MANOVA and repeated measures ANOVA compared

We now consider the situation in which there is a between-subject IV, a within-subject IV and only one DV, as the design is initially conceived. It may be possible to conceptualise levels of the within-subject IV as comprising different measures (i.e. DVs). In this situation, it is possible to carry out a between-subjects MANOVA instead of a mixed (one between, one within) factorial ANOVA.

An example of a design that can be analysed using ANOVA or MANOVA

To illustrate the difference between these analysis options, we return here to the data from the mixed design shown in Table 2.7. Each subject belongs to one of three hearing LOSS groups (the between-subject IV), and does two hearing DIFFICulty tests, one each using the analogue and digital TYPEs. TYPE was the within-subject IV, and the data were analysed in Chapter 2 using ANOVA. We could, however, regard the two DIFFICulty tests as a pair of DVs and subject the data to a MANOVA to test the effect of LOSS. In this case, LOSS would be the only IV, so we would not be able to use the MANOVA to compare the two TYPEs.

The ANOVA carried out in Chapter 2

When we carried out the ANOVA for the mixed design on these data in Chapter 2, we focussed on the univariate output, in which only one DV was assumed. The same analysis commands also generated a multivariate solution, though the solutions are identical when there are only two levels of the within-subjects factor.

When we examined the output of the univariate analysis in Chapter 2, we found that the effect of LOSS was significant ($F(2,6) = 5.35$, $p < 0.05$). We now repeat the analysis of these data using MANOVA.

Requesting the MANOVA in SPSS

We will label analogue and digital scores as DIFFIC1 and DIFFIC2 as before. Select **Analyze**, then **General Linear Model**, then **Multivariate**. Using the arrows, put LOSS into the **Fixed Factor(s)** box and DIFFIC1 and DIFFIC2 into the **Dependent Variables** box. Click the **Options** button and request **Homogeneity tests**, **Estimates of effect size** and **Observed Power,** then click **Continue** to return to the main dialog box and click **OK**.

The SPSS output for the MANOVA

The Box test (not shown here) was not significant, and the Levene tests were identical to those shown in SPSS Output 2.13. The tables of Multivariate Tests and Between-Subjects Effects are shown in SPSS Output 3.9. The results from the Multivariate Tests table suggest that LOSS has no significant effect (e.g., from Wilks' Lambda $F(4,10) = 2.15$, $p = 0.15$). However, tests on the individual DVs in the table of Between-Subjects Effects suggest LOSS has a significant effect on DIFFIC2 (probability in the Sig column = 0.028, partial eta squared = 0.70, retrospective power = 0.72) but not on DIFFIC1 (probability = 0.454).

Multivariate Tests[d]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Intercept	Pillai's Trace	.989	2.302E2	2.000	5.000	.000	.989	460.428	1.000
	Wilks' Lambda	.011	2.302E2	2.000	5.000	.000	.989	460.428	1.000
	Hotelling's Trace	92.086	2.302E2	2.000	5.000	.000	.989	460.428	1.000
	Roy's Largest Root	92.086	2.302E2	2.000	5.000	.000	.989	460.428	1.000
loss	Pillai's Trace	.717	1.678	4.000	12.000	.219	.359	6.710	.368
	Wilks' Lambda	.289	2.147[a]	4.000	10.000	.149	.462	8.588	.434
	Hotelling's Trace	2.432	2.432	4.000	8.000	.133	.549	9.727	.442
	Roy's Largest Root	2.422	7.267[c]	2.000	6.000	.025	.708	14.534	.745

a. Exact statistic

b. Computed using alpha = .05

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

d. Design: Intercept + loss

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	diffic1	8.222[a]	2	4.111	.902	.454	.231	1.805	.144
	diffic2	48.667[c]	2	24.333	6.844	.028	.695	13.688	.719
Intercept	diffic1	1708.444	1	1708.444	375.024	.000	.984	375.024	1.000
	diffic2	841.000	1	841.000	236.531	.000	.975	236.531	1.000
loss	diffic1	8.222	2	4.111	.902	.454	.231	1.805	.144
	diffic2	48.667	2	24.333	6.844	.028	.695	13.687	.719
Error	diffic1	27.333	6	4.556					
	diffic2	21.333	6	3.556					
Total	diffic1	1744.000	9						
	diffic2	911.000	9						
Corrected Total	diffic1	35.556	8						
	diffic2	70.000	8						

a. R Squared = .231 (Adjusted R Squared = -.025)

b. Computed using alpha = .05

c. R Squared = .695 (Adjusted R Squared = .594)

SPSS Output 3.9. Results from a MANOVA with IQ as the IV, RECALL1 and RECALL2 as the DVs

The SPSS multivariate output for the ANOVA in Chapter 2

Now we look again at the repeated measures ANOVA of the mixed design data in Table 2.6 reported in the previous chapter. We did not show the table of Multivariate Tests: this is now shown in SPSS Output 3.10.

Multivariate Tests[c]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
type	Pillai's Trace	.778	21.062[a]	1.000	6.000	.004	.778	21.062	.966
	Wilks' Lambda	.222	21.062[a]	1.000	6.000	.004	.778	21.062	.966
	Hotelling's Trace	3.510	21.062[a]	1.000	6.000	.004	.778	21.062	.966
	Roy's Largest Root	3.510	21.062[a]	1.000	6.000	.004	.778	21.062	.966
type * loss	Pillai's Trace	.288	1.215[a]	2.000	6.000	.360	.288	2.431	.178
	Wilks' Lambda	.712	1.215[a]	2.000	6.000	.360	.288	2.431	.178
	Hotelling's Trace	.405	1.215[a]	2.000	6.000	.360	.288	2.431	.178
	Roy's Largest Root	.405	1.215[a]	2.000	6.000	.360	.288	2.431	.178

a. Exact statistic

b. Computed using alpha = .05

c. Design: Intercept + loss
Within Subjects Design: type

SPSS Output 3.10. Multivariate Tests table from a repeated measures ANOVA

This gives just the same information as the table of Within-Subjects Effects shown in SPSS Output 2.13, and not at all the same as the Multivariate Tests table from the MANOVA.

Multivariate ANOVA and MANOVA options compared

In moving from the MANOVA to the repeated measures ANOVA we have moved from a pair of DVs to regarding the two conditions under which the DVs were

obtained as a within-subject factor, so we have two IVs instead of one. Which is the right way to do it? Is there a right way? Well, if we're interested in the effect of the TYPE of hearing aid, we have to treat that as an IV. MANOVA does not give a way to compare the elements of the DV vector. If our concern is with the effects of hearing LOSS, we can do the analysis either way. If the assumptions required for a within-subjects ANOVA are reasonable, that analysis might be preferred because the test is generally more powerful (less conservative); it found a significant effect of LOSS ($F(2,6) = 5.35$, $p = 0.046$, < 0.05, see SPSS Output 2.13 in the Tests of Between-Subjects Effects table) where the MANOVA analysis failed to do so ($F(4,10) = 2.15$, $p = 0.15$, > 0.05, see SPSS Output 3.9). If the assumptions are in doubt, however, the more conservative MANOVA, which makes less stringent assumptions, should be preferred.