Multivariate Analysis of the Tubes ata

```
/******************** tubemv.sas ******************/
/* One-way multivariate analysis of tubes data      */
/**************************************************/

%include 'tuberead2.sas';
title2 'One-way multivariate analysis of tubes data';

proc freq;
     tables mcg;

proc corr; var length10 pmscl10 weight;

proc glm;
     title3 'Basic one-way Manova';
     class mcg;
     model length10 pmscl10 weight = mcg;
     manova H=mcg;

proc glm;
     title3 'With constrasts and multiple comparisons';
     class mcg;
     model length10 pmscl10 weight = mcg;
     /* Pairwise Comparisons */
     contrast '198vs205'      mcg   1  -1   0   0   0   0;
     contrast '198vs213'      mcg   1   0  -1   0   0   0;
     contrast '198vs221'      mcg   1   0   0  -1   0   0;
     contrast '198vs223'      mcg   1   0   0   0  -1   0;
     contrast '198vs225'      mcg   1   0   0   0   0  -1;
     contrast '205vs213'      mcg   0   1  -1   0   0   0;
     contrast '205vs221'      mcg   0   1   0  -1   0   0;
     contrast '205vs223'      mcg   0   1   0   0  -1   0;
     contrast '205vs225'      mcg   0   1   0   0   0  -1;
     contrast '213vs221'      mcg   0   0   1  -1   0   0;
     contrast '213vs223'      mcg   0   0   1   0  -1   0;
     contrast '213vs225'      mcg   0   0   1   0   0  -1;
     contrast '221vs223'      mcg   0   0   0   1  -1   0;
     contrast '221vs225'      mcg   0   0   0   1   0  -1;
     contrast '223vs225'      mcg   0   0   0   0   1  -1;
     manova H=mcg; /* Must come after contrast, if there are contrasts. */

    /* Make everything a Scheffe followup to the initial multivariate test */

proc iml;
     title3 'Scheffe follow-ups for a significant multivariate test';
     k = 3;  /* Number of (transformed) DVs in initial test */
     d = 5;  /* Number of (sets of) linear constraints in initial test */
     v = 17;  /* n-p = Denominator degrees of freedom for initial test */
     alpha = 0.05;
     /*************************************************************/
     r = v - (k-d+1)/2;
     u = (k*d-2)/4;
     if k**2+d**2-5 > 0 then
        t = sqrt( (k**2 * d**2 - 4)/(k**2+d**2-5) );
        else t = 1;
     numdf = k*d; dendf = r*t-2*u;
```

```
fcrit = finv(1-alpha,numdf,dendf);
lcrit = (1+fcrit*numdf/dendf)**(-t);
reset noname; /* Makes output look nicer in this case */
print "Initial test has " k
      "(possibly transformed) dependent variables.";
print "Initial null hypothesis imposes " d " (sets of) constraints,"
      "using significance level alpha = " alpha;
print "F approximation for initial Wilks' lambda has"
      numdf " and " dendf"degrees of freedom.";
if min(k,d) <= 2 then print "In this case the approximation is exact.";
print "Based on the F approximation, critical value of"
      " Wilks' lambda is" lcrit;
print "For multivariate follow-ups, reject if Lambda is LESS THAN"
      "the critical value.";
print "For univariate follow-ups, use the table below";
zero = {0 0}; S_table = repeat(zero,d,1);  /* Make empty matrix */
/* Label the columns */
namz = {"Number of Constraints in followup test"
        "Scheffe Critical Value of F"}; mattrib S_table colname=namz;
do s = 1 to d;
   s_table(|s,1|) = s;
   critval = v/s * ( (1+fcrit*numdf/dendf)**t - 1 );
   s_table(|s,2|) =  critval;
end;
print s_table;
```

Fungus Tube data with line1=113 eliminated 1
One-way multivariate analysis of tubes data

The FREQ Procedure

Mycelial Compatibility Group

mcg	Frequency	Percent	Cumulative Frequency	Cumulative Percent
198	4	17.39	4	17.39
205	4	17.39	8	34.78
213	3	13.04	11	47.83
221	4	17.39	15	65.22
223	4	17.39	19	82.61
225	4	17.39	23	100.00

The CORR Procedure

3 Variables: length10 pmscl10 weight

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
length10	23	24.85652	1.58461	571.70000	22.30000	28.20000
pmscl10	23	28.13043	7.08587	647.00000	15.00000	44.00000
weight	23	0.62836	0.05916	14.45220	0.53980	0.72710

