EPHE 591

Between Subjects Factorial Analysis of Variance

The F Statistic

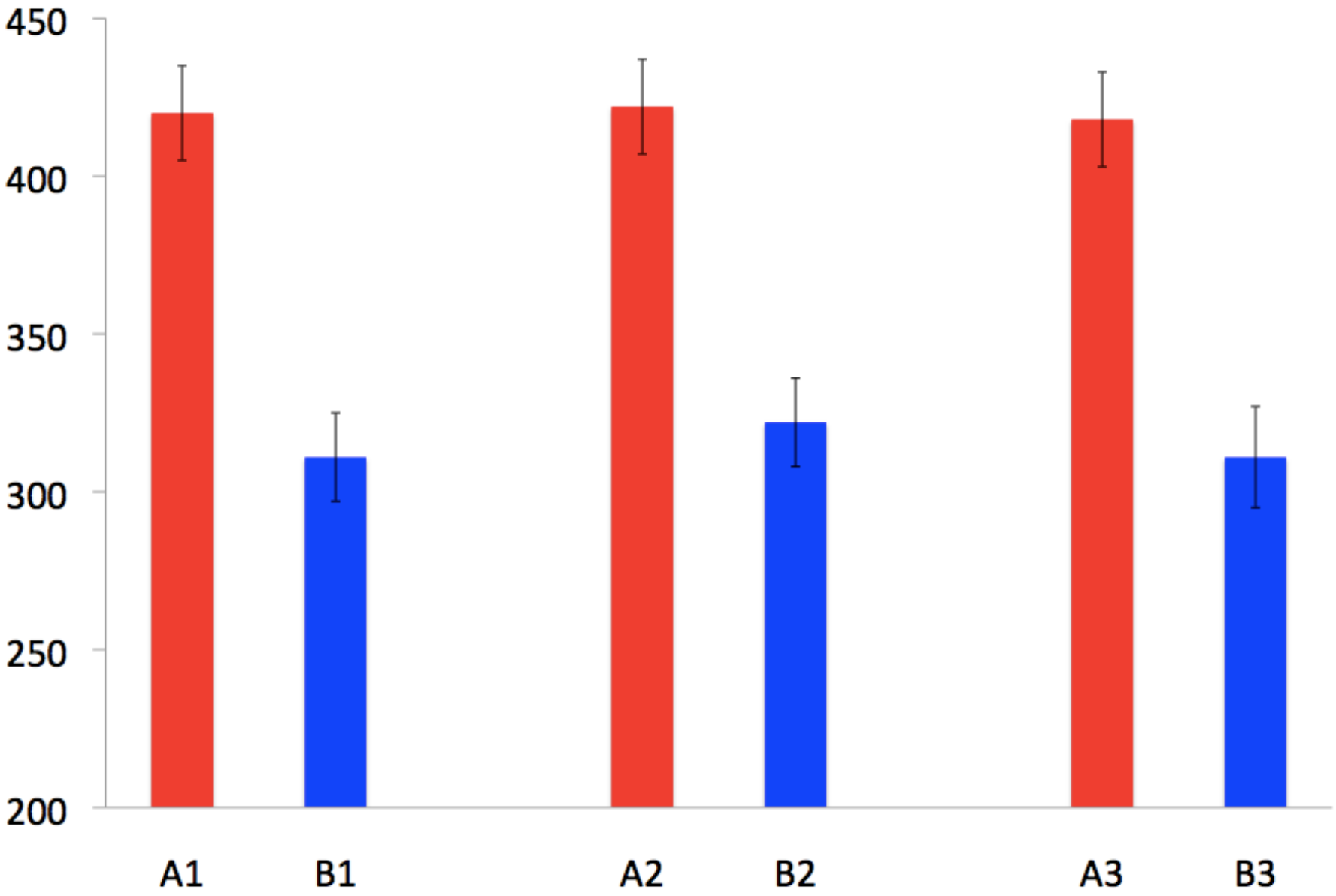
$$F = \frac{MS_{between}}{MS_{within}}$$

Factorial ANOVA

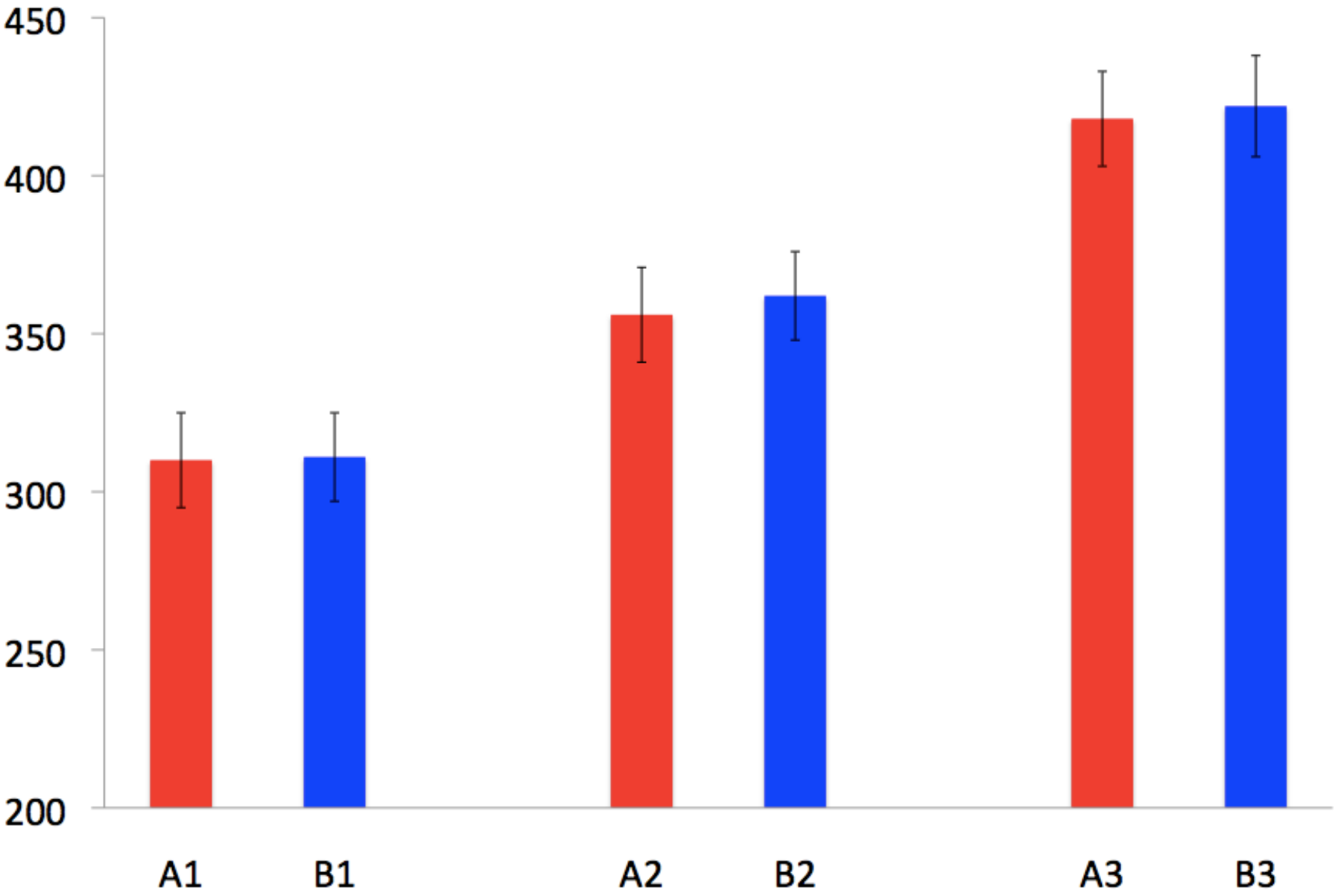
You have two groups of participants in your experiment (gender: females, males), each gender group is subdivided into three different birth locations (country: Canada, USA, UK). You test them on a single dependent measure, reaction time.

