CHAPTER 8
POWER & EFFECT SIZE

For EDUC/PSY 6600

“Cohen (1994): “Next, I have learned and taught that the primary product of research inquiry is one or more measures of effect size, not *p* values.” (p. 1310).

Abelson (1995): “However, as social scientists move gradually away from reliance on single studies and obsession with null hypothesis testing, effect size measures will become more and more popular” (p. 47).”

Types of Errors

When we conduct a hypothesis test, we wither reject or fail to reject the Null Hypothesis. Our decision usually causes four outcomes:

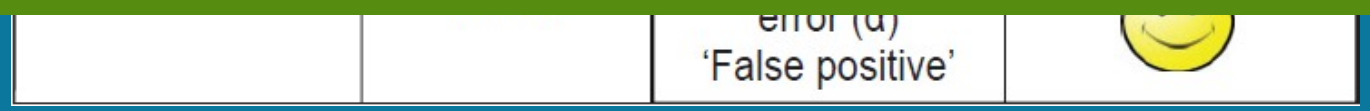
		REALITY	
		NULL HYPOTHESIS	
		TRUE	FALSE
STUDY FINDINGS	TRUE		Type II error (β) 'False negative'
	FALSE	Type I error (α) 'False positive'	

Types of Errors

When we conduct a hypothesis test, we wither reject or fail to reject the Null

$$\underline{\text{Power} = 1 - \beta}$$

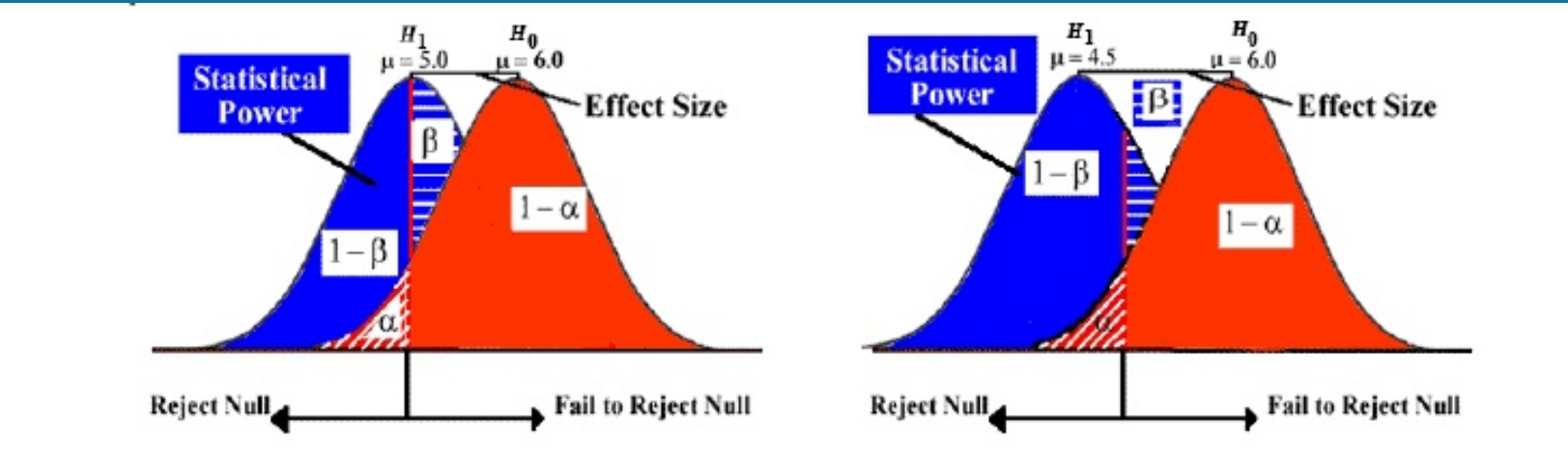
"the probability of correctly rejecting a falsely rejecting a false null hypothesis."



