Psych 610 Prof Colleen Moore

Follow-up tests for Mixed designs (some Grouping factors, and some within-subject factors)

An example with contrived data fictionalized from a paper by Surber & Gzesh,1984, Journal of Experimental Child Psychology. The task is a two arm balance scale with a constant weight on one arm. On each trial a weight is placed at some distance on one side. The participant says where to put the constant weight on the other side in order to make the two arms balance. The task can be done without feedback by fixing the arms. Inhelder and Piaget used this device in their studies of the development of logical reasoning, and so did Robert Siegler. The others used a choice task, whereas Surber & Gzesh had a continuous measure. The expectation is that there will be developmental differences in use of the Weight and Distance cues to make the scale balance. These developmental differences should show up as significant Grade x Wt or Grade x Dist interactions. Siegler claimed that children start by attending first to the #weights, then later learn to attend to distance, and finally combine them in the proper way. Siegler's choice task was insensitive to the difference between adding weight and distance versus multiplying. By using the continuous response measure, Surber & Gzesh had a better test of the multiplying model for subjective combination of weight and distance.

		1		Weight	1	W	eight 2	
			D1	D2	D3	D1	D2	D3
Р	grade	gend						
1	1	1	1	1	2	2	3	5
2	1	1	1	2	2	3	4	6
3	1	1	3	4	4	2	5	5
4	1	2	2	3	2	4	6	7
5	1	2	1	3	3	4	5	4
6	1	2	2	2	3	5	6	7
7	2	1	3	3	5	4	7	8
8	2	1	1	1	3	3	8	7
9	2	1	2	2	4	3	5	7
10	2	2	3	4	5	3	5	7
11	2	2	1	2	4	2	5	6
12	2	2	1	3	5	2	6	8

The grouping variables are Grade and Gender, and the trial factors are Weight(2) and Distance (3).

**1. The overall anova** (from my 'legacy' DOS software, BMDP): Because Grade and Gender both begin with G, I named Grade "radeg" (moved the first letter to end). We have sig main effects of Weight and Distance, and a Weight x Dist interaction. Then there are significant interactions of Grade x Gender x Weight, Distance x Grade.

## Handout #29, Followup tests in Mixed Designs Prof Moore

SO	JRCE		SUM OF	D	.F.	MEAN	F	TAIL
			SQUAR	RES		SQUARE		PROB.
	MEAN		1027.5	55556	1	1027.55556	435.20	0.0000
	radeg	(grade)	8.0	)0000	1	8.00000	3.39	0.1029
	gend		1.3	38889	1	1.38889	0.59	0.4651
	rg		4.5	50000	1	4.50000	1.91	0.2048
1	ERROR		18.8	38889	8	2.36111		
	w		102.7	12222	1	102.72222	71.12	0.0000
	wr		0.0	)5556	1	0.05556	0.04	0.8494
	wg		0.0	00000	1	0.00000	0.00	1.0000
	wrg		8.0	00000	1	8.00000	5.54	0.0464
2	ERROR		11.5	5556	8	1.44444		
	dist		78.6	59444	2	39.34722	92.89	0.0000
	dr		9.2	25000	2	4.62500	10.92	0.0010
	dq		0.1	19444	2	0.09722	0.23	0.7975
	drg		1.7	75000	2	0.87500	2.07	0.1592
3	ERROR		6.7	17778	16	0.42361		
	wd		10.0	)2778	2	5.01389	13.13	0.0004
	wdr		2.6	59444	2	1.34722	3.53	0.0538
	wdg		1.0	)8333	2	0.54167	1.42	0.2710
	wdrg		0.7	75000	2	0.37500	0.98	0.3961
4	ERROR		6.1	1111	16	0.38194		
SO	JRCE		GREENHOUSE	HUY	NH			
			GEISSER	FEL	DT			
			PROB.	PRO	в.			
	dist		0.0000	0.000	0			
	dr		0.0016	0.001	0			
	dg		0.7767	0.797	5			
	drg		0.1649	0.159	2			
	wd		0.0005	0.000	4			
	wdr		0.0559	0.053	8			
	wdg		0.2714	0.271	0			
	wdrg		0.3942	0.396	1			

**2A. Interaction contrast on the within factors**. If the task is done correctly, then the Wt x Dist interaction should be Linear x Linear.

