Chapter 13: Factorial ANOVA

Labcoat Leni's Real Research

Going out on the pierce

Problem

Guéguen, N. (2012). *Alcoholism: Clinical and Experimental Research, 36*(7), 1253–1256.

Tattoos and body piercings have become very popular since I was young. I have often contemplated having Ronald Fisher's face tattooed over my own so that people will think I'm a genius. But I digress. Research has shown that people who have tattoos and piercings are more likely to engage in risky behaviour. Nicolas Guéguen (2012) measured the level of intoxication (mass of alcohol per litre of breath exhaled, **Alcohol**) in 1965 French youths as they left bars. This measure was an indicator of risky behaviour. Each youth was also classified as having tattoos, piercings, both or neither (**Group**), and their gender was noted (**Gender**). The data are in the file **Gueguen (2012).sav**. Was the level of risk (i.e., alcohol) greater in groups who had tattoos and piercings? Did this effect interact with gender? Draw an error bar chart of the data too.

Solution

To do an error bar chart for means that are independent (i.e., have come from different groups) we need to double-click on the clustered bar chart icon in the Chart Builder (see the book chapter). All we need to do is to drag our variables into the appropriate drop zones. Select **Alcohol** from the variable list and drag it into [Y-Axis?]; select **Group** from the variable list and drag it into [X-Axis?]; finally. select the **Gender** variable and drag it into [Cluster on X: set color]. This will mean that lines representing males and females will be displayed in different colours. Select error bars in the properties dialog box and click on [Apply] to apply them to the Chart Builder. Click on [OK] to produce the graph.

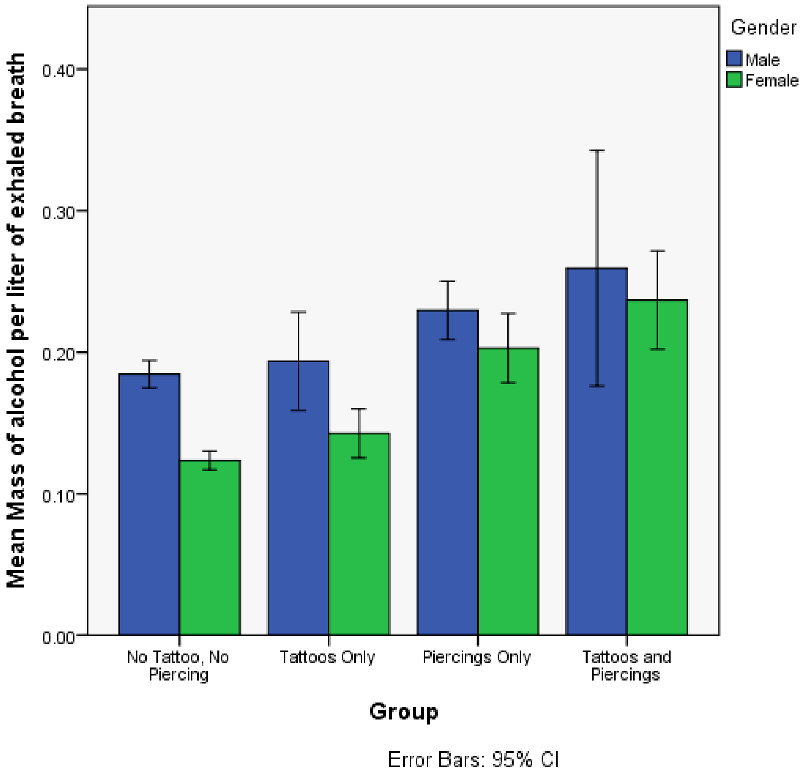

Figure 1

Figure is the resulting error bar graph of these data. Looking at the graph, we can see that in each group the men had consumed more alcohol than the women (the blue bars are taller than the green bars for all groups); this suggests that there may be a significant main effect of **Gender**. There is a steady increase in the volume of alcohol consumed as we move along the **Group** variable – the *no tattoos, no piercing* group consumed the least amount of alcohol and the *tattoos and piercings* group consumed the largest amount of alcohol – suggesting that there may be a significant main effect of **Group**. This trend appears to be the same for both men and women, suggesting that the interaction effect of **Gender** and **Group** is unlikely to be significant.

