ferent treatment conditions will in many experiments be highly correlated since they are made on the same subjects. The presence of these correlations will reduce the error term. Another advantage resides in the number of subjects. It may be more economical in terms of time and effort to test the same subjects under each treatment. A further point here is that the nature of certain experimental problems demands the use of repeated-measurement designs. One disadvantage of experiments with repeated measurements is that performance under prior treatments may affect performance under subsequent treatments due to either fatigue, practice, boredom, or some other circumstance. Effects resulting from such circumstances are sometimes called carry-over effects. An investigator may not be able to clearly decide whether the results observed under the different treatments are due to those treatments or are due to the carry-over effects. A further problem associated with repeated measurement designs in the assumption made in the analysis of data. Not only is the usual assumption of homogeneity of variances made but also an assumption is made regarding the homogeneity of covariances. This matter is discussed in some detail in Section 19.9.

19.3 ONE-FACTOR EXPERIMENTS WITH REPEATED MEASUREMENTS: COMPUTATION AND EXPECTATION OF MEAN SQUARES

As indicated above, the data resulting from a one-factor experiment with repeated measurements may be represented as a table of numbers in which rows represent experimental subjects and columns represent treatments; that is, the representation of the data is the same as that for the two-way classification with one observation per cell. The analysis of such data involves nothing new. The data are analyzed as in the two-way classification case with one observation per cell. The required computation formulas are given in Section 16.9. Three sums of squares result: sums of squares for subjects (rows), treatments (columns), and interaction.

For a one-factor experiment with repeated measurements, subjects constitute a random variable and treatments are usually viewed as fixed. The model is the mixed model for $n = 1$. The expectations of the mean squares are as follows:

Mean squares	Expectation of mean squares
Subjects, s_r^2	$\sigma_e^2 + C\sigma_a^2$
Treatments, s_c^2	$\sigma_e^2 + \sigma_{ab}^2 + R\sigma_b^2$
Interaction, s_{rc}^2	$\sigma_e^2 + \sigma_{ab}^2$

The proper error term for testing differences between treatments is s_{rc}^2; that is, $F_c = s_c^2/s_{rc}^2$. No unbiased test of individual differences