ONE-WAY REPEATED-MEASURES ANOVA'S

Purpose

Examples

Data from an experimental study evaluating the effects of different types of distraction on performance on a visual detection task.

	Visual Detection Scores		
Participant	No Distraction	Visual Distraction (flashing lights)	Auditory Distraction (banging noises)
A	47	22	41
B	57	31	52
C	38	18	40
D	45	32	43

Data from a non-experimental design evaluating the effectiveness of a clinical therapy for treating depression.

	Depression Scores		
Participant	Before Therapy	After Therapy	6-Month Follow Up
A	71	53	55
B	62	45	44
C	82	56	61
D	77	50	46
E	81	54	55

Statistical Hypotheses for ANOVA

H_0:

H_1:

The Test Statistic for the RM ANOVA

$$F = \frac{\text{variance (differences) between treatments}}{\text{variance (differences) expected by chance/error}}$$

$$F = \frac{\text{variance/diffs between treatments (w/out individual differences)}}{\text{variance/diffs expected by chance (w/ individual differences removed)}}$$

F-ratio vs. F-crit:

Individual Differences:

The Logic of ANOVA

Purpose of ANOVA:

Variance Between Treatments (s_B^2): The Numerator of the F-ratio:
Logically, any diffs found between txt conditions can be explained by only 2 factors.

1) *Treatment Effect*

2) *Error or Chance*

Variance due to Chance/Residual or Error Variance (s_E^2): The Denominator of the F-ratio: Variance due to random sources of error, excluding any individual differences.

The F-ratio:

$$F = \frac{\text{variance btn txts = txt effect + chance/error (excluding individ diffs)}}{\text{variance due to chance/error = chance/error (excluding individ diffs)}}$$

When there is no treatment effect:

When the treatment does have an effect:

RM ANOVA Notation & Formulas

Person	Placebo	Drug 1	Drug 1	Drug 1	Person Totals	
A	3	4	6	7	$P_A =$	$n =$
B	0	3	3	6	$P_B =$	$k =$
C	2	1	4	5	$P_C =$	$N =$
D	0	1	3	4	$P_D =$	$G =$
E	0	1	4	3	$P_E =$	$\Sigma x^2 =$
	$T_P =$	$T_1 =$	$T_2 =$	$T_3 =$		
	$M_P =$	$M_1 =$	$M_2 =$	$M_3 =$		
	$\Sigma X^2 =$	$\Sigma X^2 =$	$\Sigma X^2 =$	$\Sigma X^2 =$		
	$s_P = 1.41$	$s_1 = 1.41$	$s_2 = 1.22$	$s_3 = 1.58$		
	$SS_P = 8$	$SS_1 = 8$	$SS_2 = 6$	$SS_3 = 10$		

$P =$

$n =$

$k =$

$N =$

$G =$

$T =$

$\Sigma x^2 =$

$SS =$

Goal:

First Stage of the Analysis:
Identical to the IM ANOVA – the SS and df for the total set of scores are analyzed into within-treatments and between-treatments components.

Analysis of Sum of Squares

Between-Treatments Sum of Squares *(SS_B):*

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

***Within-Treatments Sum of Squares** (SS_W)*:
$SS_{\text{within}} = \Sigma SS_{\text{inside each treatment}} =$

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

***Total Sum of Squares** (SS_T)* = total sum of squared scores for the entire set of N scores = $SS_{\text{within}} + SS_{\text{between}}$

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

Analysis of Degrees of Freedom (df)

Between-treatments degrees of freedom:
df_{between} = # of levels of the IV – 1 = $k - 1$ =

Within-treatments degrees of freedom:
$df_{\text{within}} = \Sigma df_{\text{in each treatment}} = N - k =$

Total degrees of freedom: $df_{\text{total}} = N - 1 =$
$df_{\text{total}} = df_{\text{within}} + df_{\text{between}} =$

<u>Second Stage of the Analysis</u>
Involves removing the individual differences from the denominator of the F-ratio:

SS Between-Subjects

$$SS_{between-subjects} = \sum \frac{P^2}{k} - \frac{G^2}{N}$$

- The value of *SS* between-subjects provides a measure of the size of the individual differences, i.e. the differences between subjects

SS Error

- Subtract out the individual differences to obtain the measure of error that will form the denominator of the *F*-ratio:

$SS_{\text{error}} = SS_{\text{within treatments}} - SS_{\text{between subjects}} \quad =$

$df_{\text{error}} = df_{\text{within treatments}} - df_{\text{between subjects}} \quad =$

Calculations of Variances (the MS Values)

Mean Square Between Treatments

$$MS_{between} = s^2_{between} = \frac{SS_{between}}{df_{between}} = \frac{SS_{between}}{k-1} =$$

Mean Square Error

$$MS_{error} = s^2_{error} = \frac{SS_{error}}{df_{error}} =$$

The F-ratio

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

F-Criticals:

df = df between txts, df error =
For $\alpha = .05$, $F_{crit} =$
For $\alpha = .01$, $F_{crit} =$

Conclusion?

Summary Table for the RM ANOVA

Source	SS	df	MS	F
Between Treatments				
Within Treatments				
Between Subjects				
Error				
Total				

Post-Hoc Tests with Repeated Measures:

Tukey's HSD & the Scheffe test can be used, but substitute MS error in place of MS within in the formulas & use df error in place of df within when locating the critical value in the statistical table.

Example:

The following data were obtained from a research study examining the effect of sleep deprivation on motor skills performance. A sample of five participants was tested on a motor skills task after 24 hours of sleep deprivation, tested again after 36 hours of sleep deprivation, and once more after 48 hours of sleep deprivation. The dependent variable is the number of errors made on the motor skills task. Do these data indicate that the number of hours of sleep deprivation has a significant effect on motor skills performance?

Participant	24 hours	36 hours	48 hours	*P* totals	
A	0	0	6		N =
B	1	3	5		G =
C	0	1	5		$\sum X^2$ =
D	4	5	9		
E	0	1	5		
	T_1 =	T_2 =	T_3 =		
	SS_1 =	SS_2 =	SS_3 =		