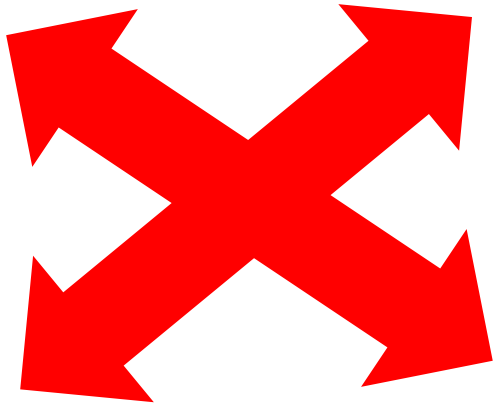
	Females	Males
Canada		
USA		
UK		

MAIN EFFECT:
Gender

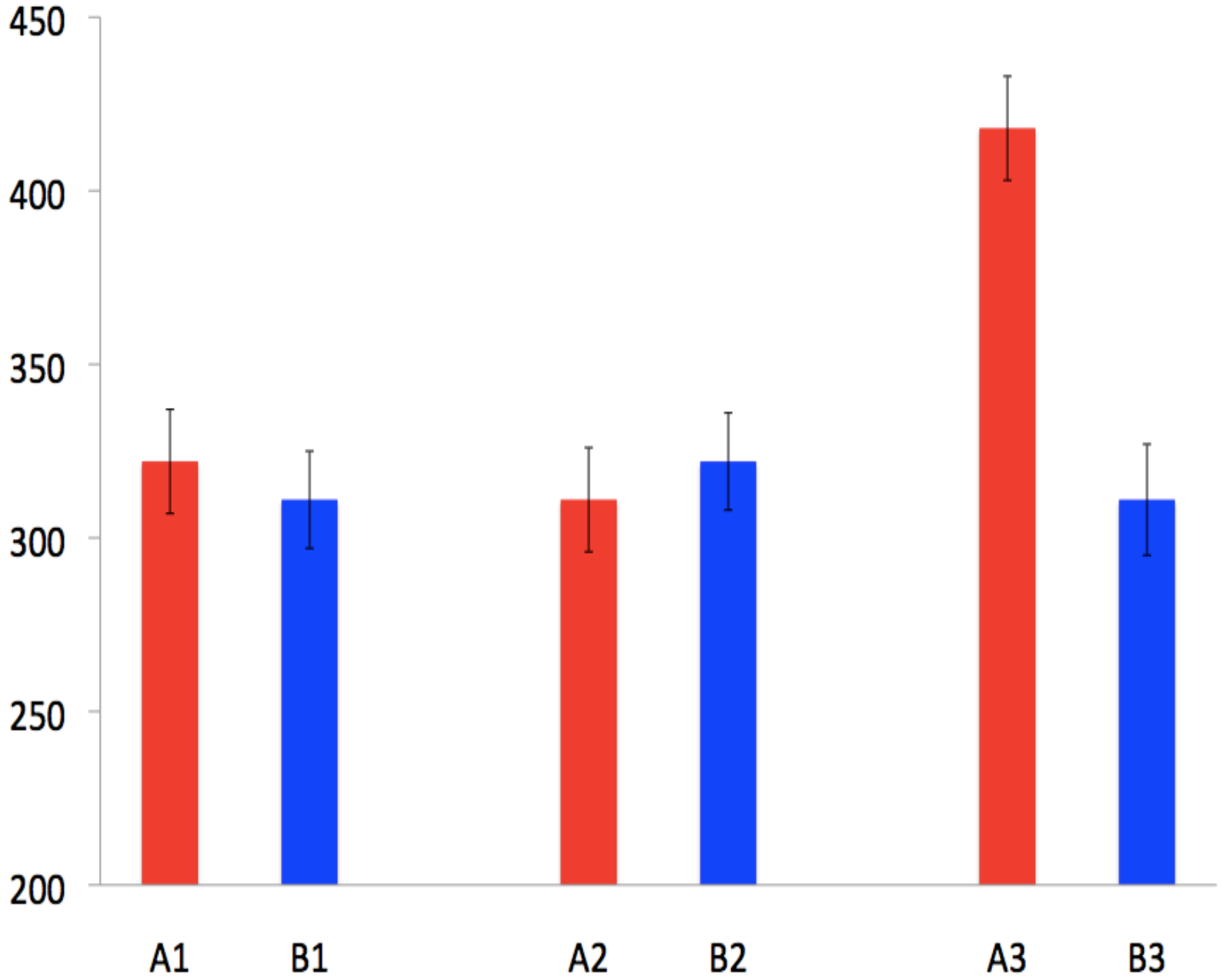

450
400
350
300
250
200
A1
B1
A2
B2
A3
B3

MAIN EFFECT:
Country


450
400
350
300
250
200
A1
B1
A2
B2
A3
B3



INTERACTION


450
400
350
300
250
200
A1
B1
A2
B2
A3
B3

What it looks like…

Four columns of data:

