Chapter 10: Answers

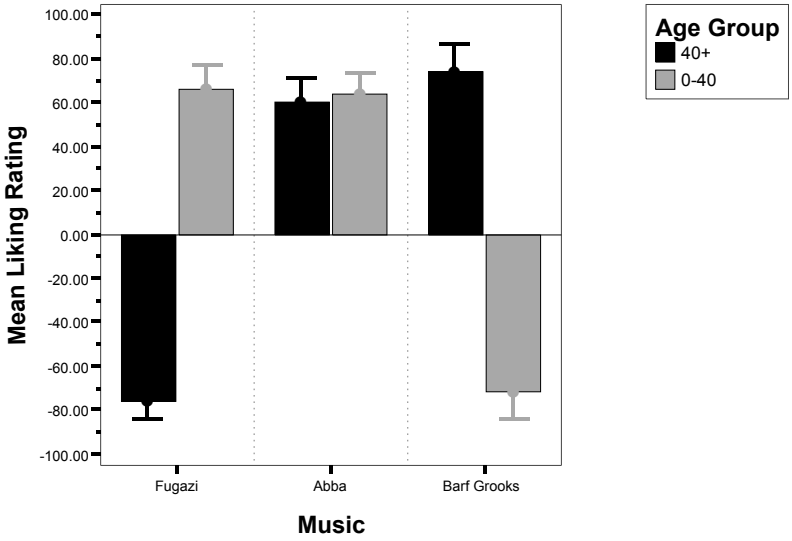
Task 1

People's musical taste tends to change as they get older (my parents, for example, after years of listening to relatively cool music when I was a kid in the 1970s, subsequently hit their mid-40s and developed a worrying obsession with country and western music—or maybe it was the stress of having me as a teenage son!). Anyway, this worries me immensely as the future seems incredibly bleak if it is spent listening to Garth Brooks and thinking 'oh boy, did I underestimate Garth's immense talent when I was in my 20s'. So, I thought I'd do some research to find out whether my fate really was sealed, or whether it's possible to be old and like good music too. First, I got myself two groups of people (45 people in each group): one group contained young people (which I arbitrarily decided was under 40 years of age), and the other group contained more mature individuals (above 40 years of age). This is my first independent variable, **age**, and it has two levels (less than or more than 40 years old). I then split each of these groups of 45 into three smaller groups of 15 and assigned them to listen to either Fugazi (who everyone knows are the coolest band on the planet)[1], ABBA, or Barf Grooks (who is a lesser known country and western musician not to be confused with anyone who has a similar name and produces music that makes you want to barf). This is my second independent variable, **music**, and has three levels (Fugazi, ABBA or Barf Grooks). There were different participants in all conditions, which means that of the 45 under 40s, 15 listened to Fugazi, 15 listened to ABBA and 15 listened to Barf Grooks; likewise of the 45 over 40s, 15 listened to Fugazi, 15 listened to ABBA and 15 listened to Barf Grooks. After listening to the music I got each person to rate it on a scale ranging from –100 (I hate this foul music of Satan) through 0 (I am completely indifferent) to +100 (I love this music so much I'm going to explode). This variable is called **liking**. The data are in the file **Fugazi.sav**. Conduct a two-way independent ANOVA on them.

SPSS Output

The error bar chart of the music data shows the mean rating of the music played to each group. It's clear from this chart that when people listened to Fugazi the two age groups were divided: the older ages rated it very low, but the younger people rated it very highly. A reverse trend is found if you look at the ratings for Barf Grooks: the youngsters give it low ratings while the wrinkly-ones love it. For ABBA the groups agreed: both old and young rated them highly.

[1] See http://www.dischord.com



The following output shows Levene's test. For these data the significance value is 0.322, which is greater than the criterion of 0.05. This means that the variances in the different experimental groups are roughly equal (i.e. not significantly different), and that the assumption has been met.

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

Dependent Variable: Liking Rating

F	df1	df2	Sig.
1.189	5	84	.322

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

a. Design: Intercept+MUSIC+AGE+MUSIC * AGE

The next output shows the main ANOVA summary table.

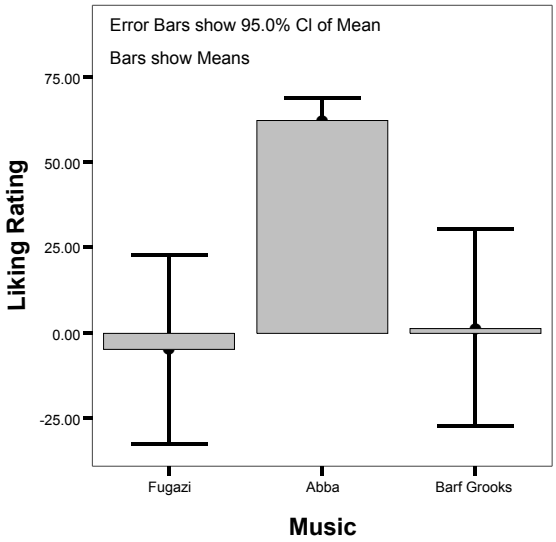
Tests of Between-Subjects Effects

Dependent Variable: Liking Rating

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	392654.933[a]	5	78530.987	202.639	.000
Intercept	34339.600	1	34339.600	88.609	.000
MUSIC	**81864.067**	**2**	**40932.033**	105.620	**.000**
AGE	**.711**	**1**	**.711**	.002	**.966**
MUSIC * AGE	**310790.156**	**2**	**155395.078**	400.977	**.000**
Error	32553.467	84	387.541		
Total	459548.000	90			
Corrected Total	425208.400	89			