Step 1: Generate contrast coeff's

Step 2: Apply contrast coeff's to indiv data, find psi-hats for individuals.

Step 3: Analyze the psi-hats in a Grade x Gender between-groups anova. The W-linear x D-linear is the test of the grand mean.

Step 1: generate contrast coefficients by multiplying them together:

		D1	D2	D3
		-1	0	1
W1	1	-1	0	1
W2	-1	1	0	-1
		1		

grade	gender	psi-hat
1	1	-2
1	1	-2
1	1	-2
1	2	-3
1	2	2
1	2	-1
2	1	-2
2	1	-2
2	1	-2
2	2	-2
2	2	-1
2	2	-2

Step 2: Multiply contrast coefficients x the individual data to make individual psi-hats.

**Step 3:** Analyze the psi-hats in a between group 2 way between-participants anova. This gives the error term we need. It is a partitioned error. Notice that we have 8 df for error for this test, whereas in the original anova there were 16 df for error.

The test of the grand mean is significant – this says the W-linear x D-linear interaction is significant.

We need to normalize the SS to make sure it is part of the SS WxD in the original anova.  $\sum c_j$ -squared = 4. So proper SS is 30.0833/4 = 7.521. This is a pretty good proportion of the SS W x D from the original anova: 7.521/10.028 = .75. We can also normalize the SS error = 13.3333/4 = 3.3333.

## DEPENDENT VARIABLE - LxL

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F	TAIL PROB.
> MEAN	30.08333	1	30.08333	18.05	0.0028
radeg (grade)	0.75000	1	0.75000	0.45	0.5212
gend	2.08333	1	2.08333	1.25	0.2960
rg	0.75000	1	0.75000	0.45	0.5212
1 ERROR	13.33333	8	1.66667		

Other things to note:

-- The Grade effect in this anova is the Grade x Wt-linear x Dist-linear interaction contrast (yes, a 3-way interaction contrast).

-- The Gender effect is the Gender x Wt-linear x Dist-linear interaction contrast (also a 3-way interaction contrast)

-- The Grade x Gender effect is the Grade x Gender x Wt-linear x Dist-linear interaction contrast (a 4-way interaction contrast).

-- If there are more than two levels of the Grouping factors, then these effects would be called 'partial interactions', which are no longer covered in this course.

Handout #29, Followup tests in Mixed Designs Prof Moore

**2B. Test of the residual** from the interaction contrast. SSresid from WxD = 10.028 - 7.521 = 2.507. Because WxD has 2 df, we can also subtract the to make a residual error SS = 6.1111 - 3.3333 = 2.7778. So the residual F = 2.507 / (2.7778 / 8) = 7.220. This has df = 1, 8. The residual is also significant, p= 0.028. My interpretation would be that the results deviate from the multiplying form predicted by correct task understanding. Plot the means to see that.

**3. Interaction contrast across a Grouping x Within factor**: Grade x Dist-linear. This would test whether Grades 1 and 2 differ in the linear trend on Distance; i.e., it looks for developmental change in use of the Distance cue (but only in the linear trend of it). To do this, we want to average over the Wt factor.

Step 1: generate contrast coefficients

Step 2: apply contrast coefficients to individual data, and make a table of psi-hats. Step 3: analyze the psi-hats in a

**Step 1**: The linear contrast coeff's are 1 0-1. Because this contrast averages across the Weight factor, we can either make individual means over the weight factor, or we can make a 'stretched out' set of contrast coefficients, 1 0-1 1 0-1, and apply those. We apply the coeff's to the individual data because part of the contrast involves a within-participants factor.