1. Subject
2. Grouping Variable A
3. Grouping Variable B
4. DV

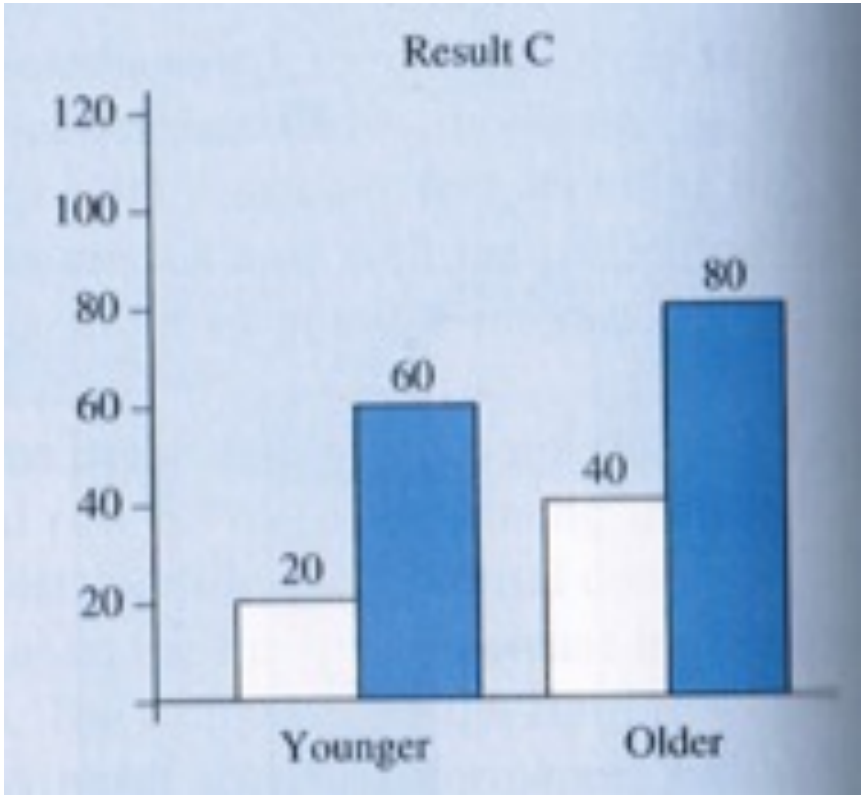
Tests of Between-Subjects Effects

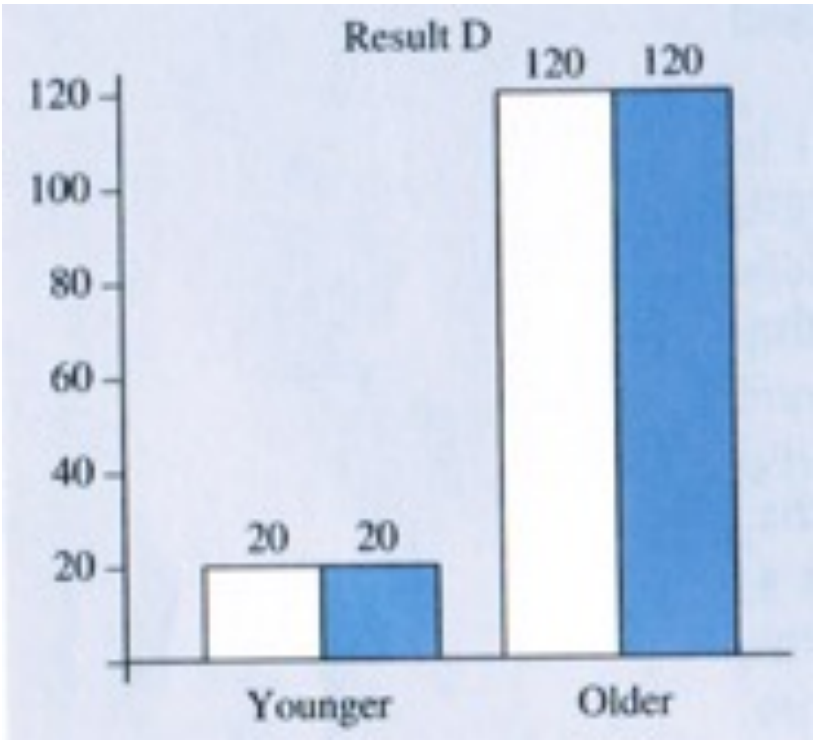
Dependent Variable: rt

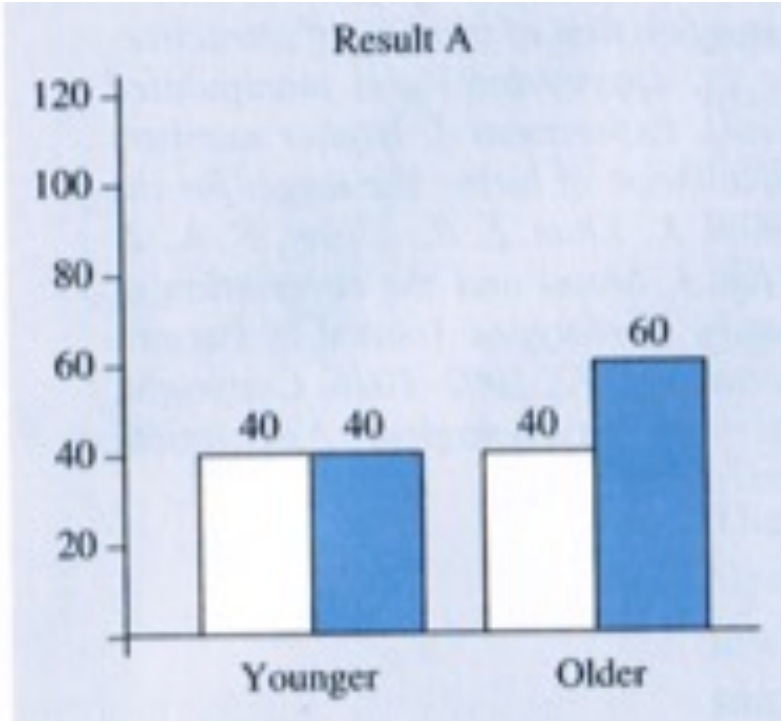
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	24082.315[a]	11	2189.301	2.833	.002
Intercept	29240127.2	1	29240127.2	37840.705	.000
group	8429.481	3	2809.827	3.636	.014
age	3158.146	2	1579.073	2.044	.133
group * age	12494.688	6	2082.448	2.695	.016
Error	129816.329	168	772.716		
Total	29394025.8	180			
Corrected Total	153898.644	179			

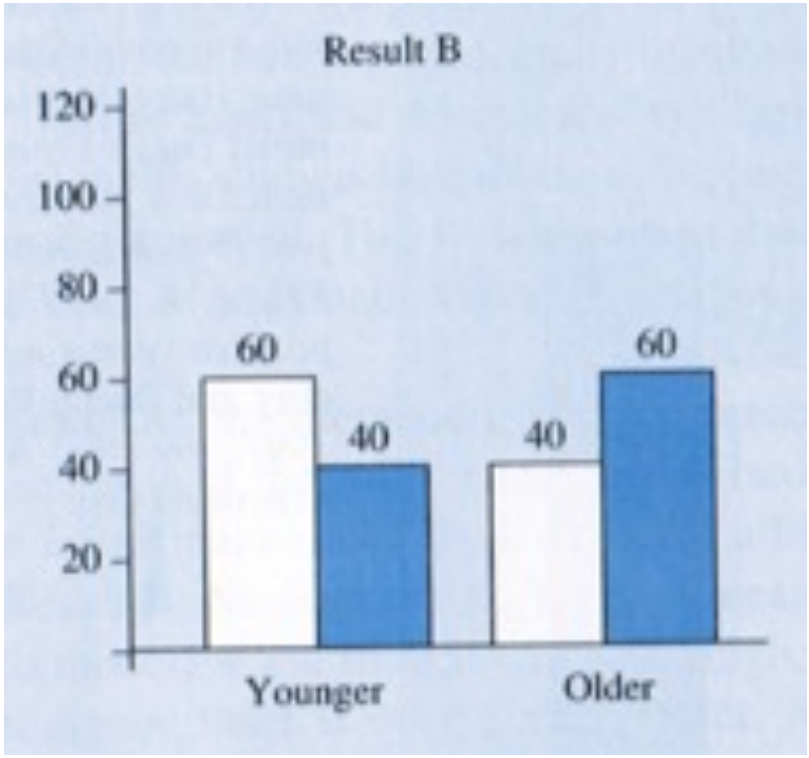
a. R Squared = .156 (Adjusted R Squared = .101)

