EDP308: STATISTICAL LITERACY

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Overview

- Statistical Significance
  - Reject or Fail to Reject the Null
- Making Mistakes – Type of Errors
  - Type I: False Positive
  - Type II: False Negative
- Sources of Error
  - Issues with Sample Size
  - Issues with Alpha Level
  - Power

Statistical Significance

- When we "Reject the Null Hypothesis," we are saying that the probability of seeing this results ($\bar{x}$), if the Null were true, is low enough (ex. less than 5% chance) that we can reject the idea that we live in the null world. We can conclude there is a statistically significant result. But… There IS still a chance the null might be true. It may be small chance but still a legitimate chance…
- When we "Reject the Null," but the Null is actually true, we've just made a mistake. We've committed an error…

Types of Errors

Type I

Type II

Making Mistakes

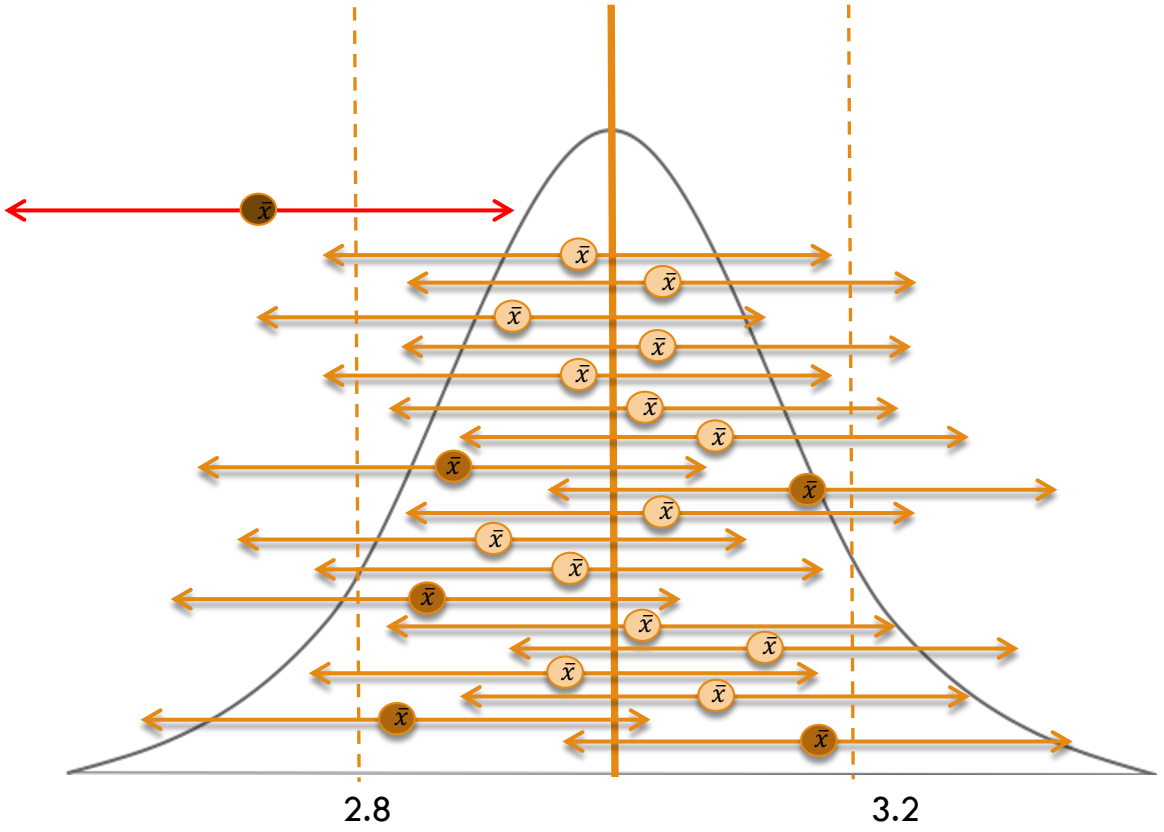
- Even with our powerful statistical tools, and even with a very small probability (ex. $p<.01$), we can still be wrong…
  - Could be that 1 in 100
- There are two main types of errors:
  - Type I: False Positive
  - Type II: False Negative

False Positives and True Negatives

		Reality (Truth)	
		No Effect (True H_0)	Effect (True H_1)
Test Results	Effect (Reject H_0)	False Positive Type I Error, α	True Positive (Correct)
	No Effect (Fail to Reject H_0)	True Negative (Correct)	False Negative Type II error, β

Type I Error: False Positive

- We could be that 1 in 20 (if $\alpha = .05$), concluding there is some difference when there is not…
- This would be an example of a False Positive (Type I Error). Saying there is something there but there really isn't.



Mistakes Were Made

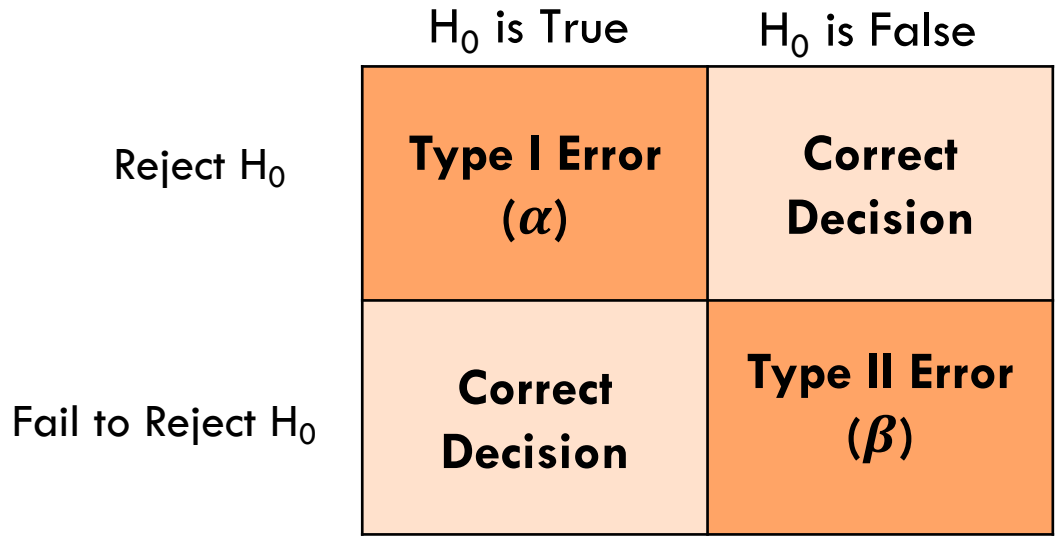
- I'm an excited research, anxious to release a new drug… I do some tests and conclude that it does indeed work better than placebo. But in reality the drug has no effect.

