

## 12.7: Between and Within Factors

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So far, all of our factors have been *between subject*, or independent, factors. But it is possible to have any or all of the factors as *within subject*, or dependent, factors in a so-called *repeated measures* design. In a repeated measures design you will have more than one DV, more than one measurement from each subject. When you have more than one DV per subject, you have measured a *vector*<sup>[1]</sup> from each subject not just a number. When you measure a vector instead of a number you need multivariate statistics. The repeated measures approach is an approach that is between univariate and multivariate statistics. With repeated measures you set up your ANOVA as if it were a univariate design and use modified sums of squares and corresponding  $F$  test statistics. Certain assumptions need to be satisfied before you can do repeated measures ANOVA with the most important criteria being one known as “sphericity”<sup>[2]</sup>. If sphericity fails then you need to use the full-blown multivariate approach known as MANOVA (Multivariate ANOVA). If you use SPSS to do a within subjects ANOVA then you can use the sphericity hypothesis test output in the same way that you used the Levine’s test output when deciding to use the homoscedastic or heteroscedastic  $t$ -test result from SPSS. Sphericity is  $H_0$  so if SPSS fails to reject  $H_0$  then you can use the repeated measures results. If  $p < \alpha$  for the sphericity test then you reject  $H_0$  and you will need to set up a MANOVA.

When you have a two-way (or higher factorial) ANOVA then *mixed designs* are possible where one factor is a between subjects factor and the other is a within subjects factor.

### 12.9.1 \*One-way ANOVA with between factors

To be completed in a later edition of this text.

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1. A vector is a collection of numbers. We will have more to say about vectors in Chapter 17. ↩
  2. Sphericity will be covered in a later edition of this text in a MANOVA chapter. ↩
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