**Step 2:** Here are the individual psi-hats, with the codes for the grouping factors: grade gender D-linear psi-hat

grade	genuer	D-III
1	1	-4
1	1	-4
1	1	-4
1	2	-3
1	2	-2
1	2	-3
2	1	-6
2	1	-6
2	1	-6
2	2	-6
2	2	-7
2	2	-10

**Step 3**: Do a 2-way between-participants anova on the psi-hats. The test of the Mean tests overall D-linear. The Grade ('randeg') effect is Grade x D-linear, and is what we are looking for. It is significant. Grade 2 has a stronger Distance-linear trend than Grade 1. Standardize the SS's by dividing by  $\sum cj$ -squared = 4. SS D-linear = 310.0833 / 4 = 77.521. This is a very large portion of the SS-D in original anova = 78.694. SS Grade x D-linear = 36.75 / 4 = 9.1875. This is part of Grade x Dist in the original anova, which had SS = 9.25. Most of the Grade x Dist interaction is linear on Distance.

SOURCE		SUM OF	SUM OF D.F.		F TAIL	
		SQUARES		SQUARE		PROB.
	MEAN	310.08333	1	310.08333	265.79	0.0000
→	radeg (grade)	36.7500	0 1	36.75000	31.50	0.0005
	gend	0.08333	1	0.08333	0.07	0.7960
	rg	6.75000	1	6.75000	5.79	0.0428
1	ERROR	9.33333	8	1.16667		

Note that you could also test D-linear on the grades separately and ask "Is linear trend on D significant for Grade 1?" and "Is linear trend on D significant for Grade 2"? But this test is more straight-forward.

## 4. Simple main effect of Grouping factor @ each level of a within factor.

To do this, just use the data from the one level of the within factor. Let's test Grade@Distance-1. I took only the Distance-1 data (with the two Weights). Here is the result: The test of Grade ('randeg') tests Grade@Dist-1. Notice that the error df is the same as in the overall anova, **BUT** the SS is different. This is because we are partitioning the error by only taking part of the data. The df is partitioned too (see below on 'partition').

I did all 3 simple effect tests here. We see that the Grade effect is only significant at Distance-3. This fits with the Grade x D-linear interaction. The slopes are different, so the means need not differ at all points. Plot the data and see.

Grade @ Distance-1 DEPENDENT VARIABLE - w1d1	w2d1				
SOURCE	SUM OF	D.F.	MEAN	F TA	IL
	SQUARES		SQUARE		PROB.
MEAN	140.16667	1	140.16667	152.91	0.0000
	0.1666	71	0.16667	0.18	0.6811
gend	0.16667	1	0.16667	0.18	0.6811
rg	4.16667	1	4.16667	4.55	0.0656
1 ERROR	7.33333	8	0.91667		
W	10.66667	1	10.66667	25.60	0.0010
Wr	0.66667	1	0.66667	1.60	0.2415
Wq	0.66667	1	0.66667	1.60	0.2415
Wrg	2.66667	1	2.66667	6.40	0.0353
2 ERROR	3.33333	8	0.41667		

