THE LATIN SQUARE AS A REPEATED MEASUREMENTS DESIGN

SEYMOUR GEISSER
NATIONAL INSTITUTE OF MENTAL HEALTH

1. Introduction

By a repeated measurements design we shall mean that type of arrangement where each experimental unit (an individual or an animal) receives all of the treatments under investigation. The simplest illustration of this type of design is m individuals each of which are subjected to k treatments. If the individuals are considered to be drawn at random from a multivariate normal population, the analysis for treatment effects depends on the structure of the variance-covariance matrix. If $k = 2$ the analysis of variance (mixed model) will be appropriate, for $m > k > 2$ an exact analysis, in the general variance-covariance case, can be made by the use of Hotelling's T^2 (see Scheffé [10]) and an approximate analysis by adjusting the degrees of freedom of the usual mixed model F ratio (see Box [2], Geisser and Greenhouse [3]). In particular, if the variance-covariance structure is uniform (equal variances and equal covariances) the usual F test ratio is exact.

Now repeated measurements designs may have certain disadvantages depending on the nature of the treatments, the response variable, and the population under study, for assessing treatment differences. The three main disadvantages are: (a) carry-over effect; (b) latent effect; (c) order or learning effect. When a treatment has been administered before a previous treatment's effect on the response variable has worn off, the assessment of the treatment differences are obscured by what we shall call carry-over effect. Sometimes when the apparent effect of a treatment has worn off the administration of another treatment may activate the effect of the previous treatment which has been dormant (or alter the effect of the new treatment). This we shall call a latent effect. Another effect may be the order or practice effect on the response variable itself, for example, the variable is the response to a performance test on which individuals may tend to improve merely by repetition of the task, independent of any treatment.

The carry-over effect is usually controlled by the administration of the treatments far enough apart in time so as to eliminate this effect. If a latency effect is suspected, the repeated measurements design probably should not be used unless this effect is itself of interest rather than a pure treatment comparison. The order effect, when carry-over is eliminated and latency is not present, is primarily a function of practice or learning (or even tolerance if very similar drugs are used). A method that has been used to eliminate this order effect from treatment