Effect Sizes

$$\text{Cohen's } d = \frac{\bar{X}_1 - \bar{X}_2}{s_p} \text{ or } t\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$$

$$\eta^2 = r_{pb}^2 = \frac{t^2}{t^2 + (n_1 + n_2 - 2)}$$



Effect Sizes

$$\text{Cohen's } d = \frac{\bar{X}_1 - \bar{X}_2}{s_p} \text{ or } t\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$$

Cohen's d	Interpretation
.2	Small
.5	Moderate
.8	Large

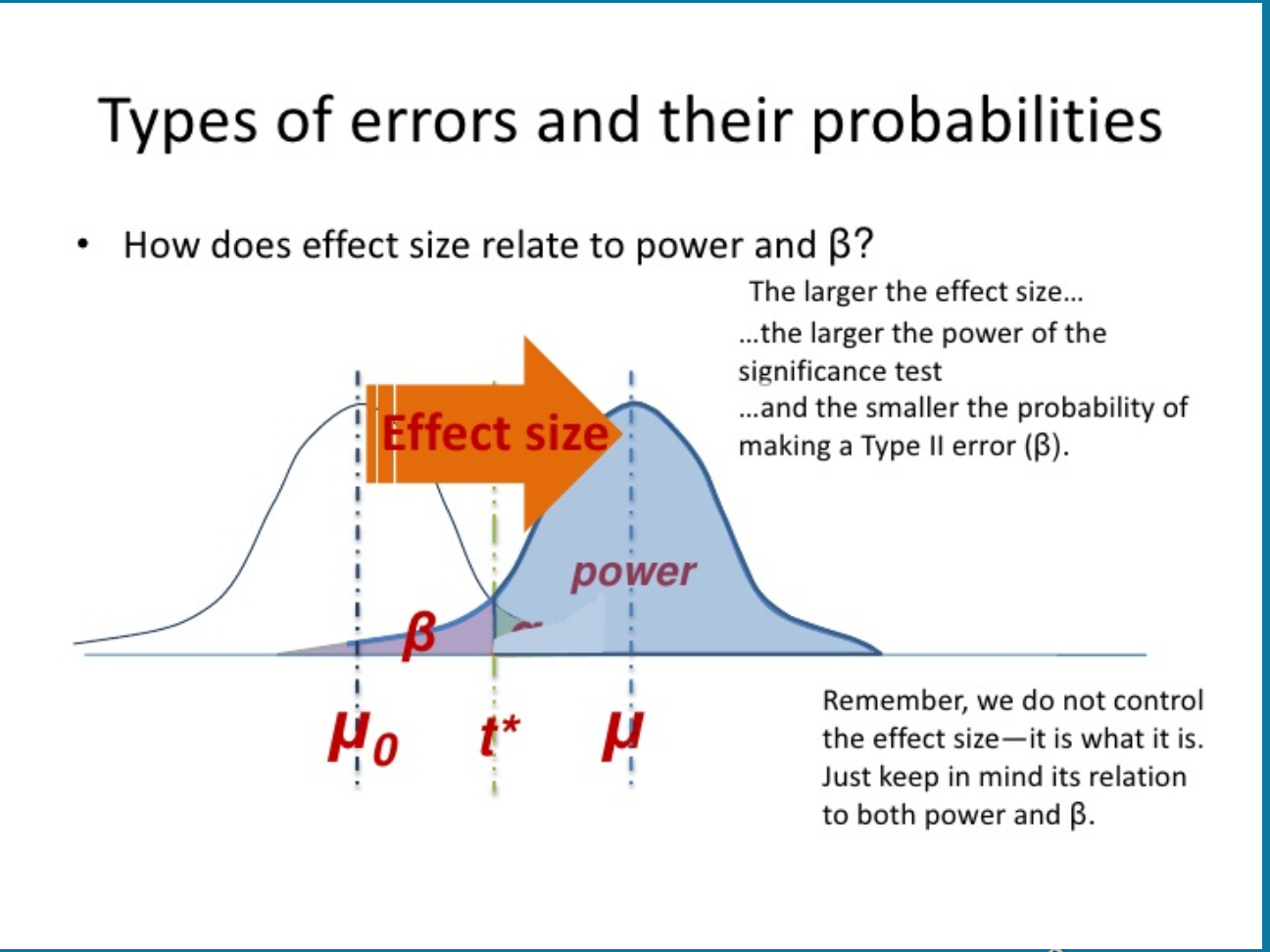
Effect Sizes

$$\eta^2 = r_{pb}^2 = \frac{t^2}{t^2 + (n_1 + n_2 - 2)}$$

- η^2 (eta squared) and r_{pb}^2
  - association between grouping variable (IV) and continuous DV
  - Ranges from 0 to 1
  - With only 2 groups, results are same

What affects power?

1. Sample Size
   - Larger sample = more power
2. Effect Size
   - Larger Effect size = more power
3. Alpha Level
   - Higher Alphas = more power
4. Directionality
   - One tail = more power