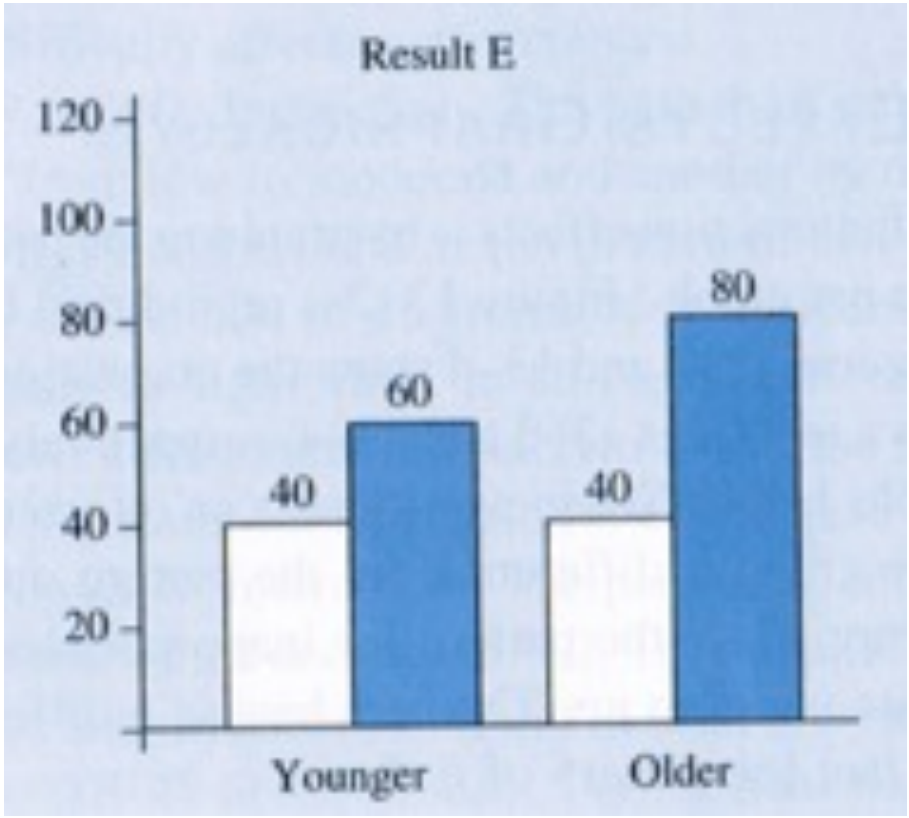
Recognizing Main Effects and Interactions