Simple Statistics

Variable	Label
length10	
pmscl10	
weight	Sclerotial Weight

Pearson Correlation Coefficients, N = 23
Prob > |r| under H0: Rho=0

	length10	pmscl10	weight
length10	1.00000	-0.27111 0.2108	-0.11164 0.6120
pmscl10	-0.27111 0.2108	1.00000	0.74040 <.0001
weight Sclerotial Weight	-0.11164 0.6120	0.74040 <.0001	1.00000

Basic one-way Manova

The GLM Procedure

Class Level Information

Class	Levels	Values
mcg	6	198 205 213 221 223 225

Number of Observations Read 23
Number of Observations Used 23

The GLM Procedure

Dependent Variable: length10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	52.94360507	10.58872101	78.34	<.0001
Error	17	2.29791667	0.13517157		
Corrected Total	22	55.24152174			

R-Square	Coeff Var	Root MSE	length10 Mean
0.958402	1.479116	0.367657	24.85652

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

The GLM Procedure

Dependent Variable: pmscl10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	892.192029	178.438406	14.28	<.0001
Error	17	212.416667	12.495098		
Corrected Total	22	1104.608696			

R-Square	Coeff Var	Root MSE	pmscl10 Mean
0.807700	12.56589	3.534841	28.13043

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	892.1920290	178.4384058	14.28	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	892.1920290	178.4384058	14.28	<.0001

The GLM Procedure

Dependent Variable: weight Sclerotial Weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	0.05306225	0.01061245	7.54	0.0007
Error	17	0.02392889	0.00140758		
Corrected Total	22	0.07699114			

R-Square	Coeff Var	Root MSE	weight Mean
0.689199	5.970775	0.037518	0.628357

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	0.05306225	0.01061245	7.54	0.0007

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	0.05306225	0.01061245	7.54	0.0007

The GLM Procedure
Multivariate Analysis of Variance

Characteristic Roots and Vectors of: E Inverse * H, where
H = Type III SSCP Matrix for mcg
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
24.3481937	82.51	0.65509013	-0.02169624	1.66450920
3.7426508	12.68	0.10586923	0.07168452	-0.60700286
1.4181124	4.81	-0.03880440	-0.05098256	8.39082531

MANOVA Test Criteria and F Approximations for
the Hypothesis of No Overall mcg Effect
H = Type III SSCP Matrix for mcg
E = Error SSCP Matrix

S=3 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.00343998	18.97	15	41.81	<.0001
Pillai's Trace	2.33615120	11.96	15	51	<.0001
Hotelling-Lawley Trace	29.50895690	27.95	15	23.537	<.0001
Roy's Greatest Root	24.34819371	82.78	5	17	<.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

The GLM Procedure

Class Level Information

Class	Levels	Values
mcg	6	198 205 213 221 223 225

Number of Observations Read 23
Number of Observations Used 23

The GLM Procedure

Dependent Variable: length10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	52.94360507	10.58872101	78.34	<.0001
Error	17	2.29791667	0.13517157		
Corrected Total	22	55.24152174			

R-Square	Coeff Var	Root MSE	length10 Mean
0.958402	1.479116	0.367657	24.85652

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
198vs205	1	11.88281250	11.88281250	87.91	<.0001
198vs213	1	18.76297619	18.76297619	138.81	<.0001
198vs221	1	46.56125000	46.56125000	344.46	<.0001
198vs223	1	23.46125000	23.46125000	173.57	<.0001
198vs225	1	26.10031250	26.10031250	193.09	<.0001
205vs213	1	1.30002976	1.30002976	9.62	0.0065
205vs221	1	11.40031250	11.40031250	84.34	<.0001
205vs223	1	1.95031250	1.95031250	14.43	0.0014
205vs225	1	2.76125000	2.76125000	20.43	0.0003
213vs221	1	3.94333333	3.94333333	29.17	<.0001
213vs223	1	0.02333333	0.02333333	0.17	0.6830
213vs225	1	0.15860119	0.15860119	1.17	0.2938
221vs223	1	3.92000000	3.92000000	29.00	<.0001
221vs225	1	2.94031250	2.94031250	21.75	0.0002
223vs225	1	0.07031250	0.07031250	0.52	0.4806

The GLM Procedure

Dependent Variable: pmscl10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	892.192029	178.438406	14.28	<.0001
Error	17	212.416667	12.495098		
Corrected Total	22	1104.608696			

