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).

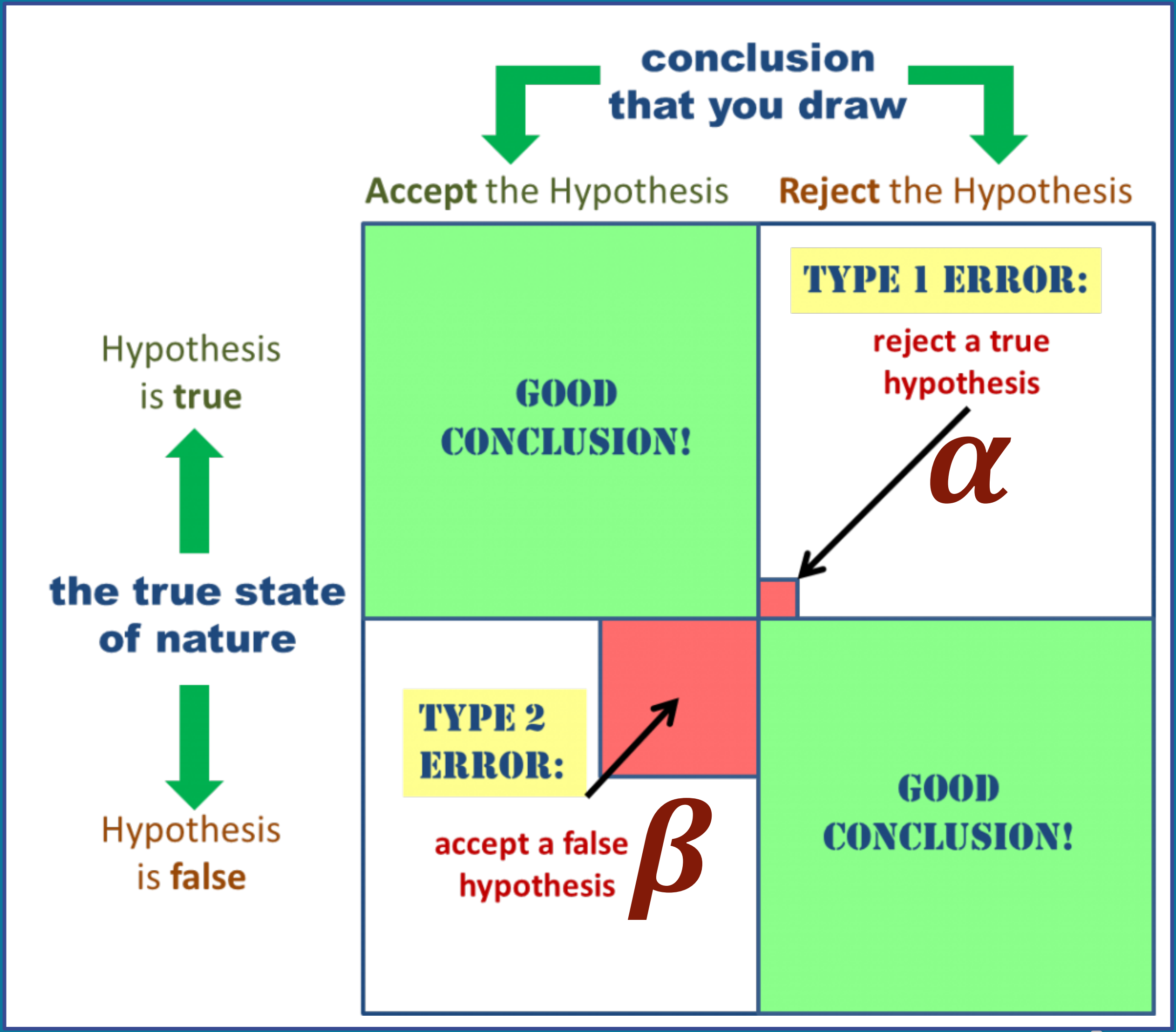
”

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:



Types of Errors

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

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

Some background on power, effect size, p-values, and test statistics:

Calculated

Before collecting data

Power
(given expected effect size, alpha, n)

P-value
(the alpha level, usually .05)

Effect Size
(how big you expect the effect to be)

Test Statistic
(the cut-off point)

Observed

After collecting and analyzing data

Power
(did you get significance?)

