Type I and II Errors

- When we make a decision about the null hypothesis there are four possible outcomes (2 correct and 2 incorrect)

	Actual Situation	
Researcher's Decision	Null Hypothesis is True	Null Hypothesis is False
Fail to reject the Null Hypothesis	Correct Decision (prob = $1 - \alpha$)	Type II Error (prob = β)
Reject the Null Hypothesis	Type I Error (prob = α)	Correct Decision (prob = $1 - \beta$, power)

Type I and II Errors, Power

- $p(\text{Type I error}) = p(\text{rejecting } H_0 | H_0 \text{ is true}) = \alpha$
- $p(\text{Type II error}) =$
  $p(\text{failing to reject } H_0 | H_0 \text{ is false}) = \beta$
- $\text{Power} = p(\text{rejecting } H_0 | H_0 \text{ is false}) = 1 - \beta$

Power

- $\text{Power} = p(\text{rejecting } H_0 | H_0 \text{ is false}) = 1 - \beta$
- Power is the probability of rejecting the null hypothesis when the null hypothesis is false (i.e., the ability to detect an effect if the effect actually exists)
- Power is determined from the Alternative Distribution

Effect Size

- The Cohen's d formula for a one-sample z-test is

$$d = \frac{M - \mu_0}{\sigma}$$

  - This tells us the two means differ by d standard deviations

Cohen’s d

- Cohen’s d interpretation

Verbal description	Effect size (d)
Small	$d < .20$
Medium	$.20 < d < .80$
Large	$d > .80$

One-sample t-test

- The z-statistic versus t-statistic
  - *z*-statistic:

$$z = \frac{M - \mu_0}{\sigma_M} = \frac{M - \mu_0}{\frac{\sigma}{\sqrt{n}}}$$

  - *t*-statistic:

$$t = \frac{M - \mu_0}{s_M} = \frac{M - \mu_0}{\frac{s}{\sqrt{n}}}$$

Effect Size

- The effect size, Cohen's *d,* for a one-sample t-test is computed the same as the one-sample z-test except s is used instead of σ

$$d = \frac{M - \mu_0}{s}$$