Assignment 8: Two-way ANOVA

Use the following data to examine differences in the number of accidents between types of vehicles (trucks and cars) and among driving skill levels (low, medium, and high).

Participant	Vehicle	Skill	Accidents
1	Truck	Low	2
2	Truck	Low	2
3	Truck	Low	2
4	Truck	Medium	3
5	Truck	Medium	4
6	Truck	Medium	5
7	Truck	High	1
8	Truck	High	1
9	Truck	High	1
10	Car	Low	2
11	Car	Low	2
12	Car	Low	2
13	Car	Medium	1
14	Car	Medium	2
15	Car	Medium	3
16	Car	High	1
17	Car	High	2
18	Car	High	3

Mean Accidents for Vehicle Type and Driving Skill

	Low Skill	Medium Skill	High Skill	Means
Truck	2	4	1	2.33
Car	2	2	2	2
Means	2	3	1.5	2.17

SPSS Instructions

- On the bottom left, click Variable View.
- Enter ‘Participant’ in the first cell, ‘Vehicle’ in the cell below it, ‘Skill’ in the next cell below, and ‘Accidents’ in the next cell below.
- On the bottom left, click Data View.
- Enter the data. For Vehicle, use 0 for Truck and 1 for Car. For Skill, use 2 for Low, 3 for Medium, and 4 for High.
- Click Analyze, General Linear Model, Univariate.
- Move Accidents into the Dependent Variable window and Vehicle and Skill into the Fixed Factor(s) window.
- Click Post Hoc. Move Skill into Post Hoc Tests for. Check LSD. Click Continue and OK.
- Save the Data file and Output file separately. Use informative file names.

SPSS Data

	Participant	Vehicle	Skill	Accidents
1	1.00	1.00	2.00	2.00
2	2.00	1.00	2.00	2.00
3	3.00	1.00	2.00	2.00
4	4.00	1.00	3.00	3.00
5	5.00	1.00	3.00	4.00
6	6.00	1.00	3.00	5.00
7	7.00	1.00	4.00	1.00
8	8.00	1.00	4.00	1.00
9	9.00	1.00	4.00	1.00
10	10.00	.00	2.00	2.00
11	11.00	.00	2.00	2.00
12	12.00	.00	2.00	2.00
13	13.00	.00	3.00	1.00
14	14.00	.00	3.00	2.00
15	15.00	.00	3.00	3.00
16	16.00	.00	4.00	1.00
17	17.00	.00	4.00	2.00
18	18.00	.00	4.00	3.00

SPSS Output

Dependent Variable: Accidents

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	14.500[a]	5	2.900	5.800	.006
Intercept	84.500	1	84.500	169.000	.000
VehTyp	.500	1	.500	1.000	.337
DriSki	7.000	2	3.500	7.000	.010
VehTyp * DriSki	7.000	2	3.500	7.000	.010
Error	6.000	12	.500		
Total	105.000	18			
Corrected Total	20.500	17			

a. R Squared = .707 (Adjusted R Squared = .585)

Multiple Comparisons

Dependent Variable: Accidents
LSD

(I) DriSki	(J) DriSki	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
2.00	3.00	-1.0000*	.40825	.031	-1.8895	-.1105
	4.00	.5000	.40825	.244	-.3895	1.3895
3.00	2.00	1.0000*	.40825	.031	.1105	1.8895
	4.00	1.5000*	.40825	.003	.6105	2.3895
4.00	2.00	-.5000	.40825	.244	-1.3895	.3895
	3.00	-1.5000*	.40825	.003	-2.3895	-.6105

Based on observed means.
The error term is Mean Square(Error) = .500.
*. The mean difference is significant at the 0.05 level.

Written Answers

Show all work.

(1) Provide the null hypotheses and the omnibus null hypothesis.
(2) Calculate the F values, provide a summary table, provide the results in APA format, and write a conclusion. Use α .01.
(3) Provide the effect sizes for the significant F values and write a conclusion.
(4) Use Fisher's LSD to determine if there is a difference between low- and medium-skilled drivers, provide the result in APA format, and write a conclusion. Use α .05.
(5) Calculate the simple effects for Skill at Truck, Vehicle at Medium Skill, and Vehicle at High Skill. Provide a summary table and write a conclusion. Use α .05.

1. $H_0: \mu_{car} = \mu_{truck}$

$H_0: \mu_{low} = \mu_{med} = \mu_{high}$

H_0: There is no skill by vehicle interaction in the population

2. $SS_{total} = \Sigma X^2 - \frac{(\Sigma X)^2}{N} = 106 - \frac{1521}{18} = 20.5$

$\Sigma X^2 = 105, \ (\Sigma X)^2 = 1521$

$n = 3$

$SS_{IV1} = n * g_{IV2} \, \Sigma(\bar{X}_{IV1} - \bar{X}_{gm})^2$

$SS_{vehicle} = 3 \cdot 3 \cdot [(2.33 - 2.17)^2 + (2 - 2.17)^2] = 0.4905$

$SS_{skill} = 3 \cdot 2 \cdot [(2 - 2.17)^2 + (3 - 2.17)^2 + (1.5 - 2.17)^2] = 7.0002$

$SS_{cells} = n \Sigma(\bar{X}_{cell} - \bar{X}_{gm})^2 = 14.5002$

$SS_{vehicle \times skill} = SS_{cells} - SS_{vehicle} - SS_{skill} = 7.0095$

$SS_{error} = SS_{total} - SS_{cells} = 5.9998$

Source	df	SS	MS	F	
Vehicle	$g-1=1$	0.4905	0.4905	0.981	$F(1,12) = .981, p > .01$
Skill	$g-1=2$	7.0002	3.5001	7*	$F(2,12) = 7, p < .01$
Vehicle x skill	vehicle x skill = 2	7.0095	3.50475	7*	$F(2,12) = 7, p < .01$
Error	$g(n-1) = 12$	5.9998	0.4999983333		
Total	$N-1 = 17$	20.5			

*$p < .01$

[illegible]

3. $\eta^2_{skill} = \frac{SS_{skill}}{SS_{total}} = 0.341$ $\eta^2_{skill \times vehicle} = \frac{SS_{skill \times vehicle}}{SS_{total}} = 0.342$

34% of the variability in the number of accidents can be attributed to skill, and about 34% to vehicle by skill interaction

4. $t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{[MS_{error}(1/n_1 + 1/n_2)]}} = \frac{1}{0.408} = 2.45$

$t(12) = 2.45,\ p = 0.031$

Conclusion: Medium-skilled drivers got into significantly more accidents than did low-skilled drivers.

5. $SS_{IV\ at\ group} = n \sum (\bar{X}_{cell} - \bar{X}_{group})^2$

$SS_{skill\ at\ truck} = 3[(2-2.\bar{3})^2 + (4-2.\bar{3})^2 + (1-2.\bar{3})^2] = 14$

$SS_{vehicle\ at\ medium} = 3[(4-3)^2 + (2-3)^2] = 6$

$SS_{vehicle\ at\ high} = 3[2(0.5)^2] = 1.5$

Source	df	SS	MS	F
Skill group				
Skill at truck	$g-1=2$	14	7	14*
Vehicle group				
Vehicle at Medium	$g-1=1$	6	6	12*
Vehicle at high	$g-1=1$	1.5	1.5	3
Error	$g(n-1)=12$	5.9998	0.4999983333	

*$p < 0.05$

Conclusion: Medium skilled truck drivers got into more accidents than high-skilled truck drivers. Also, medium skilled truck drivers got into more accidents than medium-skilled car drivers.