P-value
(the observed p-value)

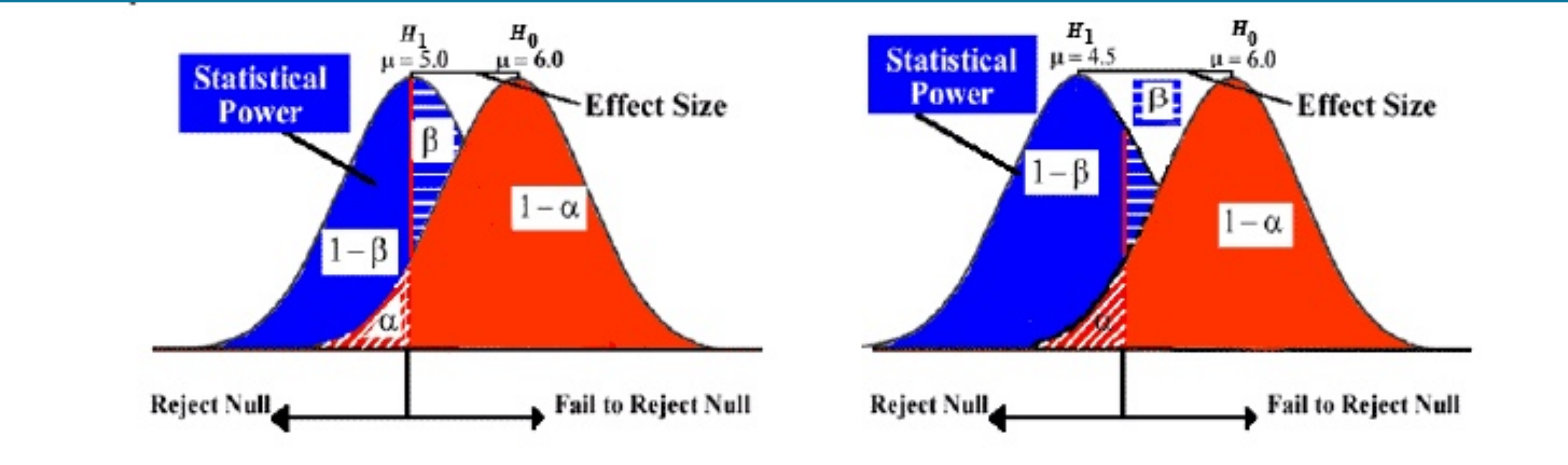
Effect Size
(how big the effect was in your sample)

Test Statistic
(the observed test statistic from data)