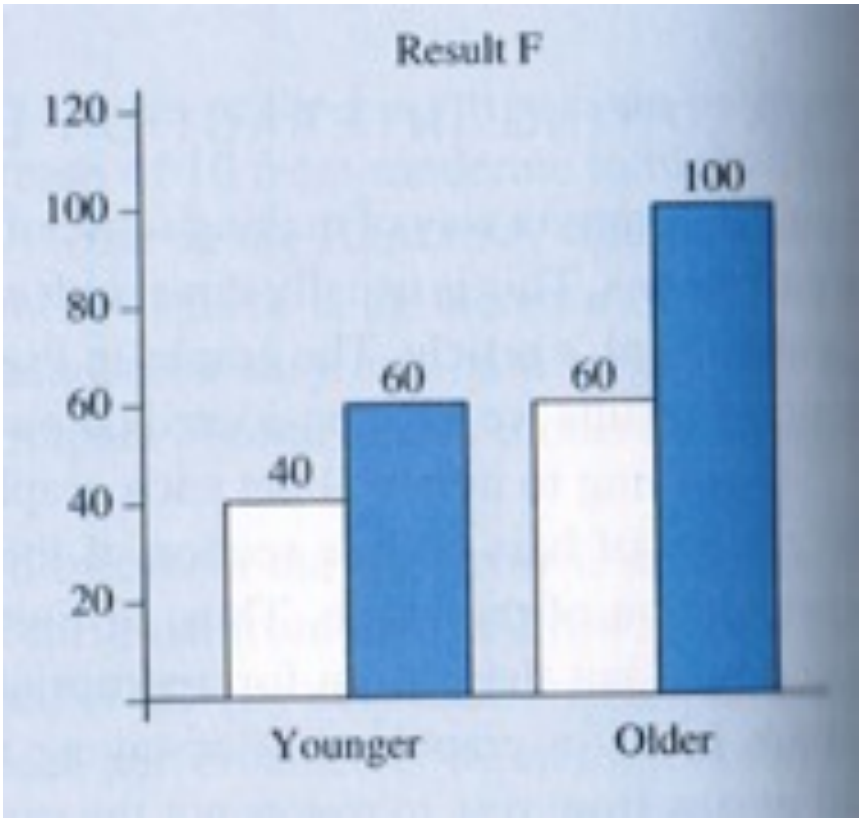

Result C
120
100
80
60
40
20
20
60
40
80
Younger
Older

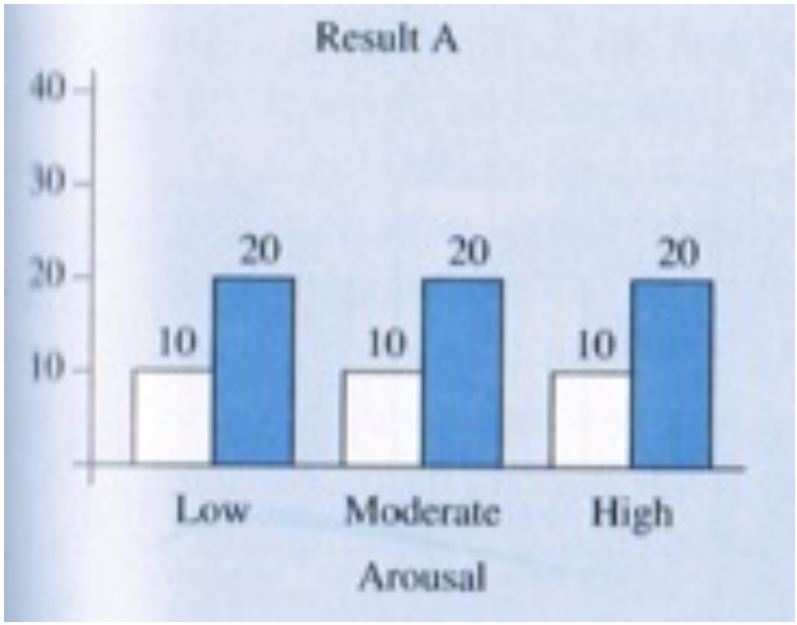

Result D
120
100
80
60
40
20
20
20
120
120
Younger
Older

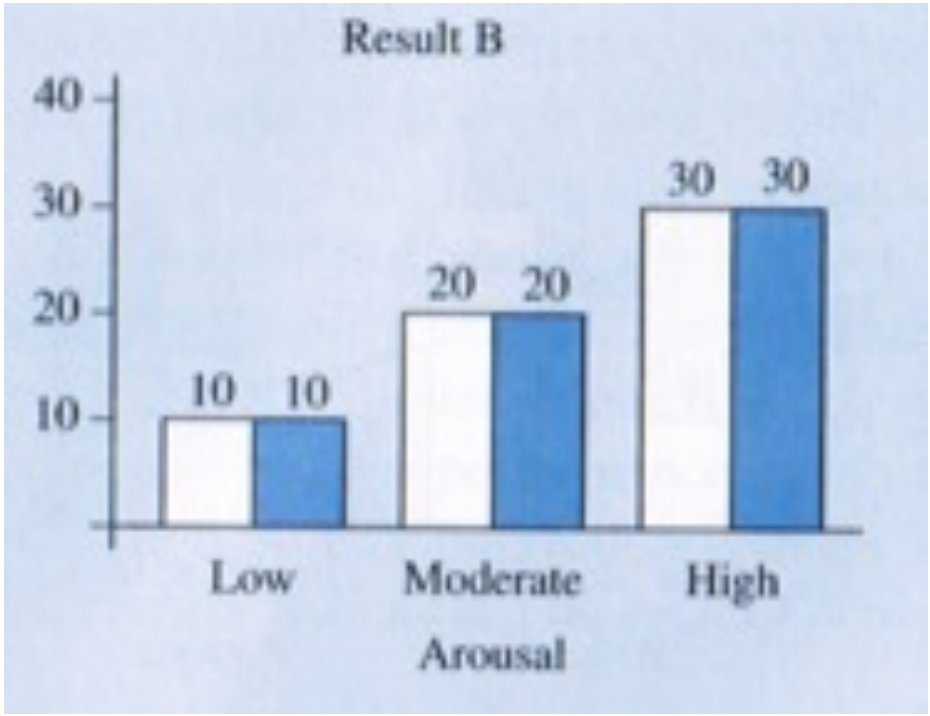

Result A
120
100
80
60
40
20
40
40
40
60
Younger
Older

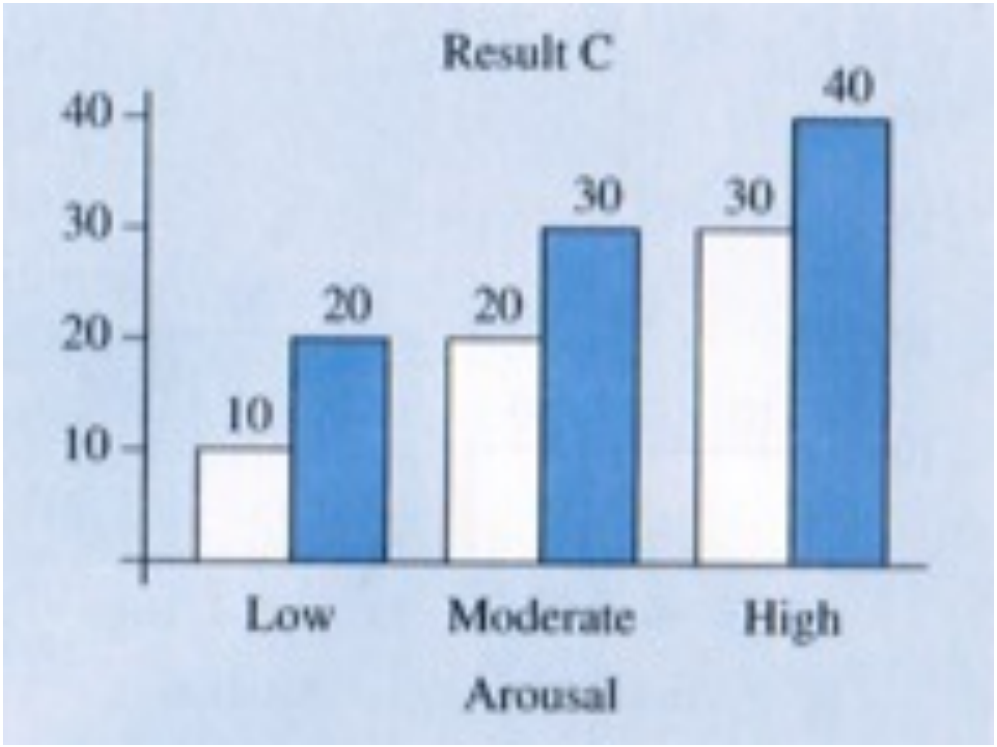

Result B
120
100
80
60
40
20
60
40
40
60
Younger
Older

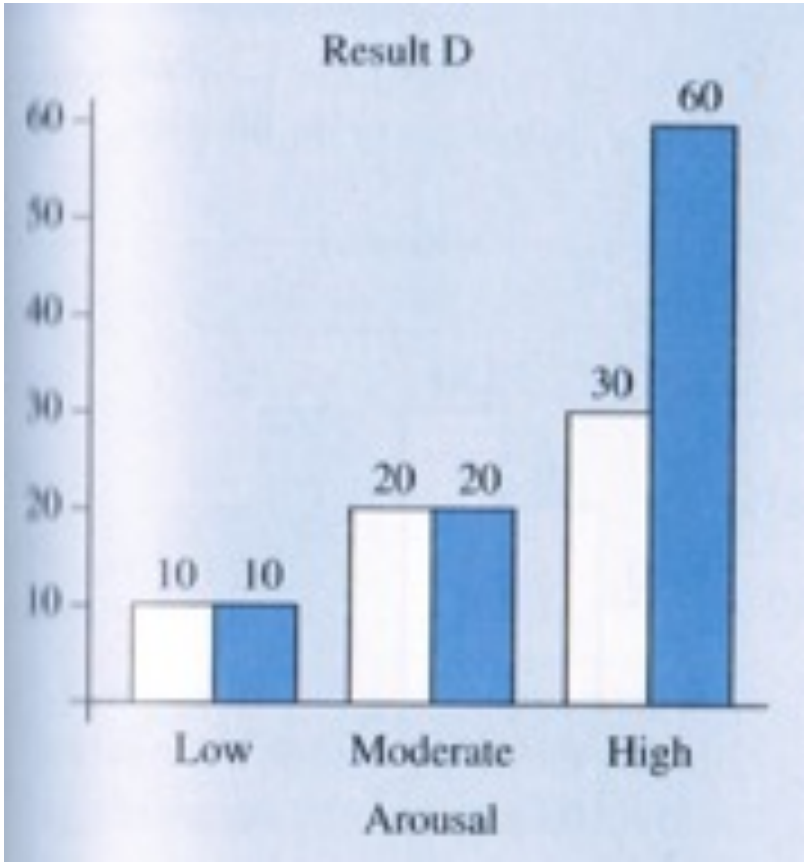

Result E
120
100
80
60
40
20
40
60
40
80
Younger
Older

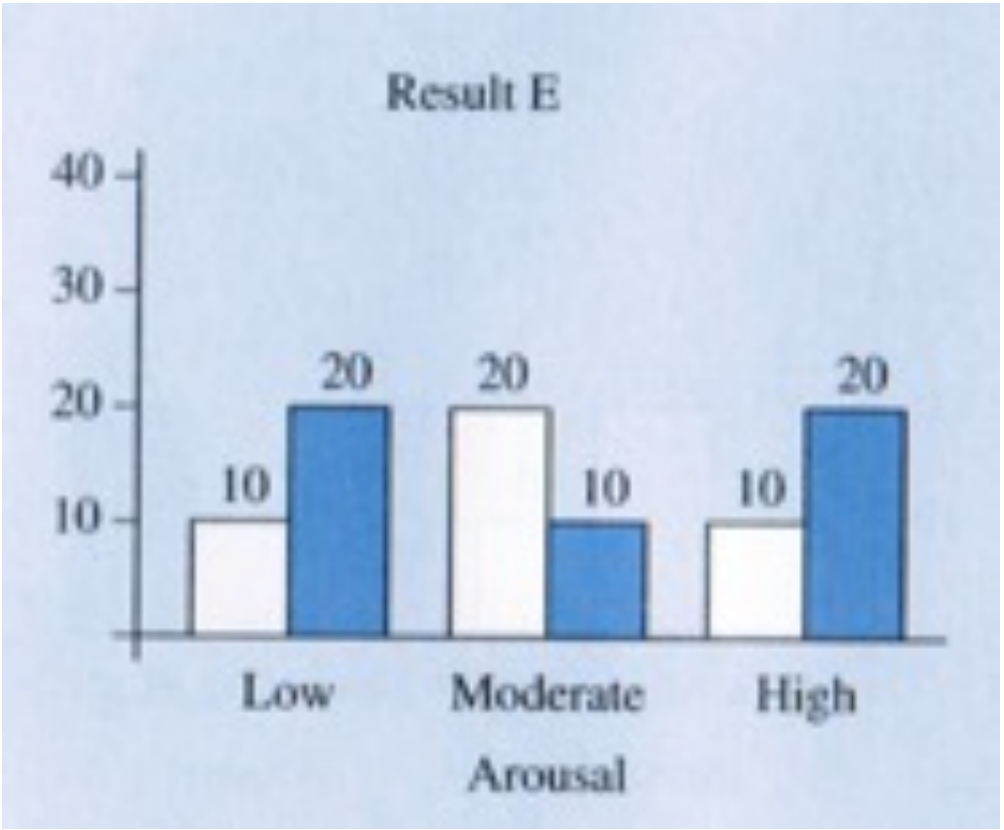

Result F
120
100
80
60
40
20
40
60
60
100