Power Analysis

- Non-centrality parameter is calculated by:

$$\delta = \frac{d}{\sigma\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

- Since it's assumed that the…
  - Variances are same in 2 groups
  - *n*s are same in 2 groups
- …and since σ is often assumed to be 1…
- …the equation is simplified…

	One-Tailed Test (α)			
	.05	.025	.01	.005
	Two-Tailed Test (α)			
δ	.10	.05	.02	.01
0.5	.14	.08	.03	.02
0.6	.16	.09	.04	.02
0.7	.18	.11	.05	.03
0.8	.21	.13	.06	.04
0.9	.23	.15	.08	.05
1.0	.26	.17	.09	.06
1.1	.29	.20	.11	.07
1.2	.33	.22	.13	.08
1.3	.37	.26	.15	.10
1.4	.40	.29	.18	.12
1.5	.44	.32	.20	.14
1.6	.48	.36	.23	.16
1.7	.52	.40	.27	.19
1.8	.56	.44	.30	.22
1.9	.60	.48	.33	.25
2.0	.64	.52	.37	.28
2.1	.68	.56	.41	.32
2.2	.71	.60	.45	.35
2.3	.74	.63	.49	.39
2.4	.77	.67	.53	.43
2.5	.80	.71	.57	.47
2.6	.83	.74	.61	.51
2.7	.85	.77	.65	.55
2.8	.88	.80	.68	.59
2.9	.90	.83	.72	.63