What kind of error have I committed?

	H_0 is True	H_0 is False
Reject H_0	**Type I Error (α)**	**Correct Decision**
Fail to Reject H_0	**Correct Decision**	**Type II Error (β)**

Mistakes Were Made

- I'm an excited research, anxious to release a new drug… I do some tests and conclude that it does indeed work better than placebo. But in reality the drug has no effect.
- I've committed a Type I Error, False Positive. I incorrectly reject the Null when it was in fact true.



Mistakes Were Made

- I'm an excited but poor research, and I can only afford a small sample. I do some tests and conclude that my new breakthrough therapy doesn't actually work. But in reality the treatment does have an effect!

What kind of error have I committed?

	H_0 is True	H_0 is False
Reject H_0	**Type I Error (α)**	**Correct Decision**
Fail to Reject H_0	**Correct Decision**	**Type II Error (β)**

Mistakes Were Made

- I'm an excited but poor research, and I can only afford a small sample. I do some tests and conclude that my new breakthrough therapy doesn't actually work. But in reality the treatment does have an effect!
- I've committed a Type II Error, False Negative. I incorrectly FAILED to reject the Null when it was in fact false.

	H_0 is True	H_0 is False
Reject H_0	**Type I Error (α)**	**Correct Decision**
Fail to Reject H_0	**Correct Decision**	**Type II Error (β)**

Type I Error, False Positives

- Type I Errors are typically the types of errors we work hard to account for and avoid committing.
  - We'll see this when we look at ANOVA and family-wise (also called experiment-wise) alpha.
- The probability of a **Type I Error** is equal to α
  - If we choose a lenient cutoff, say $\alpha = .10$ (1 in 10), we have higher chances of committing a Type I Error

Type II Errors – False Negatives

- Type II Errors in social science research can occur when there is a limited sample size or alpha is strict.
  - In medical testing, Type II Errors can have heavy consequences. One potentially dangerous example of a Type II error is when someone takes a medical test (ex. cancer screening or COVID-19 test) and is told the test is NEGATIVE when in fact they DO actually have the disease. These types of errors can occur because medical tests are not 100% accurate at detected true positives and true negatives.

The Gist of It

- Type I Errors:

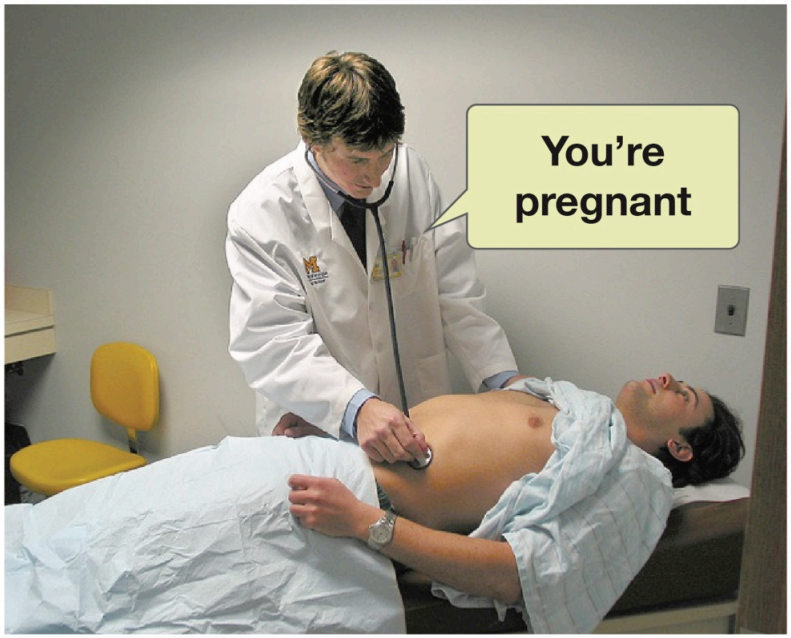
  Saying there IS something when there is NOT.

- Type II Errors:

  Saying there IS NOT something there when there IS.

A tangible example…

Type I error
(false positive)



Type II error
(false negative)

Some Sources of Error

- The probability of a **Type I Error** is equal to α
  - If we choose a lenient cutoff, say $\alpha = .10$ (1 in 10), we have higher chances of committing a Type I Error
- **Type II Errors** occur when we fail to find a significant effect when in reality there is an effect
  - This is related to Power: The probability of correctly rejecting a null when the null is in fact false
  - If we make cutoff criteria very strict (i.e. if we make α very small, .001), higher chances of **not** finding a significant effect
- The probability of a **Type II Error** occurring is high when:
  - When n is small
    - You don't have enough Power
  - α is very small
    - You're criteria is very strict

Up Next…

- We will finally dive into all the different types of Hypothesis Testing, starting with…

t-tests