Younger
Older

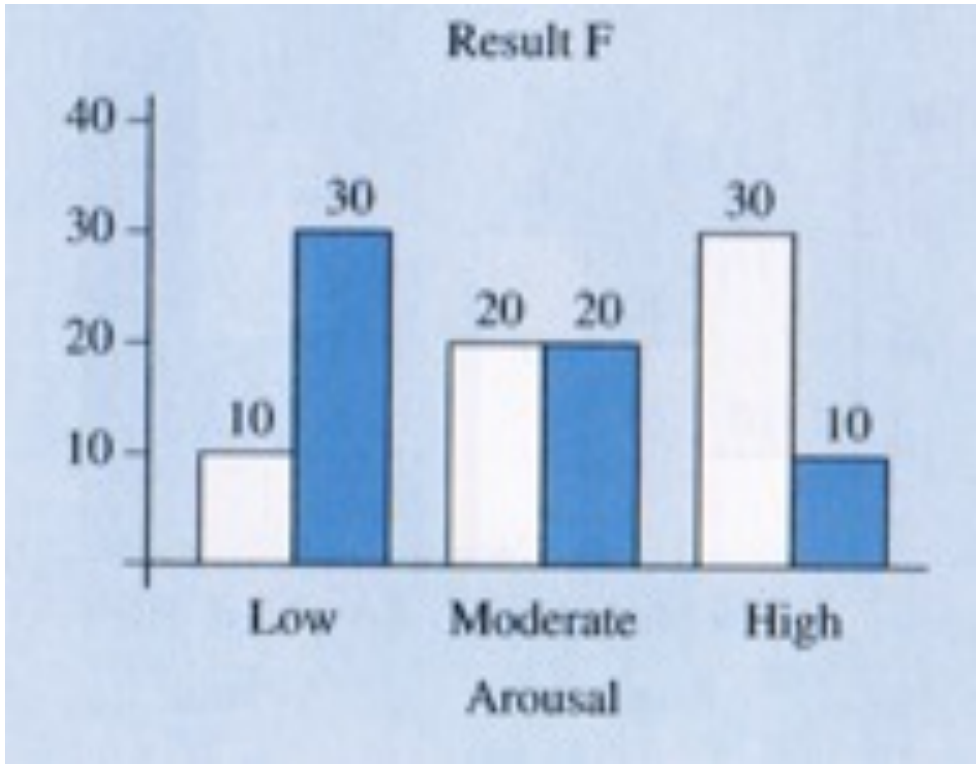

Result A
40
30
20
10
20
20
20
10
10
10
Low
Moderate
High
Arousal


Result B
40
30
20
10
10 10
20 20
30 30
Low
Moderate
High
Arousal

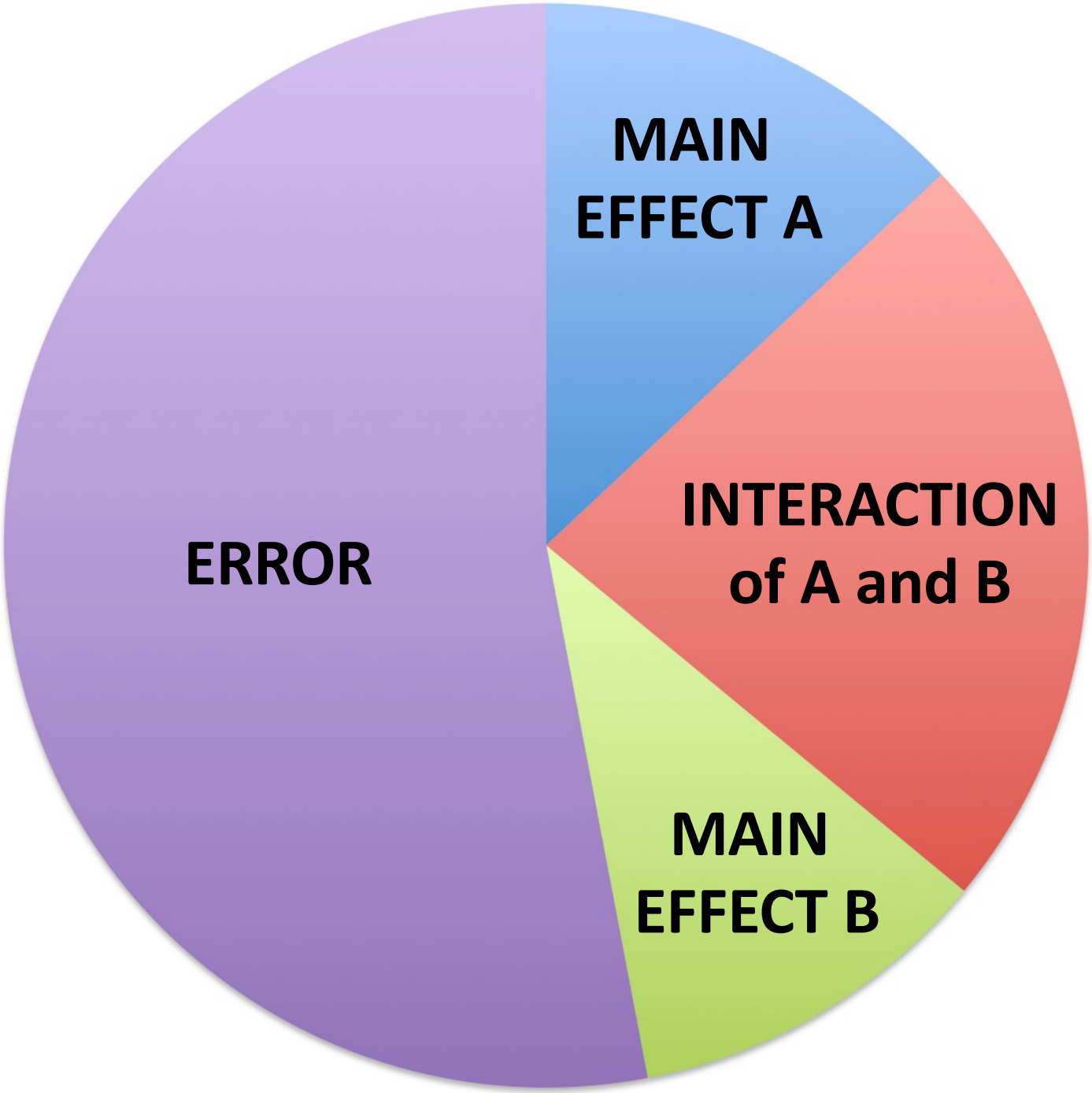

Result C
40
30
20
10
10
20
20
30
30
40
Low
Moderate
High
Arousal


Result D
60
50
40
30
20
10
10
10
20
20
30
60
Low
Moderate
High
Arousal


Result E
40
30
20
10
10
20
20
10
10
20
Low
Moderate
High
Arousal

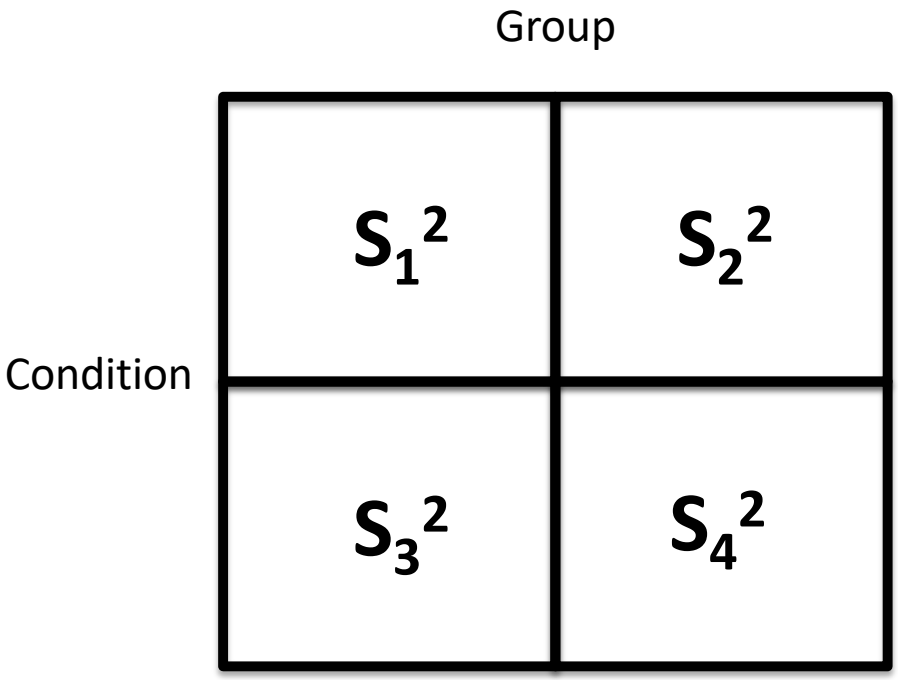

Result F
40
30
20
10
30
20
20
10
30
10
Low
Moderate
High
Arousal

Partitioning Variance Estimates in Factorial Designs