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

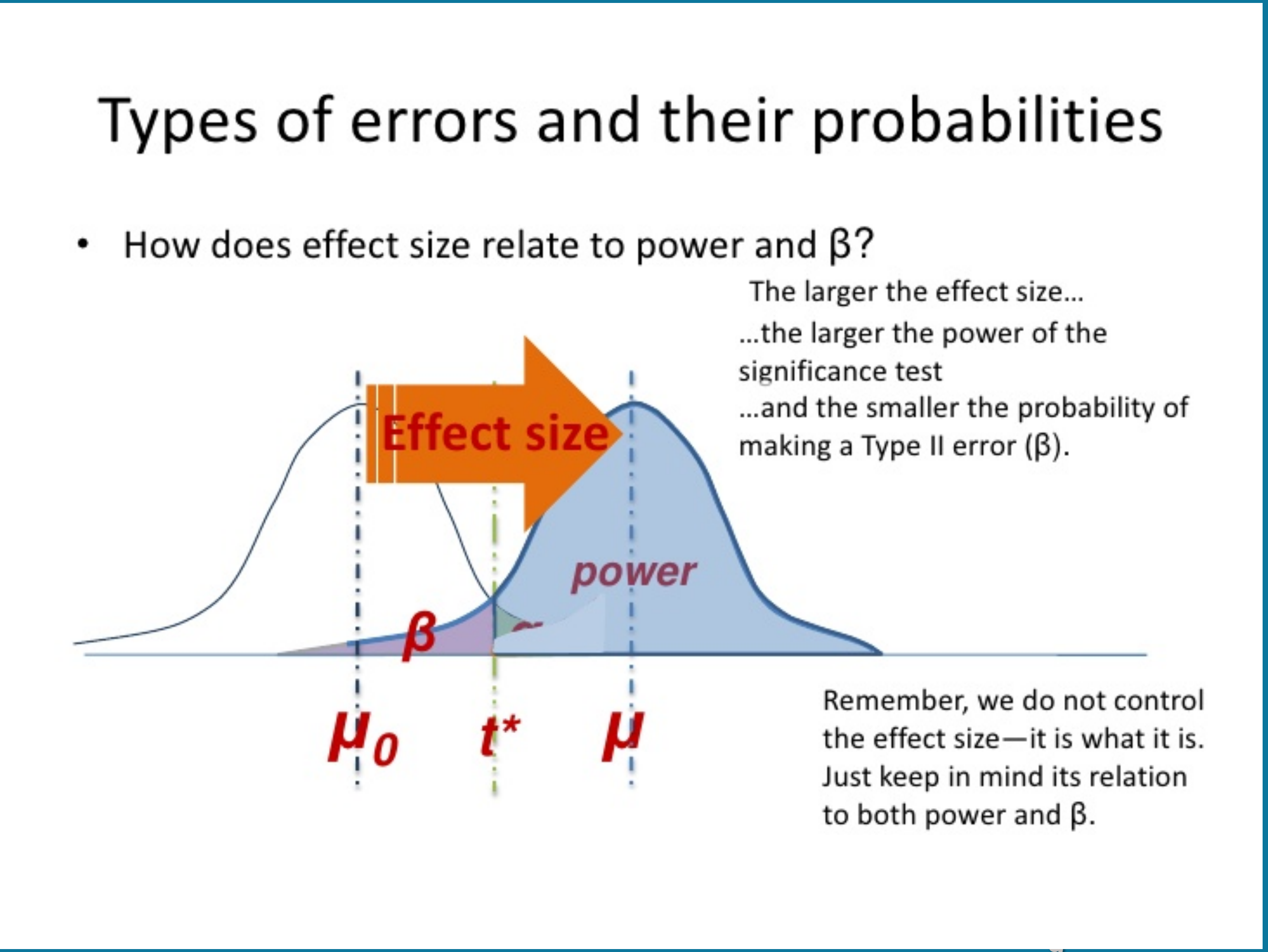
$$\eta^2 = r_{pb}^2 = \frac{t^2}{t^2 + (n_1 + n_2 - 2)}$$

