within NOISE) into PERIOD(1) × (subject within NOISE) and PERIOD(2) × (subject within NOISE) and use these as the error terms for PERIOD(1) and PERIOD(2), respectively. The choice of procedure depends in part on the assumptions of the model (see Bock, 1975, p. 460). Unless PERIOD(1) × (subject within NOISE) and PERIOD(2) × (subject within NOISE) both have a fairly large number of degrees of freedom, the single error term PERIOD × (subject within NOISE) is generally used because this test is more powerful.

All interaction terms containing PERIOD can also be partitioned; for example, NOISE × PERIOD has two components, NOISE × PERIOD(1) and NOISE × PERIOD(2), and the pooled and separated error terms described above may be used to test for these two effects. The MANOVA specifications for trend analyses of PERIOD and DIAL are presented in Figure 1.48a, and the resulting ANOVA table is displayed in Figure 1.48b.

Figure 1.48a

```
MANOVA          Y BY NOISE(1,2) SUBJECT(1,3) PERIOD DIAL(1,3)/
                CONTRAST(PERIOD)=POLYNOMIAL/
                CONTRAST(DIAL)=POLYNOMIAL/
                PARTITION(PERIOD)/
                PARTITION(DIAL)/
                DESIGN=NOISE VS 1, SUBJECT W NOISE=1, PERIOD(1) VS 2,
                      PERIOD(2) VS 2, DIAL(1) VS 3,
                      DIAL(2) VS 3, PERIOD BY SUBJECT W NOISE=2,
                      DIAL BY SUBJECT W NOISE=3, NOISE BY PERIOD VS 2,
                      NOISE BY DIAL VS 3, PERIOD BY DIAL VS 4,
                      PERIOD BY DIAL BY SUBJECT W NOISE=4,
                      NOISE BY PERIOD BY DIAL VS 4/
```

Figure 1.48b

TESTS OF SIGNIFICANCE FOR Y USING SEQUENTIAL SUMS OF SQUARES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG. OF F
RESIDUAL	0.0	0	.		
CONSTANT	105868.16667	1	105868.16667	.	.
ERROR 1	2491.11111	4	622.77778		
NOISE	468.16667	1	468.16667	.75174	.435
ERROR 2	234.88889	8	29.36111		
PERIOD(1)	3721.00000	1	3721.00000	126.73226	0.0
PERIOD(2)	1.33333	1	1.33333	.04541	.837
NOISE BY PERIOD	333.00000	2	166.50000	5.67077	.029
ERROR 3	105.55556	8	13.19444		
DIAL(1)	2256.25000	1	2256.25000	171.00000	0.0
DIAL(2)	114.08333	1	114.08333	8.64632	.019
NOISE BY DIAL	50.33333	2	25.16667	1.90737	.210
ERROR 4	127.11111	16	7.94444		
PERIOD BY DIAL	10.66667	4	2.66667	.33566	.850
NOISE BY PERIOD BY DIAL	11.33333	4	2.83333	.35664	.836

1.49 The Multivariate Approach

In the multivariate analysis of repeated measures designs, the responses of a case are treated as an h-dimensional response vector. In the current example each subject responds to nine variables, each variable representing a unique DIAL and PERIOD combination. Thus the design for Table 1.46 can be treated as a multivariate one-way design with NOISE as the grouping variable. The model can be written as

$$\mathbf{Y}_{ij} = \mu + \alpha_i + \epsilon_{ij}$$

where $\mathbf{Y}_{ij} = (Y_{ij1} \ldots Y_{ijh})'$, α_i is the treatment effect and the ϵ_{ij} are the errors (assumed to be independent with an h-variate normal distribution having mean **0** and a covariance matrix Σ). As long as Σ is positive definite, the covariance structure of the Y_{ijk} can have any pattern. This assumption is of course much less restrictive than the mixed-model assumption of compound symmetry.

The following SPSS MANOVA commands can be used to perform a multivariate analysis of the repeated measures data in Table 1.46.

```
MANOVA          Y1 TO Y9 BY NOISE(1,2)/
                WSFACTORS = PERIOD(3), DIAL(3)/
                WSDESIGN = PERIOD DIAL PERIOD BY DIAL/
                PRINT = SIGNIF(BRIEF)/
                ANALYSIS(REPEATED)/
                DESIGN = NOISE
```