MAIN
EFFECT A
INTERACTION
of A and B
MAIN
EFFECT B
ERROR

Within Group Variance Estimate

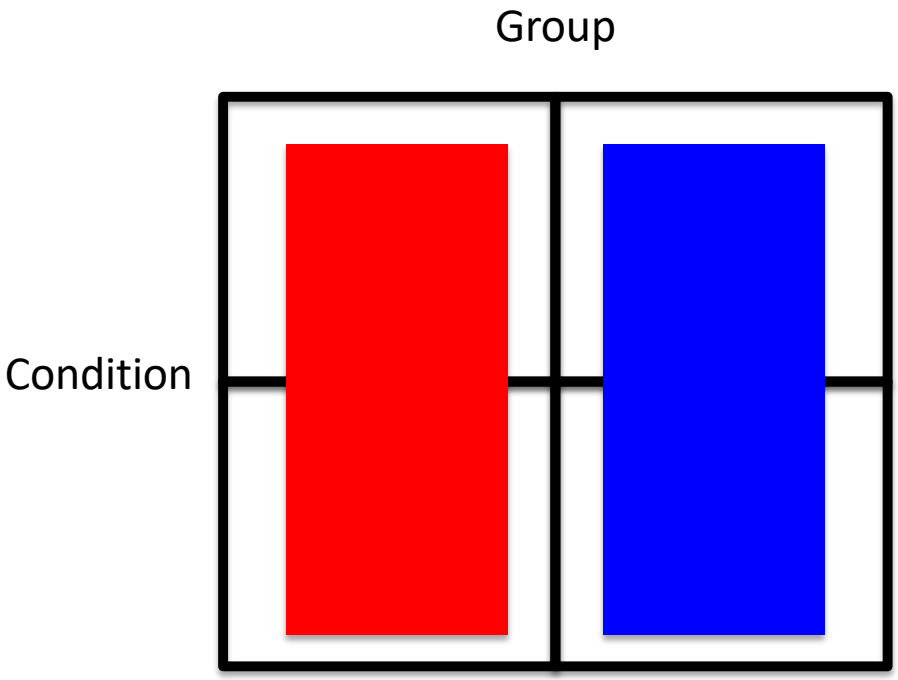
As before, the within group variance estimate reflects the average of the population variance estimates made from the scores for each cell.



$$S^2_{within} = \frac{S_1^2 + S_2^2 + S_3^2 + S_4^2}{N_{groups}}$$

Main Effect Variance Estimate

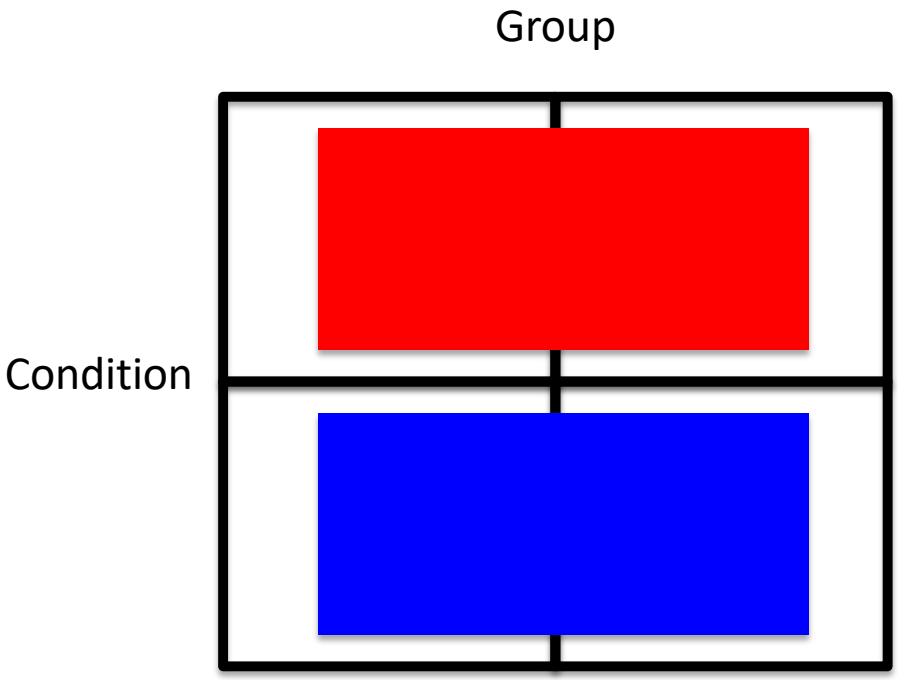
As with a single level design, the main effect between variance estimate is based on the variation between the column / row means.



