# Lecture 14
# Segment 2

## One-way ANOVA

# One-way ANOVA

- Example
  - WM training (Jaeggi et al., 2008)
    - IV: # of training sessions (8, 12, 17, 19)
    - DV: gain score (post – pre)

# WM training (dataframe)

| Subject | Condition | Pre | Post | Gain |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# WM training (raw data)

| 8 | 12 | 17 | 19 |
|---|---|---|---|
| 1 | 0 | 4 | 7 |
| 1 | 2 | 4 | 5 |
| 2 | 4 | 3 | 3 |
| 1 | 2 | 3 | 6 |
| 0 | 2 | 6 | 4 |

# One-way ANOVA

- F ratio

  F = systematic variance / unsystematic variance

  F = between-groups variance / within-groups variance

  $F = MS_{Between} / MS_{Within}$

  $F = MS_{A} / MS_{S/A}$

# One-way ANOVA

- $F = MS_A / MS_{S/A}$
- $MS_A = SS_A / df_A$
- $MS_{S/A} = SS_{S/A} / df_{S/A}$

# One-way ANOVA

- $SS_A = n \Sigma(Y_j - Y_T)^2$
  - $Y_j$ are the treatment means
  - $Y_T$ is the grand mean

# One-way ANOVA

- $SS_{S/A} = \Sigma(Y_{ij} - Y_j)^2$
  - $Y_{ij}$ are individual scores
  - $Y_j$ are the treatment means

# One-way ANOVA

- $df_A = a - 1$
- $df_{S/A} = a(n - 1)$
- $df_{TOTAL} = N - 1$

# Summary Table

| **Source** | **SS** | **df** | **MS** | **F** |
|---|---|---|---|---|
| A | $n \Sigma(Y_j - Y_T)^2$ | a - 1 | $SS_A/df_A$ | $MS_A /MS_{S/A}$ |
| S/A | $\Sigma(Y_{ij} - Y_j)^2$ | a(n -1) | $SS_{S/A}/df_{S/A}$ | ----- |
| Total | $\Sigma(Y_{ij} - Y_T)^2$ | N - 1 | ----- | ----- |

# SS calculations

$$SS_A = n \Sigma(Y_j - Y_T)^2$$

$$= 5 [(1 - 3)^2 + (2 - 3)^2 + (4 - 3)^2 + (5- 3)^2]$$
$$= 5 [4 + 1 + 1 + 4]$$
$$= 5 \times 10$$
$$= 50$$

# SS calculations

$$SS_{S/A} = \Sigma(Y_{ij} - Y_j)^2$$

$$= [(1 - 1)^2 + (1 - 1)^2 + (2 - 1)^2 + (1 - 1)^2 + (0 - 1)^2] +$$
$$[(0 - 2)^2 + (2 - 2)^2 + (4 - 2)^2 + (2 - 2)^2 + (2 - 2)^2] +$$
$$[(4 - 4)^2 + (4 - 4)^2 + (3 - 4)^2 + (3 - 4)^2 + (6 - 4)^2] +$$
$$[(7 - 5)^2 + (5 - 5)^2 + (3 - 5)^2 + (6 - 5)^2 + (4 - 5)^2]$$

$$= [2 + 8 + 6 + 10] = 26$$

# df calculations

$df_A = a - 1 = 4 - 1 = 3$

$df_{S/A} = a(n - 1) = 4(5 - 1) = 16$

# MS calculations

$MS_A = SS_A / df_A = 50 / 3 = 16.67$

$MS_{S/A} = SS_{S/A} / df_{S/A} = 26 / 16 = 1.63$

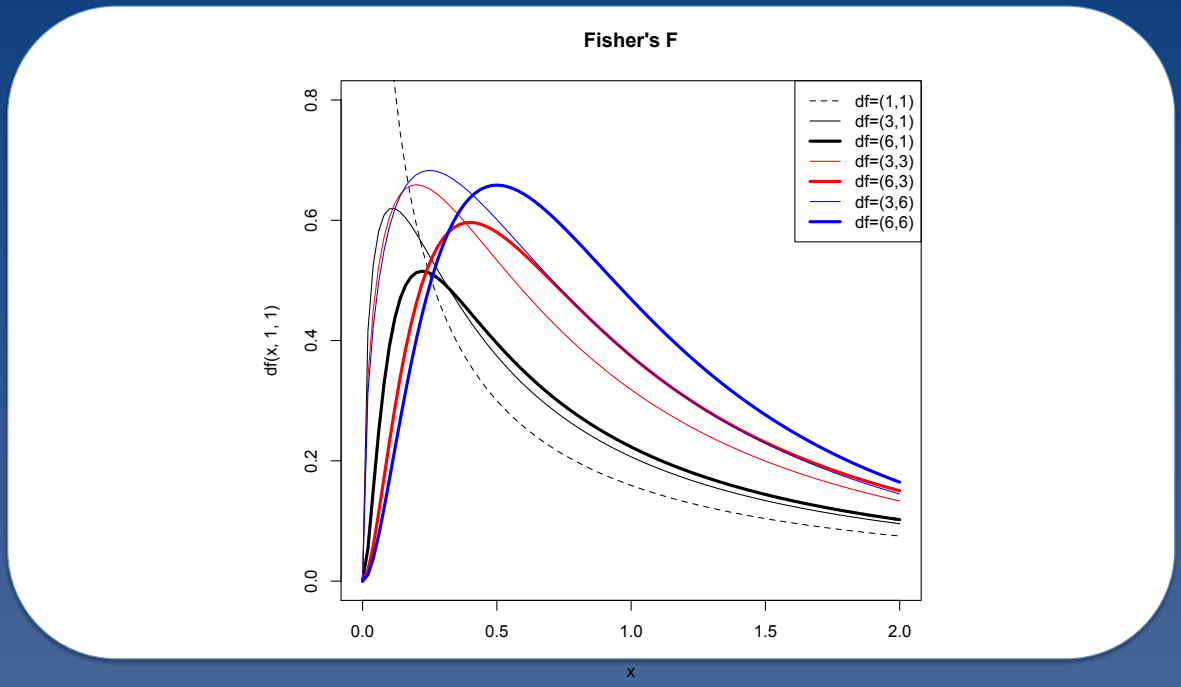
# F calculation

$F = MS_A / MS_{S/A} = 16.67 / 1.63 = 10.23$

$df_{num} = 3$
$df_{denom} = 16$

$p = .0005$
$\therefore$ Reject $H_0$

# Analysis of Variance (ANOVA)



# Effect size

- $R^2 = \eta^2$ (eta-sqaured)
- $\eta^2 = SS_A / SS_{Total}$

- So, for our example
  - $\eta^2 = SS_A / SS_{Total} = 50 / 76 = .66$

# Assumptions

- DV is continuous
- DV is normally distributed
- Homogeneity of variance
    - Within-groups variance is equivalent for all groups
        - » Levene's test

# Homogeneity of variance

- If Levene's test is significant then homogeneity of variance assumption has been violated
  - Conduct comparisons using a restricted error term
  - More on this in Lecture 15