We need to conduct a 4 (experimental group) × 2 (gender) two-way independent ANOVA on the mass of alcohol per litre of exhaled breath. To access the main dialog box for a general factorial ANOVA select Analyze General Linear Model ▸ Univariate... . First, select the dependent variable **Alcohol** from the variables list on the left-hand side of the dialog box and drag it to the space labelled *Dependent Variable*. In the space labelled *Fixed Factor(s)* we need to place any independent variables relevant to the analysis. Select **Group** and **Gender** in the variables list (these variables can be selected simultaneously by holding down *Ctrl* while clicking on the variables) and drag them to the *Fixed Factor(s)* box.

Descriptives

	Gender			Statistic	Std. Error
Mass of alcohol per liter of exhaled breath	Male	Mean		.1909	.00442
		95% Confidence Interval for Mean	Lower Bound	.1822	
			Upper Bound	.1995	
		5% Trimmed Mean		.1827	
		Median		.1700	
		Variance		.021	
		Std. Deviation		.14544	
		Minimum		.00	
		Maximum		.81	
		Range		.81	
		Interquartile Range		.14	
		Skewness		.790	.074
		Kurtosis		.202	.149
	Female	Mean		.1495	.00373
		95% Confidence Interval for Mean	Lower Bound	.1422	
			Upper Bound	.1569	
		5% Trimmed Mean		.1408	
		Median		.1500	
		Variance		.012	
		Std. Deviation		.11101	
		Minimum		.00	
		Maximum		.66	
		Range		.66	
		Interquartile Range		.14	
		Skewness		1.202	.082
		Kurtosis		2.854	.164

Output 1

Tests of Between-Subjects Effects

Dependent Variable:Mass of alcohol per liter of exhaled breath

Source	Type IV Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Model	60.869[a]	8	7.609	465.174	.000	.655
Gender	.269	1	.269	16.443	.000	.008
Group	1.319	3	.440	26.883	.000	.040
Gender * Group	.080	3	.027	1.624	.182	.002
Error	32.010	1957	.016			
Total	92.879	1965				

a. R Squared = .655 (Adjusted R Squared = .654)

Output 2

Multiple Comparisons

Dependent Variable: Mass of alcohol per liter of exhaled breath
LSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
No Tattoo, No Piercing	Tattoos Only	.0039	.01019	.704	-.0161	.0238
	Piercings Only	-.0522*	.00898	.000	-.0698	-.0345
	Tattoos and Piercings	-.0805*	.01255	.000	-.1051	-.0558
Tattoos Only	No Tattoo, No Piercing	-.0039	.01019	.704	-.0238	.0161
	Piercings Only	-.0560*	.01272	.000	-.0810	-.0311
	Tattoos and Piercings	-.0843*	.01544	.000	-.1146	-.0540
Piercings Only	No Tattoo, No Piercing	.0522*	.00898	.000	.0345	.0698
	Tattoos Only	.0560*	.01272	.000	.0311	.0810
	Tattoos and Piercings	-.0283	.01467	.054	-.0571	.0005
Tattoos and Piercings	No Tattoo, No Piercing	.0805*	.01255	.000	.0558	.1051
	Tattoos Only	.0843*	.01544	.000	.0540	.1146
	Piercings Only	.0283	.01467	.054	-.0005	.0571

Based on observed means.
The error term is Mean Square(Error) = .016.
*. The mean difference is significant at the .05 level.

Output 3

3. Group

Dependent Variable: Mass of alcohol per liter of exhaled breath

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
No Tattoo, No Piercing	.154	.003	.147	.161
Tattoos Only	.168	.010	.148	.189
Piercings Only	.216	.008	.200	.233
Tattoos and Piercings	.248	.014	.220	.276