Grade @ Distance-2 DEPENDENT VARIABLE - w1d2	w2d2				
SOURCE	SUM OF	D.F.	MEAN	F	TAIL
	SQUARES		SQUARE		PROB.
MEAN	376.04167	1	376.04167	291.13	0.0000
radeg (grade)	2.04167	1	2.04167	1.58	0.2441
gend	1.04167	1	1.04167	0.81	0.3954
rg	2.04167	1	2.04167	1.58	0.2441
1 ERROR	10.33333	8	1.29167		
W	51.04167	1	51.04167	58.33	0.0001
Wr	2.04167	1	2.04167	2.33	0.1651
Wg	0.37500	1	0.37500	0.43	0.5311
Wrg	5.04167	1	5.04167	5.76	0.0432
2 ERROR	7.00000	8	0.87500		
<b>Grade @ Distance-3</b> DEPENDENT VARIABLE - w1d3	w2d3				
SOURCE	SUM OF	D.F.	MEAN	F	TAIL
	SQUARES		SQUARE		PROB.
MEAN	590.04167	1	590.04167	590.04	0.0000
radeg (grade)	15.04167	1	15.04167	15.04	0.0047
gend	0.37500	1	0.37500	0.37	0.5573
rg	0.04167	1	0.04167	0.04	0.8434
1 ERROR	8.00000	8	1.00000		
ы	F1 04167	1	51 04167	55.68	0 0001
n	51.0416/	-	21.0410/		0.0001
Wr	0.04167	1	0.04167	0.05	0.8365
Wr Wg	0.04167 0.04167 0.04167	1 1	0.04167 0.04167	0.05	0.8365
Wr Wg Wrg	0.04167 0.04167 0.04167 1.04167	1 1 1	0.04167 0.04167 1.04167	0.05 0.05 1.14	0.8365 0.8365 0.3175

Verify the partition. This helps me think about the analyses.

 $\Sigma$ SS for the grade effects in these 3 simple effect tests = .167 + 2.042 + 15.042 = 17.251, which is SSr ( or grade) + SSdxr in the original anova = 8.00 + 9.25.

The  $\sum$ SSerror for testing grade in the 3 analyses = 7.333 + 10.3333 + 8.000 = 25.667. This is SS s/rg + SS s/rg x d = 18.889 + 6.778, the error terms for grade and grade x dist in the original omnibus anova. The  $\sum$  df-error for these three tests of the grade effects = 24. This is the sum of the dferror for the grade effect, s/rg = 8, and the dferror for Distance, s/rg x D, = 16.

## 5. Simple main effect of a Within factor @ each level of a grouping factor.

Let's test Distance @ Grade 1, and Distance @ Grade 2. I used just the data from Grade 1, then just the data from Grade 2, in separate anovas. These also test Weight @ Grade, and WxD @ Grade, and Gender @ Grade. Normally we wouldn't partition error for the Gender @ Grade test because it involves only the Grouping variables. You could use the original error term from the overall anova with a hand calculation for that.

Results show that the Distance effect is significant at both Grades. The interesting part (from the point of view of the original purpose of the study) is that the WxD interaction is signif for Grade 2 but not for Grade 1. Plot the data!