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 $n_1 = n_2$

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

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

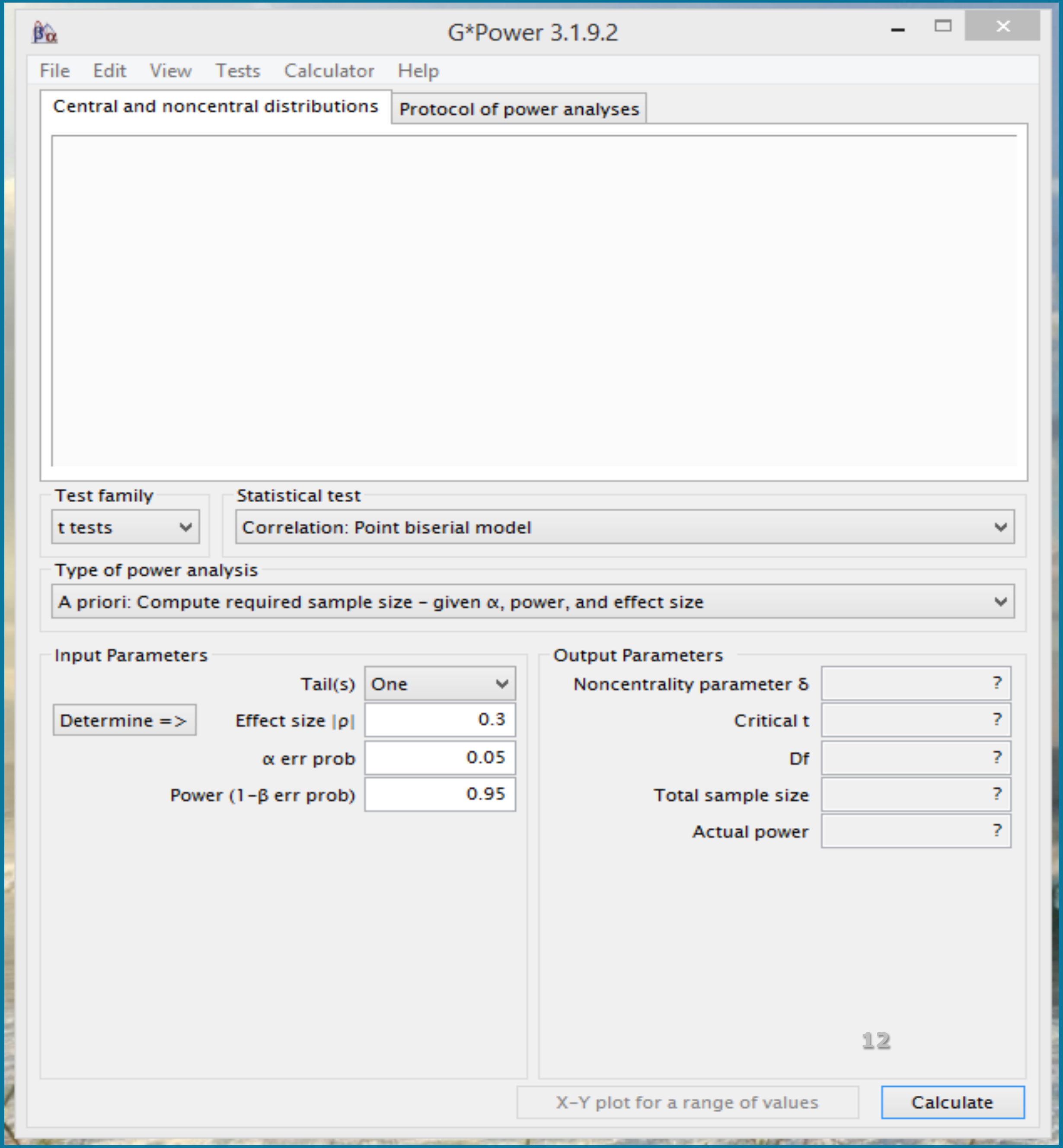
When $n_1 \neq n_2$

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

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

G-POWER

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



CHAP 8: SECTION A

- **d** is just the number of standard deviations that separate two population means

- ***g*** is the number of standard deviations (based on pooling the sample variances and taking the square-root) separating the sample means.

- connection between a calculated *t* and delta;
  - large *t's* are *usually* associated with large deltas
  - small *t's* *usually* with small deltas.
  - Of course, the alternate hypothesis distribution shows that *t* can occasionally come out very differently from delta

An estimate of *power*

is only as good as

the estimate of *effect size* upon which it

is based

...BUT determining the effect size is usually

the purpose (or should be) of the experiment.