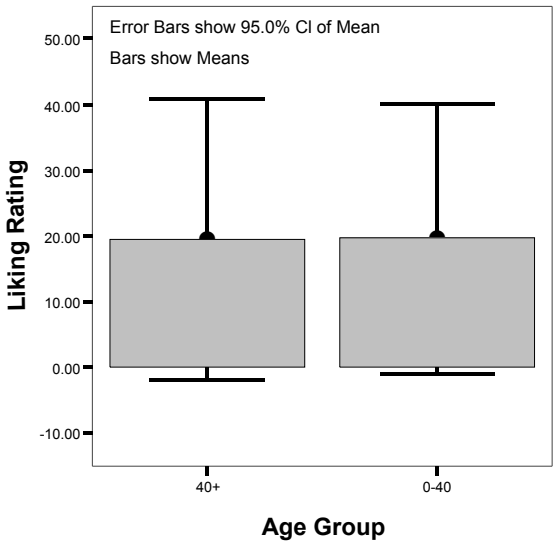
a. R Squared = .923 (Adjusted R Squared = .919)

The main effect of music is shown by the *F*-ratio in the row labeled music, in this case the significance is 0.000, which is lower than the usual cut-off point of 0.05. Hence, we can say that there was a significant effect of the type of music on the ratings. To understand what this actually means, we need to look at the mean ratings for each type of music when we ignore whether the person giving the rating was old or young:



What this graph shows is that the significant main effect of music is likely to reflect the fact that ABBA were rated (overall) much more positively than the other two artists.

The main effect of age is shown by the *F*-ratio in the row labeled age; the probability associated with this *F*-ratio is 0.966, which is so close to 1 that it means that it is a virtual certainty that this *F* could occur by chance alone. Again, to interpret the effect we need to look at the mean ratings for the two age groups ignoring the type of music to which they listened.



This graph shows that when you ignore the type of music that was being rated, older people, on average, gave almost identical ratings to younger people (i.e. the mean ratings in the two groups are virtually the same).

The interaction effect is shown by the *F*-ratio in the row labeled Music * Age; The associated significance value is small (0.000) and is less than the criterion of 0.05. Therefore, we can say that there is a significant interaction between age and the type of music rated. To interpret this effect we need to look at the mean ratings in all conditions and these means were

originally plotted at the beginning of this output. The fact there is a significant interaction tells us that for certain types of music the different age groups gave different ratings. In this case, although they agree on ABBA, there are large disagreements in ratings of Fugazi and Barf Grooks.

Given that we found a main effect of music, and of the interaction between music and age, we can look at some of the post hoc tests to establish where the difference lies. The next output shows the result of Games-Howell post hoc tests. First, ratings of Fugazi are compared to ABBA, which reveals a significant difference (the value in the column labeled Sig. is less than 0.05), and then Barf Grooks, which reveals no difference (the significance value is greater than 0.05). In the next part of the table, ratings to ABBA are compared first to Fugazi (which just repeats the finding in the previous part of the table) and then to Barf Grooks, which reveals a significant difference (the significance value is below 0.05). The final part of the table compares Barf Grooks to Fugazi and ABBA but these results repeat findings from the previous sections of the table.

Multiple Comparisons

Dependent Variable: Liking Rating

			Mean Difference			95% Confidence Interval	
	(I) Music	(J) Music	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Games-Howell	Fugazi	Abba	-66.8667*	5.08292	.000	-101.1477	-32.5857
		Barf Grooks	-6.2333	5.08292	.946	-53.3343	40.8677
	Abba	Fugazi	66.8667*	5.08292	.000	32.5857	101.1477
		Barf Grooks	60.6333*	5.08292	.001	24.9547	96.3119
	Barf Grooks	Fugazi	6.2333	5.08292	.946	-40.8677	53.3343
		Abba	-60.6333*	5.08292	.001	-96.3119	-24.9547

Based on observed means.