DEPENDENT VARIABLE - vid1    vid2    vid3    vid1    vid2    vid3      SOURCE    SUM OF SQUARES    D.F. SQUARES    MEAN SQUARE    F    TAIL FROR.      MEAN gend    427.11111    1    427.11111    167.51    0.0002      1    ERROR    5.44444    1    5.44444    1    5.44444    0.0000    2.40    0.056      W    49.00000    1    49.00000    2.40    0.0056      Dist    17.55556    2    8.77778    24.31    0.0004      Dg    0.66667    2    1.33333    2.67    0.1296      WD    2.66667    2    0.33333    2.67    0.1296      WD    2.66667    2    0.33333    2.67    0.1296      WD    0.3520    0.3335    0.67    0.5398    0.50000    0.67    0.5398      SOURCE    GEREENHOUSE FROB.    HUYNH SQUARES    N2d1    v2d2    v2d3    v2d3    0.671    0.5014    0.66144444    0.88    0.6916	Di	stance @ Grad	le 1							
SOURCE    SUM OF SQUARES    D. F.    MEAN SQUARE    F    TAIL FROB.      MEAN gend    427.11111 5.44444    1    427.11111 5.44444    1    427.11111 5.44444    187.51 5.44444    0.0000 2.40    0.1963      W wg    4.00000    1    49.00000 4.00000    1    40.0000 4.00000    2.40    0.1963      Dist    1.55556    2    8.77778    24.31    0.0004      Dg    0.88689    2    0.44444    1.23    0.3420      MD    2.66667    2    1.33333    2.67    0.1296      WD    2.66667    2    0.33333    2.67    0.1296      WD    2.66667    2    0.33333    2.67    0.1296      WD    0.1533    0.1296    0.50000    8    0.50000    8      SOURCE    GREENHOUSE WDG    HUYNE FROB.    w2d1    w2d2    w2d3      Dist    0.0059    0.0014    0.5398    SQUARE    SQUARE    1      MD    0.1533    0.1296	DEI	PENDENT VARIABLE -	wld1	w1d2	wld	3	w2d1	w2d2	w2d3	
MEAN gend  427.11111  1  427.11111  187.51  0.0002    gend  5.44444  1  5.44444  2.39  0.1970    1  ERROR  9.11111  4  2.27778  0.0000    W  49.00000  1  49.00000  2.440  0.056    Wg  4.00000  1  40.0000  2.40  0.0026    Dist  17.55556  2  8.77778  24.31  0.0004    Dg  0.88899  2  0.44444  1.23  0.3420    MD  2.66667  2  1.33333  2.67  0.1296    WD  2.66667  2  0.33333  0.67  0.5398    SOURCE  GREENHOUSE  HUYNH  FELDT  PROB.  PROB.  PROB.    Dist  0.0059  0.0014  0.5038  0.50000  PROB.  PROB.    Dist  0.0059  0.0014  V2d  V2d  V2d  V2d    Dist  0.5038  0.5996  SQUARES  P.F.  MEAN  SQUARE  SQUARE  SQUARE  SQUARE  V		SOURCE		SUM SQUZ	OF ARES	D.F.	MEAN SQUAF	I RE	F	TAIL PROB.
W  49.00000  1  49.0000  29.40  0.0056    Wg  4.00000  1  4.00000  2.40  0.1963    2 ERROR  6.66667  4  1.66667  2.43  0.0004    Dg  0.8889  2  8.77778  24.31  0.0004    Jg  0.8889  8  0.36111  0.3420    WD  2.66667  2  1.33333  2.67  0.1296    WD  2.66667  2  0.33333  0.67  0.5398    SOURCE  GREENHOUSE  FELDT  PROB.  PROB.  V  V    Dg  0.3320  0.3395  V  V24  V24  V24    Dg  0.5038  0.5398  V21  V24  V24  V24    Dg  0.5038  0.5398  V21  V24  V24  V24    Dist  0.0059  0.0014  V20  V24  V24  V24    Dist  0.5038  0.5398  V21  V24  V24  V24    Dist  0.0059  0.0014  V20  V2	1	MEAN gend ERROR		427. 5. 9.	.11111 .44444 .11111	1 1 4	427.11 5.44 2.27	111 444 778	187.51 2.39	0.0002 0.1970
Linkik  0.0000  1  1.0000    Dist  17.55556  2  8.77778  24.31  0.0004    Dg  3 ERROR  2.88889  8  0.36111  0.3420    WD  2.66667  2  1.33333  2.67  0.1296    WDg  0.66667  2  0.33333  0.67  0.5398    SOURCE  GREENHOUSE  HUYNH  GEISSER  FELDT    PROB.  PROB.  PROB.  0.014  0.3320  0.3395    WD  0.1533  0.1296  0.0014  0.0039  0.0014    Dg  0.3320  0.3395  0.5398  Distance @ Grade 2    DEPENDENT VARIABLE - widi  wid2  w2d1  w2d2  w2d3    SOURCE  SUM OF  D.F.  MEAN  F  TAIL    gend  608.44444  1  0.44444  0.18  0.6918    1  ERROR  9.77778  2.44444  0.18  0.6918    gend  608.44444  1  0.44444  0.18  0.6918    1  ERROR  9.77778	2	W Wg FBROR		49. 4.	00000	1 1 4	49.00 4.00	0000	29.40 2.40	0.0056 0.1963
