Simple Effects, Simple Contrasts, and Main Effect Contrasts

Simple Effects

Following a significant interaction, follow-up tests are usually needed to explore the exact nature of the interaction. *Simple effects* (sometimes called *simple main effects*) are differences among particular cell means within the design. More precisely, a simple effect is the effect of one independent variable within one level of a second independent variable. In our hypothetical example of the eyewitness study, one simple effect might involve the effect of violence only for individuals within the no training condition. Similar to the contrasts following a significant one-way ANOVA, the simple effect test uses the error term and *df* from the whole design. Remember that when the error term ($MS_{s/A}$) is derived using all of the cases in the study, it will be generally be smaller and will result in greater statistical power. Thus, testing simple effects is preferable to using *t*-tests.

Below, I present the means we obtained from the previous factorial ANOVA where we found a significant interaction, $F(1,16) = 8.00$, $p < .05$. One might wish to determine if the violence manipulation had any effect in the no training group—this is a simple effects hypothesis. In this case, the two means highlighted below are compared.

Table 1. Simple effect comparison for a 2 X 2 factorial ANOVA.

	No training	Training	
No violence	4.0	8.0	6.0
Violence	2.0	2.0	2.0
	3.0	5.0	4.0

The syntax for testing this simple effect in SPSS is discussed in a separate handout called "Simple Effects Test Following a Significant Interaction."

Simple Contrasts

In factorial designs with more than two levels of one or more of the independent variables, one can also distinguish between *simple effects* and *simple contrasts*. A simple contrast is a more focused test that compares only two cells.[1] Let's assume we had a third level of the training factor where a second type of training was used. In the second training, police officers are taught to rehearse the events in their minds immediately after the incidents. Below are the hypothetical results from that study, where I highlight the simple effect for training within the no violence group.

Table 2. Simple effect comparison for a 2 X 3 factorial ANOVA.

	No training	Mindfulness Training	Rehearsal Training	
No violence	4.0	8.0	9.0	7.0
Violence	2.0	2.0	5.0	3.0
	3.0	5.0	7.0	5.0

As you can see, the simple effect now refers to a test of differences among three means, because the factor being compared has three levels.

The simple contrast is a more specific test and might follow a simple effect test. An example of a simple contrast would be a test to compare the means of just the two training groups within the no violence condition, as illustrated below.

Table 3. Simple contrast for a 2 X 3 factorial ANOVA.

	No training	Mindfulness Training	Rehearsal Training	
No violence	4.0	8.0	9.0	7.0
Violence	2.0	2.0	5.0	3.0
	3.0	5.0	7.0	5.0

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[1] Contrasts can also compare more than two cells. For example, the average of two cells might be compared to a third cell.

The SPSS syntax for this comparison using the MANOVA command would look something like this:[2]

```
MANOVA memory BY violence(1,2) training(1,3)
   /ERROR=WITHIN
   /CONTRAST(training)=SPECIAL (1 1 1,
                                0 -1 1,
                               -1 0 1)
 /DESIGN=training(1) WITHIN violence(1), training(2) WITHIN violence(1).
```

Under the /CONTRAST subcommand, there are three rows of numbers. The first is required to be all 1s. The next two rows represent two contrasts. Even though only one was desired, SPSS requires that there be a contrast for every row. The first contrast, which is represented by the codes 0 -1 1 and is referred to on the /DESIGN subcommand as training(1), compares only the mindfulness and rehearsal training conditions within the no violence condition (i.e., the simple contrast shown in Table 3). The second comparison, which was not of interest, is represented by the codes -1 0 1 and is referred to on the /DESIGN subcommand as training(2) and compares the no training and rehearsal training groups within the violence condition (not shown in Table 3).

Main Effect Contrasts
In the circumstance where a main effect is significant for a factor that has more than two levels, one can also compare specific means (typically not pursued if the interaction is significant). This comparison is called a main effect contrast. Remember that a main effect is the difference between or among marginal means, where the levels of the other independent variable are combined. In the table below, the main effect for training is highlighted.

Table 4. Main effect in a 2 X 3 ANOVA.

	No training	Mindfulness Training	Rehearsal Training	
No violence	4.0	8.0	9.0	7.0
Violence	2.0	2.0	5.0	3.0
	3.0	5.0	7.0	5.0

The main effect indicates there are differences among these three means, but we do not know exactly where the differences may lie. We might, for instance, have a special interest in knowing whether, overall, the mindfulness and rehearsal training groups differed from one another.

Table 5. Main effect contrast in a 2 X 3 ANOVA.

	No training	Mindfulness Training	Rehearsal Training	
No violence	4.0	8.0	9.0	7.0
Violence	2.0	2.0	5.0	3.0
	3.0	5.0	7.0	5.0

Because many authors do not recommend interpreting main effects when there is a significant interaction, one would usually only test this contrast using a one-factor ANOVA. The MANOVA syntax for the contrast shown in Table 5 is generated from the syntax below with the special contrast weights 0, -1, 1 and labeled as the "training (1)" contrast in the output.

```
MANOVA memory BY training(1,3)
     /CONTRAST(training)=SPECIAL(1 1 1, 0 -1 1, 1 0 -1)
     /DESIGN=training(1), training(2).
```

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[2] These examples are based on syntax provided by Page, M.C., Braver, S.L., & MacKinnon, D.P. (2003). *Levine's guide to SPSS for analysis of variance* (2nd Edition). Mahway, NJ: Erlbaum.

R

Without going into complete detail, the `phia` package in R allows for a number of special contrasts as well. Just as in the MANOVA command examples above, contrast codes can be specified to test particular comparisons.

Simple Effect Contrasts

For simple effects contrast, two steps are needed. The contrast coefficients are named and specified first, and, then, the `testInteractions` function indicates that the comparisons represented by the coefficients are made within the levels of the other factor (e.g., training groups are compared within violence levels). Reminder: for the correct `car` result for the `Anova` test, make sure the IVs are designated as factors in R (see factorial example handout for sample code for transforming numeric variables to factors).

```
library(car)
mymodel = lm(memory ~ violence + training + violence:training, data=d)
Anova(mymodel, type = "III")

#name each contrast
#no training vs. mindfulness training
no_vs_mi <- list(training = c(1, -1, 0))
#no training vs. rehearsal training
no_vs_re <- list(training = c(1, 0, -1))
#specify these two comparisons within the levels of violence
testInteractions (mymodel, custom = c(no_vs_mi, no_vs_re), fixed = "violence", adjustment="none")
```

Main Effect Contrasts

For main effects contrasts, use the same approach above, but leave off the `fixed =` statement.

```
no_vs_mi <- list(training = c(1, -1, 0))
no_vs_re <- list(training = c(1, 0, -1))
#specify these two comparisons, collapsing violence levels is assumed
testInteractions (mymodel, custom = c(no_vs_mi, no_vs_re), adjustment="none")
```

See the phia documentation for more details, features, and examples, https://cran.r-project.org/web/packages/phia/phia.pdf