Beyond Summary

Two major ways

- Hypothesis testing
  - Is there an effect or not?
- Parameter estimation
  - How large is the effect, if it's there?

- Together or separate

Hypothesis testing

- Is there an effect or not?
- Oddly, we test if there is NO difference between two groups
  - H_0 = null hypothesis (no difference)
    - If our statistic has a $p \geq \alpha$, we fail to reject
    - If our statistic has a $p < \alpha$, we reject
  - H_A = alternative hypothesis (difference)
    - Mutually exclusive to the null
- We don't ACCEPT the null, just fail to reject it

Zs and ts

$$z = \frac{M - \mu}{\sigma_{SE}} \qquad t = \frac{M - \mu}{s_{SE}}$$

$$\sigma_{SE} = \frac{\sigma}{\sqrt{n}} \qquad s_{SE} = \frac{s}{\sqrt{n}}$$

$$df = (n_1 - 1)$$

$$SS_{Total} = SS_{Model} + SS_{\mathrm{Residual}}$$

$$MS_{Model} = \frac{SS_{Model}}{df_{Model}}$$

$$MS_{\mathrm{Residual}} = \frac{SS_{\mathrm{Residual}}}{df_{\mathrm{Residual}}}$$

$$F = \frac{MS_{Model}}{MS_{\mathrm{Residual}}}$$

$$df_{Model} = k - 1$$

$$df_{\mathrm{Residual}} = n - k$$

Omnibus F ANOVA

$$SS_{Total} = SS_{Model} + SS_{\mathrm{Residual}}$$

$$MS_{Model} = \frac{SS_{Model}}{df_{Model}}$$

$$MS_{\mathrm{Residual}} = \frac{SS_{\mathrm{Residual}}}{df_{\mathrm{Residual}}}$$

$$F = \frac{MS_{Model}}{MS_{\mathrm{Residual}}}$$

$$df_{Model} = k$$

$$df_{\mathrm{Residual}} = n - k - 1$$

Omnibus F Regression

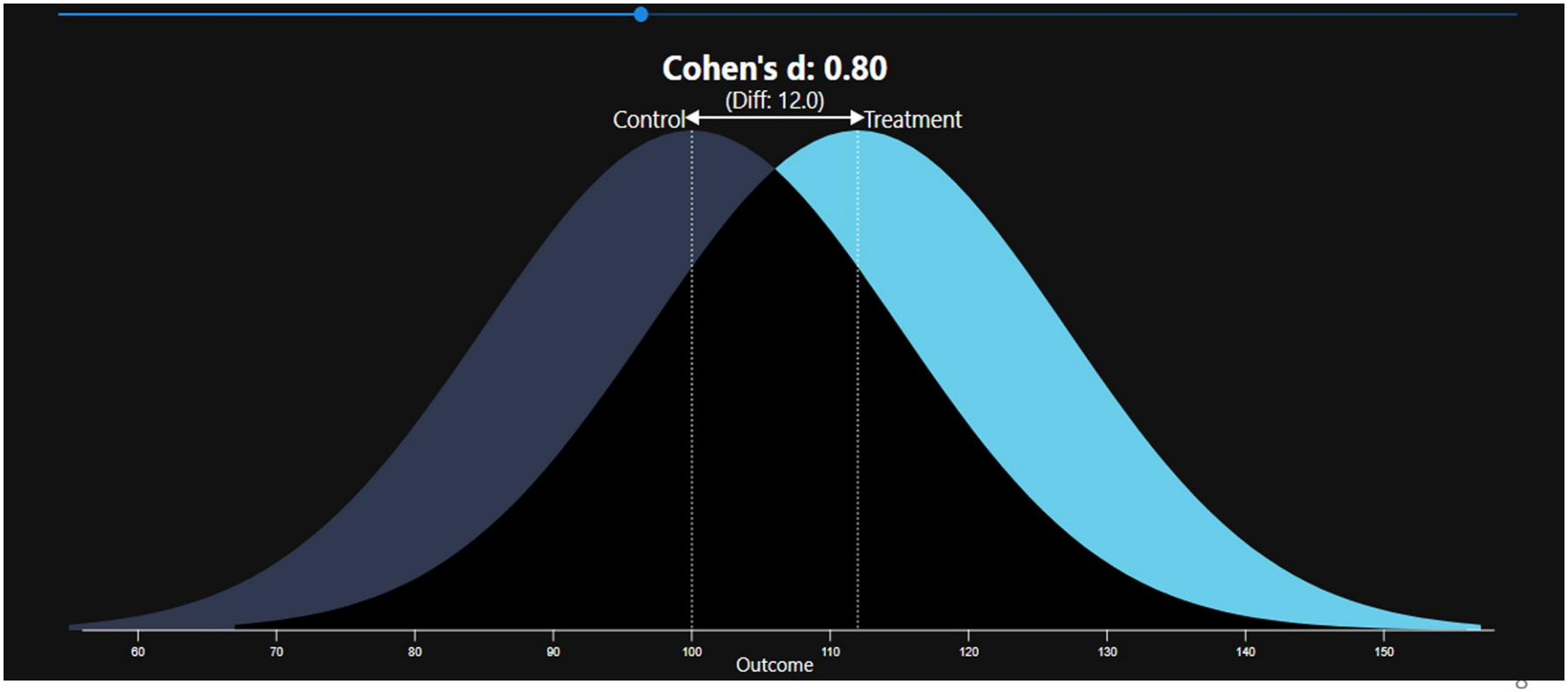
Parameter estimation

- How large is the effect, if it's there?
- Types
  - Distance
  - Association
  - Variance Explained

Cohen's d

$$d = \frac{M_1 - M_2}{s_p}$$

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$



Correlation coefficient

- Correlation
  - *Pearson's correlation (r)*
    - **Variables**: Interval and Interval
    - **Describes**: Linearity
  - *Spearman's rank order (rho)*
    - **Variables**: Ordinal and Ordinal
    - **Describes**: Monotonicity
  - *Point-biserial correlation (r_{pb})*
    - **Variables**: Interval and Dichotomous
    - **Describes**: Discriminability
  - *Phi coefficient*
    - **Variables**: Dichotomous and Dichotomous
    - **Describes**: association

$$r = \frac{\sum z_X z_Y}{n-1}$$

$$r = \frac{\mathrm{COV}_{XY}}{s_X s_Y} = \frac{\frac{\sum[(X - M_X)(Y - M_Y)]}{n-1}}{\sqrt{\frac{\sum (X - M_X)^2}{n-1} \frac{\sum (Y - M_Y)^2}{n-1}}}$$

Regression Coefficients

- **(Partial) Regression Coefficients**: slope values for the individual predictors
- Called b-weights if they are unstandardized

$$\hat{y} = a + b_1 x_1 + b_2 x_2 + b_3 x_3 \ldots$$

- Called Beta (β) – weights if they are standardized

$$E(y) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ldots$$

Re*gression case*

$$R^2 = \frac{SS_M}{SS_T} = \frac{\sum(\hat{Y} - M_Y)^2}{\sum(Y - M_Y)^2}$$

ANOVA case

$$\eta^2 = \frac{SS_M}{SS_T} = \frac{\sum n_k (M_k - M_G)^2}{\sum (X - M_G)^2} = \frac{\sum n_k (M_k - M_G)^2}{s^2_{grand}(n-1)}$$

or

$$\frac{s^2_{grand}(n-1) - \sum s^2_k (n_k - 1)}{s^2_{grand}(n-1)}$$

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.666568159
R Square	0.444313111
Adjusted R Square	0.415570686
Standard Error	10.70587104
Observations	62