$$S^2_{between} = (S^2_M)(n)$$

Main Effect Variance Estimate

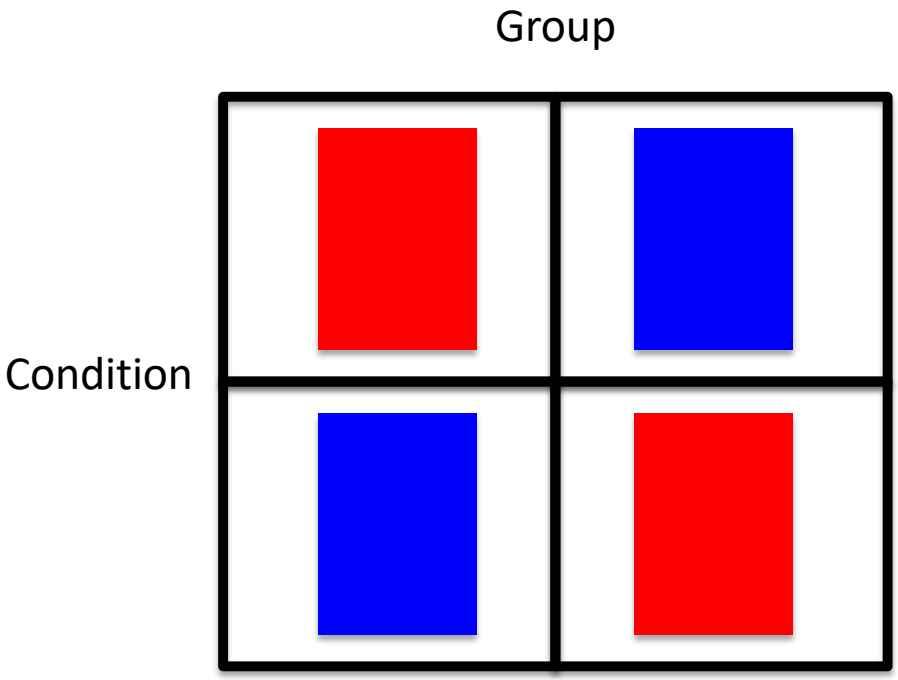
As with a single level design, the main effect between variance estimate is based on the variation between the column / row means.



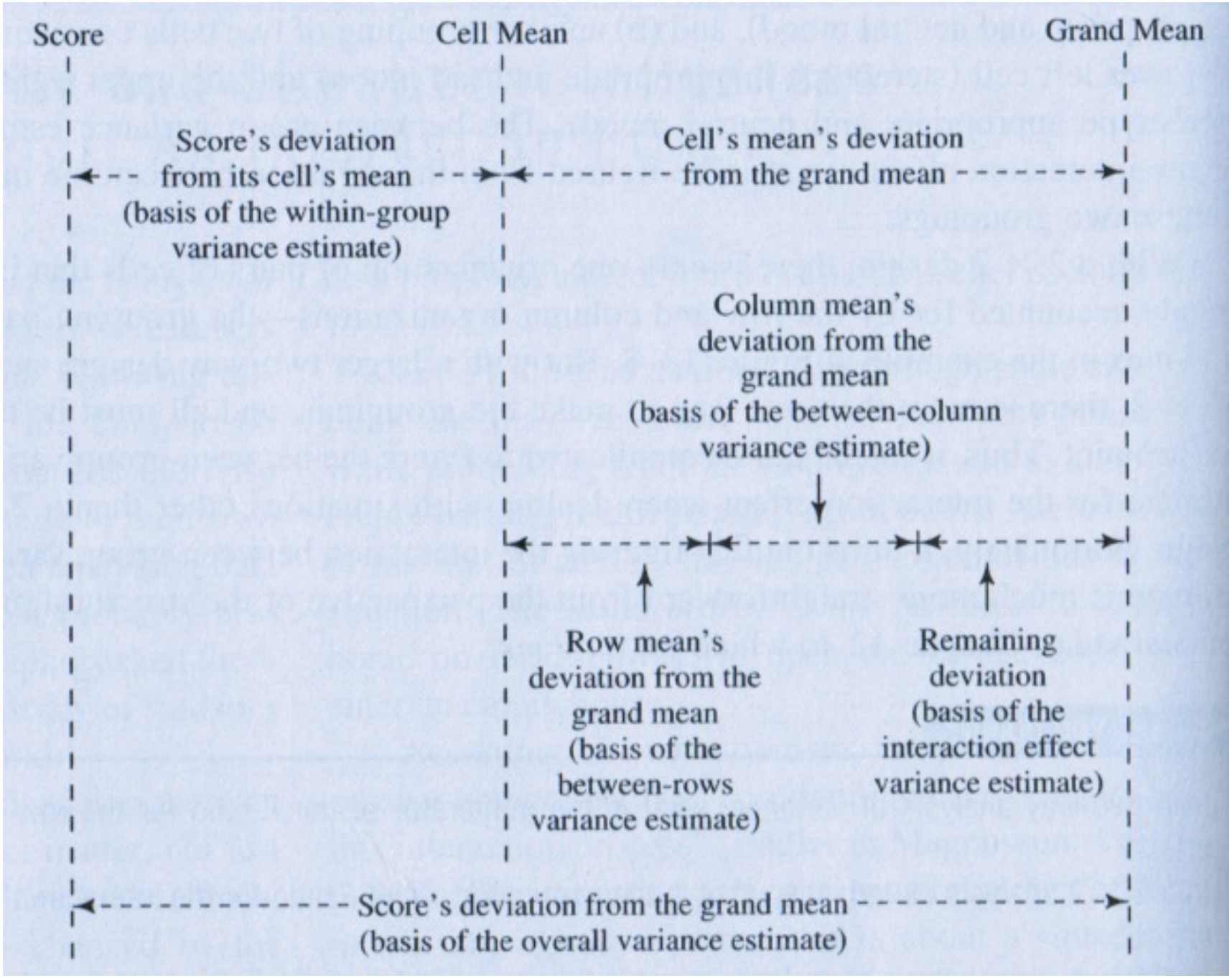
$$S^2_{between} = (S^2_M)(n)$$

Interaction Variance Estimate

The interaction variance estimate is based on the variation between the other possible cell groupings.



$$S^2_{between} = (S^2_M)(n)$$


Score
Cell Mean
Grand Mean
Score's deviation from its cell's mean (basis of the within-group variance estimate)
Cell's mean's deviation from the grand mean
Column mean's deviation from the grand mean (basis of the between-column variance estimate)
Row mean's deviation from the grand mean (basis of the between-rows variance estimate)
Remaining deviation (basis of the interaction effect variance estimate)
Score's deviation from the grand mean (basis of the overall variance estimate)

Degrees of Freedom in a Factorial ANOVA

$df_{Rows} = N_{Rows} - 1$

$df_{Columns} = N_{Columns} - 1$

$df_{Interaction} = N_{cells} - df_{Rows} - df_{Columns} - 1$

$df_{Within} = df_1 + df_2 + df_3 + df_4$ (the df of the cells)

$df_{Total} = N - 1$

$$MS = \frac{SS}{df}$$

$$F = \frac{MS_{Effect}}{MS_{Within}}$$

Assumptions

Normality

Homogeneity of Variance

And the Design…

ONLY ADD AS MANY LEVELS AS YOU NEED FOR YOUR ACTUAL HYPOTHESIS.

DO NOT ADD LEVELS SIMPLY BECAUSE YOU CAN!