Psychology 610 R-13 Latin Square Prof Colleen F. Moore

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Example #1: using the data in HO#30, originally from Kirk, p. 353

```
> your.data=read.table(pipe("pbpaste"),header=T)
> your.data
   subject B A  Y
1        1 1 1  7
2        1 2 2 14
3        1 3 3 12
4        2 1 1  3
5        2 3 2 11
6        2 2 3  5
7        3 2 1  7
8        3 3 2 11
9        3 1 3  6
10       4 3 1  9
11       4 1 2 12
12       4 2 3 13
13       5 2 1  9
14       5 1 2  7
15       5 3 3  8
16       6 3 1  9
17       6 2 2 13
18       6 1 3  8
> attach(your.data)
> A=factor(A)
> B=factor(B)
> subj=factor(subject)
> model1=aov(Y~A+B+subj)
> summary(model1,intercept=T)
            Df  Sum Sq Mean Sq  F value    Pr(>F)
(Intercept)  1 1494.22 1494.22 773.9856 3.008e-09 ***
A            2   49.78   24.89  12.8921  0.003144 **
B            2   34.11   17.06   8.8345  0.009435 **
subj         5   58.44   11.69   6.0547  0.013098 *
Residuals    8   15.44    1.93
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

>
```

Note: we should ignore the test of 'subj'

Find group means and so forth, can use 'tapply' or 'model.tables'

```
> A.means=tapply(Y,A,mean)
> A.means
       1         2         3
```

```
 7.333333 11.333333  8.666667
> B.means=tapply(Y,B,mean)
> B.means
        1         2         3
 7.166667 10.166667 10.000000

> model.tables(model1,"means",se=T)
Tables of means
Grand mean

9.111111

 A
A
     1      2      3
 7.333 11.333  8.667

 B
B
     1      2      3
 7.167 10.167 10.000

 subj
subj
     1      2      3      4      5      6
11.000  6.333  8.000 11.333  8.000 10.000

Standard errors for differences of means
             A      B   subj
        0.8022 0.8022 1.1345
replic.      6      6      3
```

Now do the analysis *incorrectly*, ignoring factor B, and analyzing only factor A, as a one-way within.

```
> model2=aov(Y~A+Error(subj))
```
can use 'aov', but it doesn't give us the Huynh-Feldt adjusted p's for sphericity violations. See below for that

```
> summary(model2,intercept=T)

Error: subj
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals  5 58.444  11.689

Error: Within
          Df Sum Sq Mean Sq F value Pr(>F)
A          2 49.778  24.889  5.0224 0.0309 *
Residuals 10 49.556   4.956
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
```

.Note that the Error for A is SS-B + SS-Residual from the correct Latin Square analysis above.

Example #2: Data are from Maxwell & Delaney, p. 541

```
> your.data=read.table(pipe("pbpaste"),header=T)
> your.data
   subject Treatment Time  Y
1        1         2    1  9
2        1         3    2  3
3        1         1    3  6
4        2         1    1 18
5        2         2    2  6
6        2         3    3 12
7        3         3    1 12
8        3         1    2 15
9        3         2    3  5
10       4         3    1 14
11       4         1    2 11
12       4         2    3  8
13       5         1    1 17
14       5         2    2  9
15       5         3    3  9
16       6         2    1  7
17       6         3    2  7
18       6         1    3  7
> attach(your.data)
> A=factor(Treatment)
> time=factor(Time)
> subj=factor(subject)
> model1=aov(Y~A+time+subj)
> summary(model1,intercept=T)
            Df  Sum Sq Mean Sq  F value    Pr(>F)
(Intercept)  1 1701.39 1701.39 345.0704 7.274e-08 ***
A            2   75.44   37.72   7.6507   0.01389 *
time         2   88.44   44.22   8.9690   0.00905 **
subj         5   98.28   19.66   3.9865   0.04115 *
Residuals    8   39.44    4.93
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Next I show the **INCORRECT** repeated measures anova that does NOT take order into account. I rearranged the data in the excel sheet rather than doing it in R. Notice the advantage of

removing the effect of 'time' from the SSerror. The SSerror for A below is SStime + SSresiduals in the correct analysis. This time I carry it out with Anova (capital 'A') in the 'car' package.

```
> library(car)  # set up for repeated measures
> options(contrasts=c("contr.sum","contr.poly"))
> your.data=read.table(pipe("pbpaste"),header=T)
> your.data
  subj A1 A2 A3
1    1  6  9  3
2    2 18  6 12
3    3 15  5 12
4    4 11  8 14
5    5 17  9  9
6    6  7  7  7
> attach(your.data)
> multmod1=lm(cbind(A1,A2,A3)~1) # model the intercept first
> Trials=factor(c("A1","A2","A3"),ordered=F)
> Trials
[1] A1 A2 A3
Levels: A1 A2 A3
> model1=Anova(multmod1,idata=data.frame(Trials),idesign=~Trials,type="III")
> summary(model1,multivariate=F)

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

                SS num Df Error SS den Df       F    Pr(>F)
(Intercept) 1701.39      1    98.28      5 86.5602 0.0002414 ***
Trials        75.44      2   127.89     10  2.9496 0.0984286 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


Mauchly Tests for Sphericity

       Test statistic p-value
Trials        0.80753 0.65210


Greenhouse-Geisser and Huynh-Feldt Corrections
 for Departure from Sphericity

        GG eps Pr(>F[GG])
Trials 0.83859     0.1119

       HF eps Pr(>F[HF])
Trials 1.2133    0.09843 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Warning message:
In summary.Anova.mlm(model1, multivariate = F) : HF eps > 1
treated as 1
```