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

Calculating Effect Sizes

$$\hat{\sigma}_{\alpha}^2 = \frac{(3-1)(40932.033-387.541)}{15\times 3\times 2} = 900.99$$

$$\hat{\sigma}_{\beta}^2 = \frac{(2-1)(0.711-387.541)}{15\times 3\times 2} = -4.30$$

$$\hat{\sigma}_{\alpha\beta}^2 = \frac{(3-1)(2-1)(155395.078-387.541)}{15\times 3\times 2} = 3444.61$$

We also need to estimate the total variability and this is just the sum of these other variables plus the residual mean squares:

$$\begin{aligned}\hat{\sigma}_{\text{total}}^2 &= \hat{\sigma}_{\alpha}^2 + \hat{\sigma}_{\beta}^2 + \hat{\sigma}_{\alpha\beta}^2 + MS_R \\ &= 900.99 - 4.30 + 3444.61 + 387.54 \\ &= 4728.84\end{aligned}$$

The effect size is then simply the variance estimate for the effect in which you're interested divided by the total variance estimate:

$$\omega_{\text{effect}}^2 = \frac{\hat{\sigma}_{\text{effect}}^2}{\hat{\sigma}_{\text{total}}^2}$$

As such, for the main effect of music we get:

$$\omega_{\text{music}}^2 = \frac{\hat{\sigma}_{\text{music}}^2}{\hat{\sigma}_{\text{total}}^2} = \frac{900.99}{4728.84} = 0.19$$

For the main effect of age we get:

$$\omega_{\text{age}}^2 = \frac{\hat{\sigma}_{\text{age}}^2}{\hat{\sigma}_{\text{total}}^2} = \frac{-4.30}{4728.84} = 0.00$$

For the interaction of music and age we get:

$$\omega^2_{\text{music}\times\text{age}} = \frac{\hat{\sigma}^2_{\text{music}\times\text{age}}}{\hat{\sigma}^2_{\text{total}}} = \frac{3444.61}{4728.84} = 0.73$$

Interpreting and Writing the Result

As with the other ANOVAs we've encountered we have to report the details of the *F*-ratio and the degrees of freedom from which it was calculated. For the various effects in these data the *F*-ratios will be based on different degrees of freedom: it was derived from dividing the mean squares for the effect by the mean squares for the residual. For the effects of music and the music × age interaction, the model degrees of freedom were 2 (df_M = 2), but for the effect of age the degrees of freedom were only 1 (df_M = 1). For all effects, the degrees of freedom for the residuals were 84 (df_R = 84). We can, therefore, report the three effects from this analysis as follows:

- ✓ The results show that the main effect of the type of music listened to significantly affected the ratings of that music ($F(2, 84) = 105.62$, $p < .001$, $r = .94$). Games-Howell post hoc test revealed that ABBA were rated significantly higher than both Fugazi and Barf Grooks (both *p*s < .01).
- ✓ The main effect of age on the ratings of the music was nonsignificant ($F(1, 84) < 1$, $r = .00$).
- ✓ The music × age interaction was significant ($F(2, 84) = 400.98$, $p < .001$, $r = .98$) indicating that different types of music were rated differently by the two age groups. Specifically, Fugazi were rated more positively by the young group (M = 66.20, SD = 19.90) than the old (M = –75.87, SD = 14.37); ABBA were rated fairly equally in the young (M = 64.13, SD = 16.99) and old groups (M = 59.93, SD = 19.98); Barf Grooks was rated less positively by the young group (M = –71.47, SD = 23.17) compared to the old (M = 74.27, SD = 22.29). These findings indicate that there is no hope for me, the minute I hit 40 I will suddenly start to love country and western music and will burn all of my Fugazi CDs (it will never happen … arghhhh!!!).

Task 2

Change the syntax in **GogglesSimpleEffects.sps** to look at the effect of alcohol at different levels of gender.

The correct syntax to use is:

```
MANOVA
  attract BY gender (0 1) alcohol(1 3)
/DESIGN = alcohol WITHIN gender(1) alcohol WITHIN gender (2)
  /PRINT
        CELLINFO
        SIGNIF( UNIV MULT AVERF HF GG ).
```

SPSS Output

The main part of the analysis is:

```
* * * * * * A n a l y s i s   o f   V a r i a n c e -- design   1 * * * * * *

 Tests of Significance for ATTRACT using UNIQUE sums of squares
 Source of Variation          SS      DF        MS          F  Sig of F

 WITHIN+RESIDUAL         3656.25      43     85.03
 ALCOHOL WITHIN GENDE    5208.33       2   2604.17     30.63      .000
 R(1)
 ALCOHOL WITHIN GENDE     102.08       2     51.04       .60      .553
 R(2)

 (Model)                 5310.42       4   1327.60     15.61      .000
 (Total)                 8966.67      47    190.78

 R-Squared =           .592
 Adjusted R-Squared =  .554
```

What this shows is a significant effect of alcohol at level 1 of gender. Because we coded gender as 0 = male, 1 = female, this means there's a significant effect of alcohol for men. Think back to the chapter and this reflects the fact that men choose very unattractive dates after 4 pints. However, there is no significant effect of alcohol at level 2 of gender. This tells us that women are not affected by the beer goggles effect: they attractiveness of their dates does not chance as they drink more.

Calculating the Effect Size

These effects have 2 df in the model so we can't calculate an effect size (well, technically we can calculate omega squared (ω^2) but I'm not entirely sure how useful that is.