

# Problem set $2 \times 3$ between s factorial

[Science](#), [Statistics](#)



PSY 870: Module 4 Problem Set 2 × 3 Between s Factorial ANOVA: Study Environments by Gender This study investigates whether study environment affects academic performance. In addition, this study investigates whether sex of student "moderates" the effect of study environment on academic performance (that is, do males and females differ in how much benefit they get from studying in certain environments).

During the first half of the spring semester, 120 male students and 120 female students in grade 10 at a public high school in a large metropolitan area in the southwestern region of the United States were randomly assigned to one of three study environment: study in front of the TV, at the library, or in the food court. The students could ONLY study in the environment to which they were assigned during the research period. At the end of the 7-week research period, mid-term GPA was computed for each student. A change score was computed for each student: each students spring midterm GPA was subtracted from his or her GPA for the preceding fall semester. The difference was each students GPA Improvement score. The GPA improvement score was used to measure academic performance.

Directions:

Using the SPSS 2 × 3 ANOVA data file for Module 4 (located in Topic Materials), answer the following questions. NOTE: Helpful hints are provided here for you to use while answering these questions. There is no separate answer sheet/guide to use while doing this assignment.

1. What are the two independent variables in this study? What is the dependent variable?

Independent variable:

Study environment

Sex

Dependent variable:

Academic performance

2. Why is a two-way between-subjects factorial ANOVA the correct statistic to use for this research design?

Then two-way between subjects ANOVA is used to analyze the results of a between subjects factorial design with two independent variables (factors).

The two-way ANOVA tests three hypotheses: the main effects for each of the two factors and the interaction effect

3. Did you find any errors that the researcher made when setting up the SPSS data file (Remember to check the variable view)? If so, what did you find? How did you correct it?

No errors are observed in setting up of the data file; the data is coded and appropriately entered

4. Run Descriptive Statistics on the dependent variable data. What do the skewness and kurtosis values tell you about whether the data satisfy the assumption of normality?

Descriptive Statistics

N

Minimum

Maximum

Mean

Std. Deviation

Skewness

Kurtosis

Statistic

Statistic

Statistic

Statistic

Statistic

Statistic

Std. Error

Statistic

Std. Error

GPA Improvement

240

-. 10

1. 00

. 2867

. 24781

. 652

. 157

-. 063

. 313

Valid N (listwise)

240

The data is positively skewed while the kurtosis value is -.063 and is platykurtic. The assumption is not satisfied.

5. Perform a between-subjects factorial ANOVA on the data.

Multivariate Tests<sup>b</sup>

Effect

Value

F

Hypothesis df

Error df

Sig.

Environment

Pillais Trace

. 785

867. 008a

1. 000

238. 000

. 000

Wilks Lambda

. 215

867. 008a

1. 000

238. 000

. 000

Hotellings Trace

3. 643

867. 008a

1. 000

238. 000

. 000

Roys Largest Root

3. 643

867. 008a

1. 000

238. 000

. 000

Environment \* sex

Pillais Trace

. 000

. 099a

1. 000

238. 000

. 753

Wilks Lambda

1. 000

. 099a

1. 000

238. 000

. 753

Hotellings Trace

. 000

. 099a

1. 000

238. 000

. 753

Roys Largest Root

. 000

. 099a

1. 000

238. 000

. 753

a. Exact statistic

b. Design: Intercept + sex

Within Subjects Design: Environment

6.

a. What do the results of the Levenes Test tell you about your data? What does this mean in terms of interpreting the outcomes of the ANOVA?

Multiple Comparisons

GPA Improvement

LSD

(I) Environment

(J) Environment

Mean Difference (I-J)

Std. Error

Sig.

95% Confidence Interval

Lower Bound

Upper Bound

Front of TV

Library

-. 2200\*

. 02758

. 000

-. 2743

-. 1657

Food Court

. 1175\*

. 02758

. 000

. 0632

. 1718

Library

Front of TV

. 2200\*

. 02758

. 000

. 1657

. 2743

Food Court

. 3375\*

. 02758

. 000

. 2832

. 3918



Food Court

Front of TV

-. 1175\*

. 02758

. 000

-. 1718

-. 0632

Library

-. 3375\*

. 02758

. 000

-. 3918

-. 2832

Based on observed means.