Dg  0.88889  2  0.44444  1.2.3  0.3420    3 ERROR  2.88889  8  0.36111    WD  2.66667  2  1.33333  2.67  0.1296    WDg  0.66667  2  0.33333  0.67  0.5398    4 ERROR  4.00000  8  0.50000  0.67  0.5398    SOURCE  GREENHOUSE  HUYNH  GEISSER  FELDT  PROB.  PROB.    Djst  0.0059  0.0014  Dg  0.3320  0.3395  WD  0.1533  0.1296    WDg  0.1533  0.1296  0.5038  0.5398  PROB.  PROB.    Distance @ Grade 2  DEPENDENT VARIABLE - wildi  wild wildi  w2di  w2di  w2di    SOURCE  SUM OF  D.F.  MEAN  F  TAIL    gend  0.44444  1  0.44444  0.18  0.6918    1 ERROR  9.77778  1  53.77778  4  2.44444    W  53.77778  1  53.19444  72.40  0.0000    Wg  1.05556	-	Dist		17.	.55556	2	8.77	778	24.31	0.0004
WD  2.666667  2  1.33333  2.67  0.1296    WDg  0.66667  2  0.33333  0.67  0.5398    4 ERROR  4.00000  8  0.50000  0.5398    SOURCE  GREENHOUSE  HUYNH GEISSER  FELDT PROB.  0.0014    Dg  0.3320  0.3395  0.3395    WD  0.1533  0.1296  0.5038  0.5398    Distance @ Grade 2  Dependent Variable - widi  wid2  w2d1  w2d2    SOURCE  SUM OF SQUARES  D.F.  MEAN SQUARE  F  TAIL PROB.    MEAN  608.44444  1  608.44444  0.44444  0.18  0.6918    1  ERROR  9.77778  4  2.44444  0.40000  3.27  0.1447    W  53.77778  1  53.77778  44.00  0.0027  0.327  0.1447    Wg  1.05556  2  0.52778  1.09  0.3327    Jist  70.38889  2  35.19444  72.40  0.0000    Dg  1.05556  2  5.02778  1	3	Dg ERROR		2.	.88889 .88889	2 8	0.44	1444 5111	1.23	0.3420
SOURCE  GREENHOUSE GEISSER PROB.  HUYNH FELDT PROB.    Dist Dg  0.0059 0.3320  0.0014 0.3320	4	WD WDg ERROR		2. 0. 4.	.66667 .66667 .00000	2 2 8	1.33 0.33 0.50	3333 3333 0000	2.67 0.67	0.1296 0.5398
Dist  0.0059  0.0014    Dg  0.3320  0.3395    WD  0.1533  0.1296    WDg  0.5038  0.5398    Distance @ Grade 2  w1d2  w2d1  w2d2    DEPENDENT VARIABLE - w1d1  w1d2  w1d3  w2d1  w2d2    SOURCE  SUM OF  D.F.  MEAN  F  TAIL    gend  0.44444  1  608.44444  0.18  0.6011    gend  0.44444  1  0.44444  0.18  0.6918    Wg  53.77778  1  53.77778  44.00000  3.27  0.1447    Wg  4.00000  1  4.00000  3.27  0.1447    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  1.05556  2  0.52778  1.09  0.3827    Jerror  3.88889  8  0.48611  0.0009  0.3827    WD  10.05556  2  5.02778  19.05  0.0009    WDg  1.16667  2  0.58333  2.21  0.1721	SO	JRCE	GREENH GEIS PRO	OUSE SER DB.	HUYNH FELD PROB	Г				
WD  0.1533  0.1296    WDg  0.5038  0.5398    Distance @ Grade 2  wid2  wid2  wid2  wid2  wid2    Dependent Variable - wid1  wid2  wid2  wid2  wid2  wid2  wid2    Source  Sum of squares  D.F.  MEAN Square  F  TAIL PROB.    MEAN gend  608.44444  1  608.44444  0.44444  0.18  0.6018    MEAN gend  608.377778  1  53.77778  42.44444  0.18  0.6027    Wg  53.77778  1  53.77778  44.00  0.0027    Wg  3.77778  1  53.77778  44.00  0.0027    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  3.88889  8  0.48611  0.3827    WD  10.05556  2  5.02778  19.05  0.0009    WDg  11.16667  2  0.58333  2.21  0.1721		Dist Dg	0. 0.	0059 3320	0.0014 0.3395					
