$$F = \frac{MS_B}{MS_{res}}$$

should provide independent estimates of the same population error variance, σ_ε^2. It is apparent from an examination of the expected values of the two mean squares that this can occur only if $\sigma_{\beta\pi}^2 = 0$. We shall return to this point in Chapter 5.

Fortunately, a transformation that accomplishes any one of the objectives listed above will usually accomplish the other two objectives. In general, a transformation can be used whenever there is a relationship between the means and variances of the treatment levels and whenever the form of the treatment level distributions is homogeneous. It is not always possible to find an appropriate transformation for a set of data. For example, if any of the following conditions are present, no transformation exists that will make the data more suitable for analysis of variance: (1) means of treatment levels are approximately equal but variances are heterogeneous, (2) means of treatment levels vary independently of variances, or (3) variances are homogeneous but treatment level distributions are heterogeneous in form. If no transformation is appropriate, and if the departures from normality and homogeneity are gross, an experimenter may be able to use one of the nonparametric statistics for k treatment levels described in Chapter 13. Although these statistics require less stringent assumptions than analysis of variance, they are less powerful and provide less information concerning the outcome of an experiment. It should also be noted that the nonparametric procedures described in Chapter 13 provide a test of the hypothesis that $k \geq 2$ population distributions of *unspecified* form are exactly alike. In order to test hypotheses concerning population means, the homogeneity assumptions of analysis of variance must be tenable. This point is discussed in Section 13.1. Another alternative that may be available to the experimenter is to select a different criterion measure. The choice of a dependent variable in the behavioral sciences is often arbitrary; a different choice may fulfill the requirements of additivity, normality, and homogeneity.

A number of procedures exist for determining which transformation is appropriate for a set of data. Several methods are described by Olds, Mattson, and Odeh (1956) and by Tukey (1949b). One procedure is to follow general rules concerning situations in which a given transformation is often successful. This approach will be emphasized in presenting each of the types of transformations. Alternative procedures for selecting a transformation will be described later.

SQUARE-ROOT TRANSFORMATION

For certain types of data, treatment level means and variances tend to be proportional, as in a Poisson distribution, where $\mu = \sigma^2$. This kind of distribution often results when the dependent variable is a frequency