ONE-WAY INDEPENDENT MEASURES ANOVA'S

Summary ANOVA Table:

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate (Mean Square)	F-ratio
Between	$SS_B = \sum_{k=1}^{K} \frac{T_k^2}{n_k} - \frac{G^2}{N}$	K – 1	$MS_B = \frac{SS_B}{K-1}$	$F = \frac{MS_B}{MS_W}$
Within	$SS_W = \sum X^2 - \sum \frac{(T_k)^2}{n_k}$	N – K	$MS_W = \frac{SS_W}{N-K}$	
Total	$SS_T = SS_W + SS_B$	N – 1		

Steps:

1) State the research question that the analysis is intended to answer. Did the IV have any effect on performance?

2) State the null hypothesis (all grp means are =; the IV has no effect). State the alternative hypothesis (1 or more of the grp means aren't =; there is a difference somewhere).

3) Locate the critical region and determine the df's:
   $df_{between}$ = # of levels of the IV – 1 = $k - 1$
   $df_{within} = N - k$
   $df_{total} = N - 1$

4) Complete the necessary computations to compute the Sum of Squares.

5) Compute the Mean-Squares:
   $MS_{between}$ = (systematic variance + error variance) / $df_{between\ groups}$
   = $SS_{between}$ / $df_{between\ groups}$
   MS_{within} = error variance / $df_{within\ groups}$ = SS_{within} / $df_{within\ groups}$

6) Compute the F-ratio: $F = MS_{between} / MS_{within}$

7) Interpret the results: Is the result significant?

- Compare the p-value to the criterion level (level of significance)
- Compare F-obtained to F-critical

Example 1

Research Purpose: to assess the effect of frat membership on the popularity of college men
Research methodology:

- Compare the avg # of phone calls received each week for male college students living in residence halls & for male college students living in fraternity houses
- Randomly select 10 sophomores from each grp & assess the # of phone calls received by each in a 1-wk pd

Independent Variable:
Dependent Variable:

Step 1: State the research question

Step 2: State the hypotheses
Null hypothesis:
Alternate hypothesis:

Step 3: Locate the critical region – what are the criteria for rejecting the null hypothesis?

- α-level?
- 1-tailed or 2-tailed?
- df's associated with the 2 variance estimates?
  $df_B = k - 1 =$

$df_W = N - k =$

- Critical value for F:

Step 4: Complete the Sum of Squares:
Compute the sum of scores (the total), the mean score, & the sum of squared scores for each grp, & the grand total & the grand mean.

Res Hall	X_1^2	Frat	X_2^2	
2		4		
6		6		
3		4		
2		2		
4		12		
0		16		
2		4		
15		10		
1		0		
0		5		Totals
$\sum X_1 = T_1 =$	$\sum X_1^2 =$	$\sum X_2 = T_2 =$	$(\sum X_2)^2 =$	G=
$(\sum X_1)^2 =$	$\bar{X}_1 =$	$\sum X_2^2 =$	$\bar{X}_2 =$	$\sum X^2 =$
$s_1^2 =$		$S_2^2 =$		

Calculate the sum of squares between-groups, the sum of squares within-groups & the total sum of squares.

$$SS_B = \sum_{k=1}^{K} \frac{T_k^2}{n_k} - \frac{G^2}{N} =$$

$$SS_W = \sum X^2 - \sum \frac{(T_k)^2}{n_k} =$$

$$SS_T = \sum X^2 - \frac{G^2}{N} =$$

Step 5: Calculate the variance estimates, the mean squares for between groups and within-groups.

$$MS_B = \frac{SS_B}{K-1} =$$

$$MS_W = \frac{SS_W}{N-K} =$$

Step 6: Compute the test statistic, the F-ratio.

$$F = \frac{MS_B}{MS_W} =$$

Summary ANOVA for Telephone Calls Example

	Summary ANOVA				
Source	SS	Df	MS	F	F_{CV}
Between					
Within					
Total					

Step 7: Interpret the results

Compare the test statistic (the computed *F* ratio) with the critical value (from the table):

The *p*-value:

Conclusion?

EXAMPLE #2

Purpose of study: to assess the effect of method of reinforcement on the # of trials needed to complete a learning task

Research methodology:

- 21 subjects are randomly assigned to 1 of 3 methods of reinforcement
- After the experimental txt, each subject completes the learning task

Independent Variable:
Dependent Variable:

Methods of Reinforcement

Method 1	X_1^2	Method 2	X_2^2	Method 3	X_3^2	
1		8		7		
4		6		6		
3		7		4		
2		4		9		
5		3		8		
1		5		5		
6				7		
				5		Totals
$n_1 =$	$\sum X_1^2 =$	$n_2 =$	$\sum X_2^2 =$	$n_3 =$	$\sum X_3^2 =$	N=
$\sum X_1 = T_1 =$		$\sum X_2 = T_2 =$		$\sum X_3 = T_3 =$		G=
$\bar{X}_1 = \sum X / n =$		$\bar{X}_2 =$		$\bar{X}_3 =$		$\sum X^2 =$
$(\sum X_1)^2 = T_1^2 =$		$(\sum X_2)^2 = T_2^2 =$		$(\sum X_3)^2 = T_3^2 =$		$\sum_{k=1}^{K} T^2 =$
$s^2 =$		$s^2 =$		$s^2 =$		grand mean=

Summary ANOVA for Learning Trials Example

Summary ANOVA

Source	SS	df	MS	F	F_{Crit}
Between					
Within					
Total					