Output 4

Output is the output of the main ANOVA. We can see that there was a significant main effect of gender, $F(1, 1957) = 16.44$, $p < .001$, with a partial eta squared of .01. The means in Output (and Figure), reveal that men ($M = 0.19$, $SD = 0.15$) consumed a significantly higher mass of alcohol than women ($M = 0.15$, $SD = 0.11$). There was also a significant main effect of group, $F(3, 1957) = 26.88$, $p < .001$, with a partial eta squared of .04. *Post hoc* tests (Output) revealed that participants who only had piercings ($M = 0.22$) consumed a significantly greater mass of alcohol than those who only had tattoos ($M = 0.17$) (least significant difference (LSD) test, $p < .001$) and those who had no tattoos and no piercings ($M = 0.15$) (LSD test, $p < .001$). Participants who had both tattoos and piercings ($M = 0.25$) consumed a significantly greater mass of alcohol than those who only had tattoos ($M = 0.17$) (LSD test, $p < .001$), and those who had no tattoos and no piercings ($M = 0.15$) (LSD test, $p < .001$). However, they did not consume a significantly greater mass than those who only had piercings ($M = 0.22$) (LSD test, $p = .05$).

In summary, we can conclude that individuals who have both piercings and tattoos, and those who only have piercings, consumed significantly more alcohol than those who had no tattoos and no piercings and those who only had tattoos. This effect was found in both men and women.

Don't forget your toothbrush?

Problem

Davey, G. C. L., et al. (2003). *Journal of Behavior Therapy & Experimental Psychiatry*, *34*, 141–160.

We have all experienced that feeling after we have left the house of wondering whether we remembered to lock the door, close the window, or remove the bodies from the fridge in case the police turn up. This behaviour is common; however, people with obsessive compulsive disorder (OCD) tend to check things excessively. They might, for example, check whether they have locked the door so often that it takes them an hour to leave their house.

One theory suggests that this checking behaviour is caused by a combination of the mood you are in (positive or negative) interacting with the rules you use to decide when to stop a task (do you continue until you feel like stopping, or until you have done the task as best you can?). Davey, Startup, Zara, MacDonald, and Field (2003) tested this hypothesis by putting people into a negative, positive or no mood (**Mood**) and then asking them to generate as many things as they could that they should check before going on holiday (**Checks**). Within each mood group, half of the participants were instructed to generate as many items as they could, whereas the remainder were asked to generate items for as long as they felt like continuing the task (**Stop_Rule**). The data are in the file **Davey(2003).sav**.

Draw an error bar chart of the data and then conduct the appropriate analysis to test Davey et al.'s hypotheses that (1) people in negative moods who use an 'as many as can' stop rule would generate more items than those using a 'feel like continuing' stop rule; (2) people in a positive mood would generate more items when using a 'feel like continuing' stop rule compared to an 'as many as can' stop rule; (3) in neutral moods, the stop rule used won't have an effect.

Solution

To do an error bar chart for means that are independent (i.e., have come from different groups) we need to double-click on the clustered bar chart icon in the Chart Builder (see the book chapter). All we need to do is to drag our variables into the appropriate drop zones. Select **Checks** from the variable list and drag it into 

; select **Mood** from the variable list and drag it into 

; finally, select the **Stop_Rule** variable and drag it into

Cluster on X: set color. This will mean that lines representing males and females will be displayed in different colours. Select error bars in the *properties* dialog box and click on Apply to apply them to the Chart Builder. Click on OK to produce the graph.