The error term is Mean Square (Error) = . 030.

\*. The mean difference is significant at the 0. 05 level.

The results are statistically significant

b. What do the results of the Tests of Between-Subjects Effects tell you? Was there a significant main effect of Environment on GPA improvement? Was there a significant main effect of Sex on GPA improvement? Was there a significant interaction effect of Environment X Sex on GPA improvement?

Report the results for each of these questions providing the actual F-value and p value using the following format:  $F(df1, df2) = 0.785$ \_\_\_\_,  $p = .\_000\_$  or if the p is shown as . 000, write it as  $p < . 001$ ; an example of this formatting is  $F(1, 400) = 15.4, p = . 02$ .

## Tests of Between-Subjects Effects

Dependent Variable: GPA Improvement

Source

Type III Sum of Squares

df

Mean Square

F

Sig.

Corrected Model

7. 557a

5

1. 511

49. 675

. 000

Intercept

19. 723

1

19. 723

648. 189

. 000

envir

4. 696

2

2. 348

77. 173

. 000

sex

. 081

1

. 081

2. 651

. 105

envir \* sex

2. 780

2

1. 390

45. 688

. 000

Error

7. 120

234

. 030

Total

34. 400

240

Corrected Total

14. 677

239

a. R Squared = . 515 (Adjusted R Squared = . 505)

For environment,

$F(2, 239) = 77.173, p < 0.05$ ), significantly related to academic performance

For sex  $(2, 239) = 2.651, p = 0.105$ , not significant related to academic performance

c. Use eta squared to provide effect size/proportion of variance accounted associated with each F-value. If the F-value for a main effect and/or for an interaction effect is statistically significant, what is the eta squared ( $\eta^2$ ) value associated with that outcome?

HINT:

Report eta squared,  $\eta^2$ ; ignore partial eta squared that SPSS can provide. You have to calculate eta squared yourself. It is not given to you by SPSS, but you can use what SPSS provides to calculate it. Eta squared is calculated by using the values in the column headed "Type III Sum of Squares" from the table with the results for Tests of Between-Subjects Effects." To compute eta squared, which would be notated as  $\eta^2$ , take that sources Type III Sum of Squares and divide it by the value for Corrected Total in the same column. For example, if the Type III Sum of Squares for Environment had been 4.5 rather than 4.696, you would divide 4.5 by 14.677 to get the effect size for Environment. If the Type III Sum of Squares for Sex had been 2.0, you also would divide that by 14.677, etc. Interpret these eta squared results for effect size using the following guidelines from Cohen (1988):

.01 ~ small

.06 ~ medium

.14 ~ large

For environment,  $4.696/14.677$  which gives 0.319956394 and hence

considered large

For sex, its  $0.081/14.677 = 0.005518839$  and hence considered small

d. If the result for the main effect of Environment was statistically significant, what did you find out when you performed post hoc tests (Tukey HSD) to look at possible statistically significant differences in the pairs of means for Environment groups?

GPA Improvement

Environment

N

Subset

1

2

3

Tukey Ba,, b

Food Court

80

. 1350

Front of TV

80

. 2525

Library

80

. 4725

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .030.

a. Uses Harmonic Mean Sample Size = 80.000.

b. Alpha = 0.05.

The results are confirmed as being statistically significant. It is more better to study in the library than in front of TV or food court.

e. When you have a factorial ANOVA and the interaction effect is significant, does the researcher give much attention to any significant main effects when interpreting the results of the study?

Yes, these are important in further explaining the findings of the research.

7. Citing the results of your statistical analyses, what is the conclusion you can draw (and support) regarding research question that was posed in this research (see problem statement)? Write a results section for this study that expresses and supports this conclusion.

HINT:

Use the sample write-up of the results for the Two-Way Between-Subjects ANOVA example that is in the textbook to see what you should report and how to say it. Just substitute the correct language and values for the analyses you have done for this problem.

There is a relationship between academic environment and academic performance but not sex