When $n_1 = n_2$

$$\delta = \mathbf{d}\sqrt{\frac{n_k}{2}}$$

$$n_k = 2\left(\frac{\delta}{\mathbf{d}}\right)^2$$

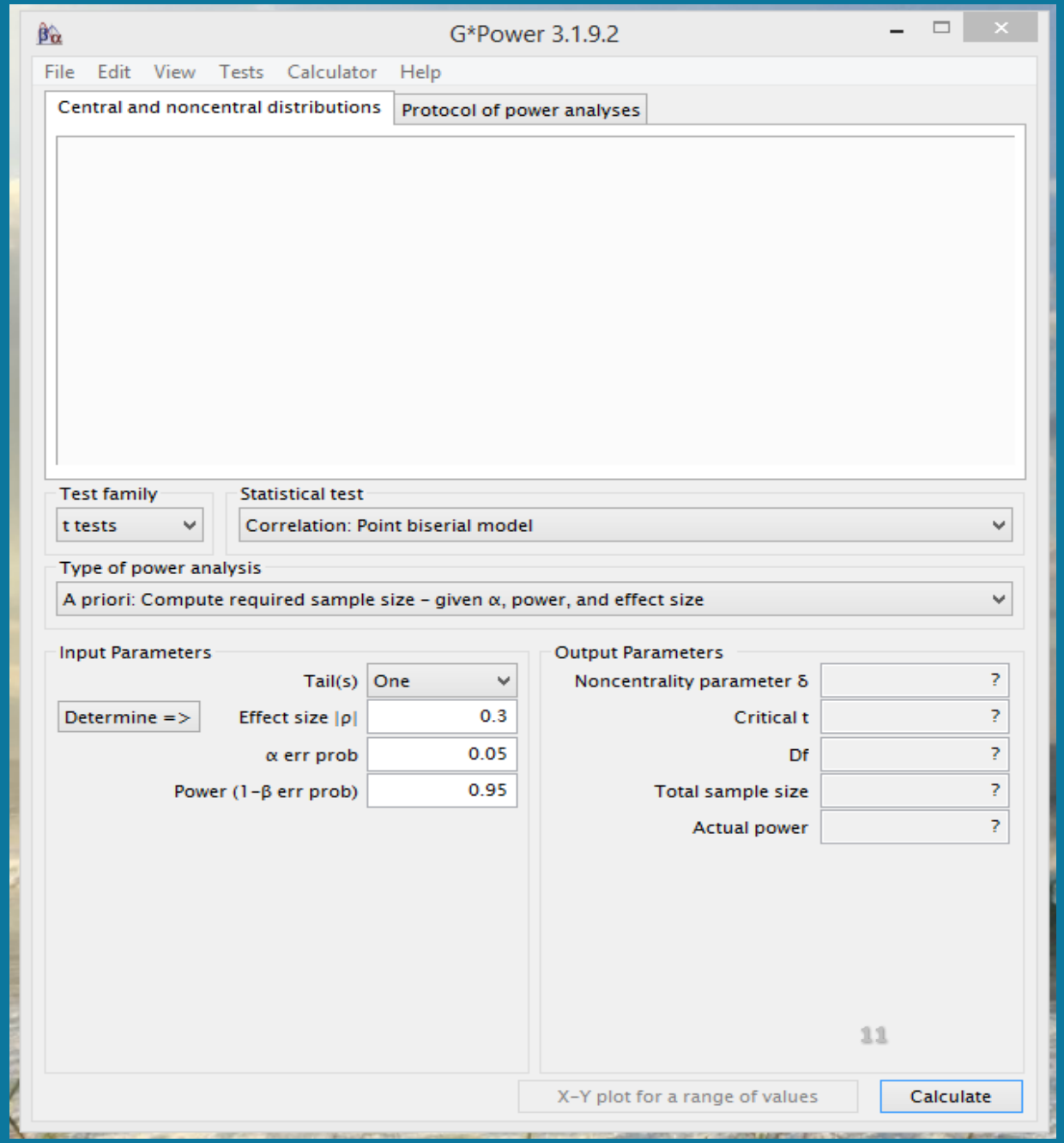
When $n_1 \neq n_2$

$$\bar{n}_h = \frac{2}{\frac{1}{n_1} + \frac{1}{n_2}} = \frac{2n_1n_2}{n_1 + n_2}$$

$$\delta = \mathbf{d}\sqrt{\frac{\bar{n}_h}{2}}$$

G-POWER

Download at: http://www.gpower.hhu.de/



CHAP 8: SECTION A

- These exercises make it clear to the student that:
  - **d** is just the number of standard deviations that separate two population means, and
  - *g* is the number of standard deviations (based on pooling the sample variances and taking the square-root) separating the sample means.
- Exercise 9 requires students to draw the connection between a calculated *t* and delta; large *t*s are *usually* associated with large deltas, and small *t*s *usually* with small deltas. Of course, the alternate hypothesis distribution shows that *t* can occasionally come out very differently from delta

CHAP 8: SECTION B

The most important purpose of these exercises is not to prepare students for power analyses of their own future experiments (although that is one of the purposes), but to **deepen students' understanding of null hypothesis testing**, and increase their appreciation for the need to supplement hypothesis testing with estimates of **effect size or confidence interval**s. Some students get confused when they realize that *an estimate of power is only as good as the estimate of effect size upon which it is based*, but that determining the effect size is usually the purpose (or should be) of the experiment. … The center of the AHD (i.e., delta) is determined by both the **true effect size** and the **sample sizes**. The last few exercises are concerned with refining students' abilities to estimate the power of a study already conducted.