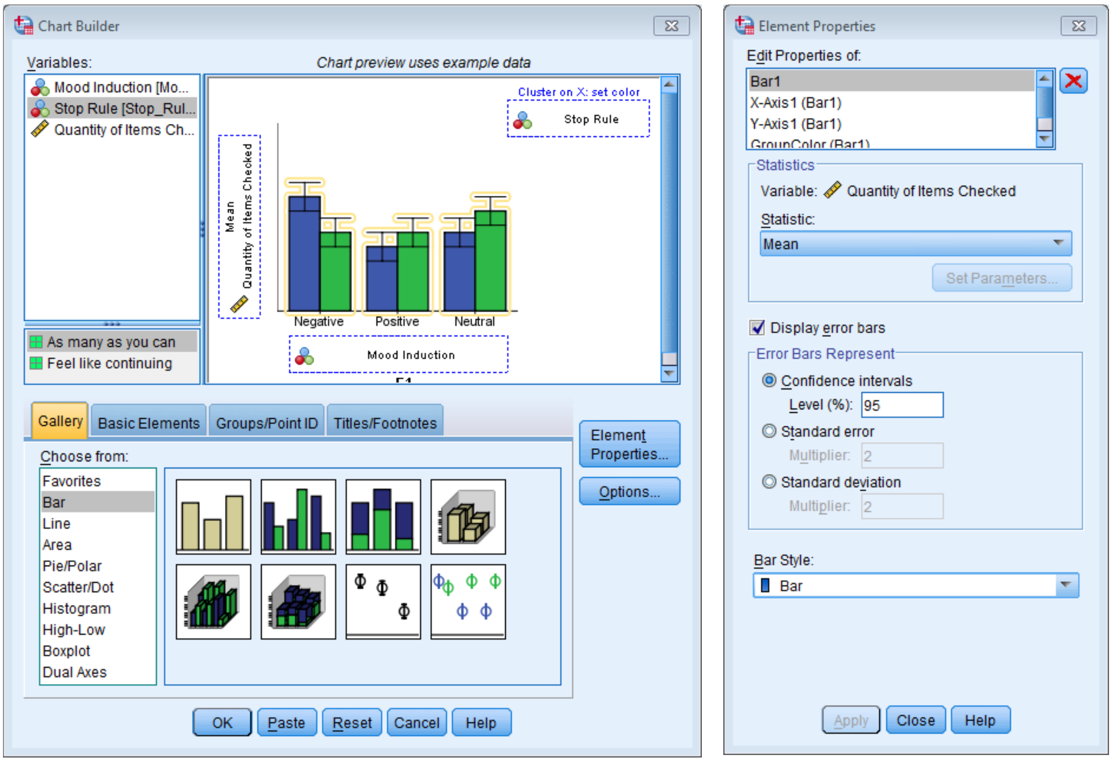

Figure 2

The resulting graph should look like Figure .

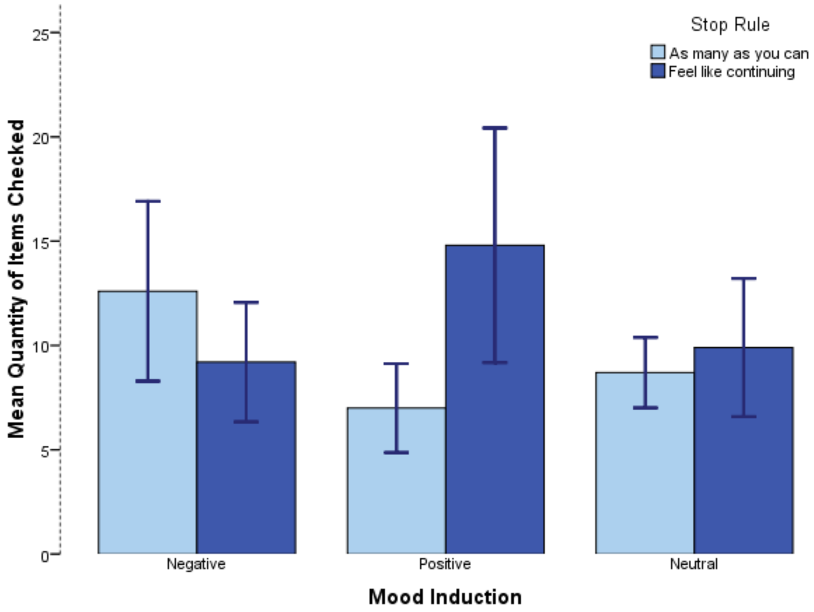

Figure 3

To access the main dialog box for a general factorial ANOVA, select Analyze General Linear Model ▸ Univariate... . First, select the dependent variable **Checks** from the variables list on the left-hand side of the dialog box and drag it to the space labelled *Dependent Variable*. In the space labelled *Fixed Factor(s)* we need to place any independent variables relevant to the analysis. Select **Mood** and **Stop_Rule** in the variables list (these variables can be selected simultaneously by holding down *Ctrl* while clicking on the variables) and drag them to the *Fixed Factor(s)* box.

