

## EXERCISE 14

## Two-factor within subjects ANOVA

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### Before you start

We suggest that you read Section 9.4 before proceeding. In this Exercise, we consider the ANOVA of within subjects factorial experiments, that is, experiments with repeated measures on all factors.

### A two-factor within subjects experiment

An experiment is carried out to investigate the effects of two factors upon the recognition of symbols briefly presented on a screen, as measured by the number of correct identifications over a fixed number of trials. The factors are Symbol (with levels Digit, Lower Case, and Upper Case) and Font (with levels Gothic and Roman). Each of the six participants in the experiment is tested under all six combinations of the two treatment factors. The results are shown in Table 1.

Case	Digit		Lower Case		Upper Case	
	Gothic	Roman	Gothic	Roman	Gothic	Roman
1	2	6	18	3	20	5
2	4	9	20	6	18	2
3	3	10	15	2	21	3
4	1	12	10	9	25	10
5	5	8	13	8	20	8
6	6	10	14	10	16	6

### Opening SPSS

Open SPSS and select the **Type in data** radio button in the opening window. If **Data View** appears first, click the **Variable View** tab to open **Variable View**.

### Preparing the SPSS data set

In **Variable View**, define the variables as described in Section 9.4, assigning the variable names systematically, as in DigitGothic, DigitRoman, LowerGothic, LowerRoman,

UpperGothic, UpperRoman. For clarity, it is recommended that self-explanatory labels such as Gothic digits, Roman digits, Gothic lowercase, and so on, be assigned by making appropriate entries in the **Label** column of **Variable View**. Enter the data into **Data View**, under the appropriate pre-headed columns. Ensure that the values in the **Decimals** column are all 0.

## Exploring the data

Use the methods described in Section 9.2.2 to check for any distribution problems.

## Running the two-factor within subjects ANOVA

To run the ANOVA, select **Analyze** → **General Linear Model** → **Repeated Measures...** and complete the various dialog boxes following the procedure described in Section 9.4.2. Name the factors as *Symbol* and *Font*. Name the **Measure Name** as *Recognition*. Remember to click **Plots...** and complete the **Repeated Measures: Profile Plots** dialog box by transferring *Symbol* to the **Horizontal Axis:** box and *Font* to the **Separate Lines:** box, clicking **Add** and finally **Continue**, to return to the **Repeated Measures** dialog box. Remember, too, to select **Options...** and click *Symbol* and then **Bonferroni** as the measure for comparisons and to click the check boxes for **Descriptive statistics** and for **Estimates of effect size** as described in Section 9.4.2.

## Output for the two-factor within subjects experiment

When answering the bullet point relating to effect size, use the following ranges of partial eta squared ( $\eta_p^2$ ) for deciding whether its value is Small, Medium or Large: Small:  $.01 \leq \eta_p^2 < .06$ ; Medium:  $.06 \leq \eta_p^2 < .14$ ; Large:  $\eta_p^2 \geq .14$ . Note that these are the ranges of values given for omega squared in Table 5 on page 236. While omega squared corrects for positive bias, there are problems with that statistic in experiments of mixed factorial design and we must use eta squared as an equivalent measure of effect size.

The output for the two-factor repeated measures ANOVA is explained in Section 9.4.3. Remove the unnecessary tables at the beginning.

Next comes a table of **Mauchly's Test of Sphericity**. Check carefully to see whether there is evidence of non-sphericity. The main table of interest is the **Tests of Within-Subjects Effects**. For each factor and interaction, read the row **Sphericity Assumed** if the relevant Mauchly test is not significant; otherwise read the **Greenhouse-Geisser** row. If none of the Sphericity tests is significant, you should delete the conservative tests rows by double-clicking anywhere in the table, highlighting the material to be deleted and pressing the **Delete** key. The remaining two tables can be ignored.

- Give the *F* ratio and p-value for each factor and the interaction. Interpret these results in terms of the aims of the study.
- What is the value of Partial Eta Squared for each factor? Describe each value as either a small, medium or large effect?

Look at the table of **Pairwise Comparisons**.

- Which symbols differ significantly?

Finally inspect the **Profile Plots**.

- Describe the plot and comment on whether it confirms the various ANOVA results.

## Teasing out the interaction

Following what you have noticed in the pattern of results in the profile plot, the levels of the factor Symbol within each of the two levels of the factor Font can be teased out by using SPSS Syntax. Open the Syntax Editor as described in Section 8.5 and then enter subcommands similar to those in Chapter 9, Figure 17 but amended for the variable names and factor names of this example (e.g. the /WSDDESIGN subcommand would be /WSDDESIGN=Symbol WITHIN Font(1) Symbol WITHIN Font(2) ). Ensure that there is a period (.) after the /WSDDESIGN subcommand and then run the three-line command as described in Section 8.5. The output is extensive: look for the table headed “Tests involving ‘SYMBOL WITHIN FONT(1)’ Within-Subject Effect” and “Tests involving ‘SYMBOL WITHIN FONT(2)’ Within-Subject Effect”.

- **Compare the significance levels of the F ratios of these two simple main effects. Comment on your findings.**

## Finishing the session

Close down SPSS and any other windows before logging out of the computer.