Distance @ Grade 2 DEPENDENT VARIABLE - w1d1  w1d2  w1d3  w2d1  w2d2  w2d3    SOURCE  SUM OF SQUARES  D.F.  MEAN SQUARE  F  TAIL PROB.    MEAN gend  608.44444  1  608.44444  0.18  0.0001    1 ERROR  0.44444  0.44444  0.18  0.6918    W  53.77778  4  2.44444  0.18  0.6918    Wg  53.77778  1  53.77778  44.00  0.0027    Wg  4.00000  1  4.00000  3.27  0.1447    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  3.8889  8  0.48611  0.3827    WD  10.05556  2  5.02778  1.09  0.3827    WD  10.05556  2  0.58333  2.21  0.1721		WD WDg	0. 0.	1533 5038	0.1296 0.5398					
DEPENDENT VARIABLE - w1d1  w1d2  w1d3  w2d1  w2d2  w2d3    SOURCE  SUM OF SQUARES  D.F.  MEAN SQUARE  F  TAIL PROB.    MEAN gend 1  608.44444  1  608.44444  0.18  0.0001    0.444444  1  0.444444  0.18  0.6918    W  53.77778  1  53.77778  44.000  0.0027    Wg  53.77778  1  53.77778  44.00000  0.0027    Wg  53.77778  1  53.77778  44.00000  0.0027    Joist  70.38889  2  35.19444  72.40  0.0000    Dg  3.88889  8  0.48611  0.3827    WD  10.05556  2  5.02778  1.09  0.3827    WD  10.05556  2  0.58333  2.21  0.1721	Di	stance @ Grad	le 2							
SOURCE  SUM OF SQUARES  D.F.  MEAN SQUARE  F  TAIL PROB.    MEAN gend  608.44444  1  608.44444  248.91  0.0001    0.44444  1  0.44444  0.18  0.6918    1 ERROR  9.77778  4  2.44444  0.18  0.6027    Wg  53.77778  1  53.77778  44.00  0.0027    Wg  4.00000  1  4.00000  3.27  0.1447    2 ERROR  4.88889  4  1.22222  0.1447    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  3.88889  8  0.48611  0.48611  0.3827    WD  10.05556  2  5.02778  19.05  0.0009    WDg  1.16667  2  0.58333  2.21  0.1721	DEI	PENDENT VARIABLE -	wld1	w1d2	wld	3	w2d1	w2d2	w2d3	
MEAN  608.44444  1  608.44444  248.91  0.0001    gend  0.44444  1  0.44444  0.18  0.6918    1  ERROR  9.77778  4  2.44444  0.18  0.6918    W  53.77778  1  53.77778  44.00  0.0027    Wg  4.00000  1  4.00000  3.27  0.1447    2  ERROR  4.88889  4  1.22222  0.1447    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  1.05556  2  0.52778  1.09  0.3827    3  ERROR  3.88889  8  0.48611  0.0000    WD  10.05556  2  5.02778  19.05  0.0009    WDg  1.16667  2  0.58333  2.21  0.1721		SOURCE		SUM SQUZ	OF ARES	D.F.	MEAN SQUAF	I RE	F	TAIL PROB.
W  53.77778  1  53.77778  44.00  0.0027    Wg  4.00000  1  4.00000  3.27  0.1447    2 ERROR  4.88889  4  1.22222  0.1447    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  1.05556  2  0.52778  1.09  0.3827    3 ERROR  3.88889  8  0.48611  0.0009    WD  10.05556  2  5.02778  19.05  0.0009    WD  11.6667  2  0.58333  2.21  0.1721	1	MEAN gend ERROR		608. 0. 9.	.44444 .44444 .77778	1 1 4	608.44 0.44 2.44	444 444 444	248.91 0.18	0.0001 0.6918
2 ERROR  4.88889  4  1.22222    Dist  70.38889  2  35.19444  72.40  0.0000    Dg  1.05556  2  0.52778  1.09  0.3827    3 ERROR  3.88889  8  0.48611  0.0009    WD  10.05556  2  5.02778  19.05  0.0009    WDg  1.16667  2  0.58333  2.21  0.1721		W Wg		53. 4.	.77778 .00000	1 1	53.77 4.00	778 0000	44.00 3.27	0.0027 0.1447
Dist    70.38889    2    35.19444    72.40    0.0000      Dg    1.05556    2    0.52778    1.09    0.3827      3 ERROR    3.88889    8    0.48611    0.0009      WD    10.05556    2    5.02778    19.05    0.0009      WDg    1.16667    2    0.58333    2.21    0.1721	2	ERROR		4.	.88889	4	1.22	2222		
WD10.0555625.0277819.050.0009WDg1.1666720.583332.210.1721	3	Dist Dg ERROR		70. 1. 3.	.38889 .05556 .88889	2 2 8	35.19 0.52 0.48	9444 2778 3611	72.40 1.09	0.0000 0.3827
		WD WDg		10. 1.	05556	2 2	5.02	2778	19.05 2.21	0.0009 0.1721