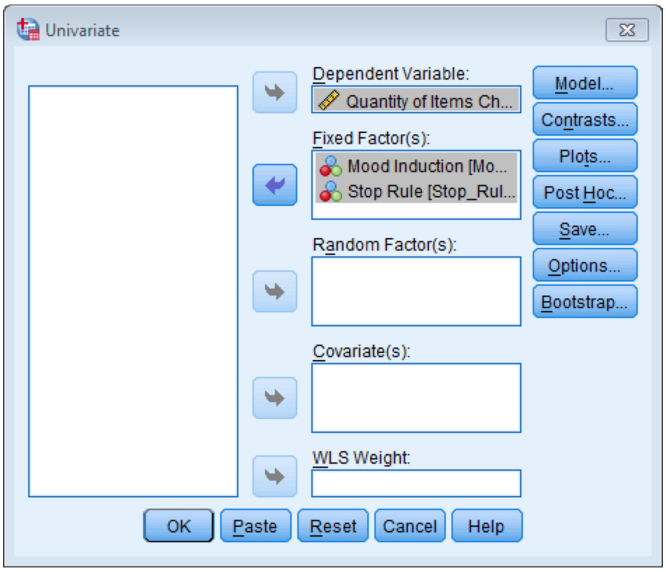

Figure 4

The resulting output can be interpreted as follows (see Output 5). First, Levene's test is significant, indicating a problem with homogeneity of variance. If we compare the largest and smallest variances (smallest = 2.35^2 = 5.52; largest = 7.86^2 = 61.78) we find a ratio of 61.78/5.52 = 11. We have six variances, and $N - 1 = 9$, and so the critical value from Hartley's table (which you can find in the web material for Chapter 5) is 7.80. Our observed value of 11 is bigger than this, so we definitely have a problem.

Descriptive Statistics

Dependent Variable:Quantity of Items Checked

Mood ...	Stop Rule	Mean	Std. Deviation	N
Negative	As many as you can	12.6000	6.02218	10
	Feel like continuing	9.2000	3.99444	10
	Total	10.9000	5.27057	20
Positive	As many as you can	7.0000	2.98142	10
	Feel like continuing	14.8000	7.85706	10
	Total	10.9000	7.03300	20
Neutral	As many as you can	8.7000	2.35938	10
	Feel like continuing	9.9000	4.62961	10
	Total	9.3000	3.62883	20
Total	As many as you can	9.4333	4.62887	30
	Feel like continuing	11.3000	6.09777	30
	Total	10.3667	5.44920	60

Levene's Test of Equality of Error Variances[a]

Dependent Variable:Quantity of Items Checked

F	df1	df2	Sig.
2.919	5	54	.021

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Mood + Stop_Rule + Mood * Stop_Rule

Tests of Between-Subjects Effects

Dependent Variable:Quantity of Items Checked

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	403.333[a]	5	80.667	3.230	.013
Intercept	6448.067	1	6448.067	258.190	.000
Mood	34.133	2	17.067	.683	.509
Stop_Rule	52.267	1	52.267	2.093	.154
Mood * Stop_Rule	316.933	2	158.467	6.345	.003
Error	1348.600	54	24.974		
Total	8200.000	60			
Corrected Total	1751.933	59			

a. R Squared = .230 (Adjusted R Squared = .159)

Output 5

The main effect of mood was not significant, $F(2, 54) = 0.68$, $p = .51$, indicating that the number of checks (when we ignore the stop rule adopted) was roughly the same regardless of whether the person was in a positive, negative or neutral mood. Similarly, the main effect of stop rule was not significant, $F(1, 54) = 2.09$, $p = .15$, indicating that the number of checks (when we ignore the mood induced) was roughly the same regardless of whether the person used an ‘as many as can’ or a ‘feel like continuing’ stop rule. The mood × stop rule interaction was significant, $F(2, 54) = 6.35$, $p = .003$, indicating that the mood combined with the stop rule significantly affected checking behaviour. Looking at the graph, a negative mood in combination with an ‘as many as can’ stop rule increased checking, as did the combination of a ‘feel like continuing’ stop rule and a positive mood, just as Davey et al. predicted.