu_c$, $H_a: \mu_s \neq \mu_c$
3. $H_0: \mu_s \neq \mu_c$, $H_a: \mu_s > \mu_c$
4. $H_0: \mu_s = \mu_c$,

Statistical Significance



xkcd.com

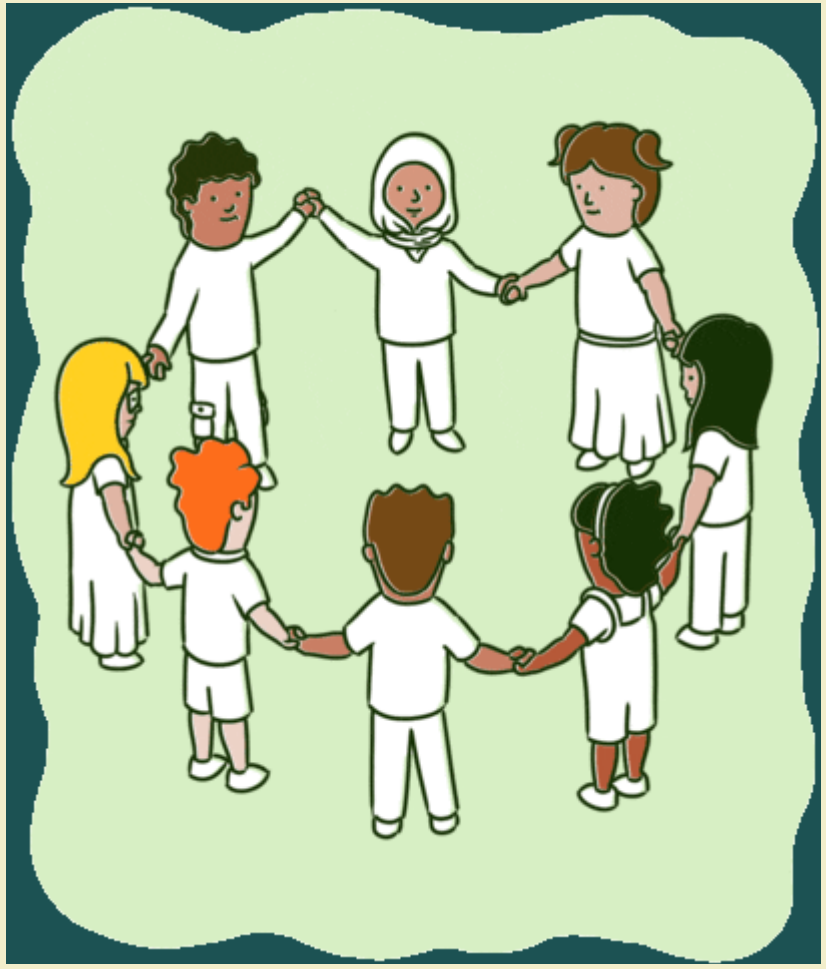
Statistical Significance

When results as extreme as the observed sample statistic are unlikely to occur by random chance alone (assuming the null hypothesis is true), we say the sample results are statistically significant

- *If our sample is statistically significant, we have convincing evidence against* H_0, *in favor of* H_a
- *If our sample is not statistically significant, our test is inconclusive. The null hypothesis may be true (or maybe not).*

YOUR TURN 2

15:00



- *Please work on the in-class activity and we will discuss this together!*
- *We will also do a brief midterm review if time permits!*