SOURCE	GREENHOUSE GEISSER PROB.	HUYNH FELDT PROB.
Dist	0.0000	0.0000
Dg	0.3797	0.3827
WD	0.0081	0.0019
WDg	0.2053	0.1828

Verify the Partition so we understand what we did.

- a) The **between-participants** part of the design:
  - i.  $\sum$ SSerror for gender@grade = 9.111 + 9.778 = 18.889 = SS s/rg in omnibus anova.  $\sum$ dferror for gender@grade = 4 + 4 = 8, the dferror for the between part of the analysis in the original anova.
  - ii.  $\sum$ SSgender = 5.444 + .444 = 5.888 = SSgend + Ssgradexgend in omnibus anova. When we divide the data by Grade, we are essentially doing simple effect tests of Gender@Grade.
- b) Weight, a **within**-participant variable:
  - ∑SSerror for W@grade = 6.667 + 4.889 = 11.556 = SSerror for weight (s/rg x w) in omnibus anova. ∑dferror for W @grade = 4 + 4 = dferror for weight in omnibus.
  - ii.  $\Sigma$ SSweight@grade = 49.0 + 53.778 = 102.778 = SSweight + SS weight x grade in omnibus anova = 102.7222 + .0556.
- c) Distance
  - i.  $\sum$ SSerror for D@grade = 2.889 + 3.889 = 6.778 = SSerror for distance (s/rg x d) in the omnibus anova. And the df's add up properly too.
  - ii.  $\sum$ Ssdistance@grade = 17.556 + 70.389 = 87.945 = SSdist + SS dist x grade in omnibus anova = 78.694 + 9.250.
- d) Within x Between partitions
  - i. Weight x gender in the simple effect analyses here sum to weight x grade x gender + weight x gender in the omnibus anova (it so happens that one of these values is zero for these contrived data).
  - ii. Dist x gender in the simple effects sum to dist x grade x gender + dist x gender in the omnibus anova.

**Stop and think**: Do we want partitioned error for these tests? Remember, any test that involves a within-participant (repeated measures) factor should probably use a partitioned error. Partitioned error reduces the scope over which the sphericity assumption must hold.

(version 12-7-2009)