R-Square	Coeff Var	Root MSE	pmscl10 Mean
0.807700	12.56589	3.534841	28.13043

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	892.1920290	178.4384058	14.28	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	892.1920290	178.4384058	14.28	<.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
198vs205	1	8.0000000	8.0000000	0.64	0.4347
198vs213	1	36.0119048	36.0119048	2.88	0.1078
198vs221	1	220.5000000	220.5000000	17.65	0.0006
198vs223	1	200.0000000	200.0000000	16.01	0.0009
198vs225	1	8.0000000	8.0000000	0.64	0.4347
205vs213	1	11.4404762	11.4404762	0.92	0.3520
205vs221	1	144.5000000	144.5000000	11.56	0.0034
205vs223	1	288.0000000	288.0000000	23.05	0.0002
205vs225	1	0.0000000	0.0000000	0.00	1.0000
213vs221	1	60.0119048	60.0119048	4.80	0.0426
213vs223	1	364.5833333	364.5833333	29.18	<.0001
213vs225	1	11.4404762	11.4404762	0.92	0.3520
221vs223	1	840.5000000	840.5000000	67.27	<.0001
221vs225	1	144.5000000	144.5000000	11.56	0.0034
223vs225	1	288.0000000	288.0000000	23.05	0.0002

The GLM Procedure

Dependent Variable: weight Sclerotial Weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	0.05306225	0.01061245	7.54	0.0007
Error	17	0.02392889	0.00140758		
Corrected Total	22	0.07699114			

R-Square	Coeff Var	Root MSE	weight Mean
0.689199	5.970775	0.037518	0.628357

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	0.05306225	0.01061245	7.54	0.0007

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	0.05306225	0.01061245	7.54	0.0007

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
198vs205	1	0.01026028	0.01026028	7.29	0.0152
198vs213	1	0.01199302	0.01199302	8.52	0.0096
198vs221	1	0.00443682	0.00443682	3.15	0.0937
198vs223	1	0.00680945	0.00680945	4.84	0.0420
198vs225	1	0.00001176	0.00001176	0.01	0.9282
205vs213	1	0.00024754	0.00024754	0.18	0.6802
205vs221	1	0.00120295	0.00120295	0.85	0.3682
205vs223	1	0.03378700	0.03378700	24.00	0.0001
205vs225	1	0.00957728	0.00957728	6.80	0.0184
213vs221	1	0.00228907	0.00228907	1.63	0.2194
213vs223	1	0.03456280	0.03456280	24.55	0.0001
213vs225	1	0.01130768	0.01130768	8.03	0.0114
221vs223	1	0.02223940	0.02223940	15.80	0.0010
221vs225	1	0.00399171	0.00399171	2.84	0.1105
223vs225	1	0.00738720	0.00738720	5.25	0.0350

The GLM Procedure
Multivariate Analysis of Variance

Characteristic Roots and Vectors of: E Inverse * H, where
H = Type III SSCP Matrix for mcg
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
24.3481937	82.51	0.65509013	-0.02169624	1.66450920
3.7426508	12.68	0.10586923	0.07168452	-0.60700286
1.4181124	4.81	-0.03880440	-0.05098256	8.39082531

MANOVA Test Criteria and F Approximations for
the Hypothesis of No Overall mcg Effect
H = Type III SSCP Matrix for mcg
E = Error SSCP Matrix

S=3 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.00343998	18.97	15	41.81	<.0001
Pillai's Trace	2.33615120	11.96	15	51	<.0001
Hotelling-Lawley Trace	29.50895690	27.95	15	23.537	<.0001
Roy's Greatest Root	24.34819371	82.78	5	17	<.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 198vs205
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
5.38138882	100.00	0.63166514	0.00524456	-1.55167862
0.00000000	0.00	0.05564167	0.06852839	-0.01996793
0.00000000	0.00	0.19939986	-0.05903367	8.43426864

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 198vs205 Effect
H = Contrast SSCP Matrix for 198vs205
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.15670570	26.91	3	15	<.0001
Pillai's Trace	0.84329430	26.91	3	15	<.0001
Hotelling-Lawley Trace	5.38138882	26.91	3	15	<.0001
Roy's Greatest Root	5.38138882	26.91	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 198vs213
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
8.37814494	100.00	0.64436597	-0.00477257	-0.68220917
0.00000000	0.00	0.13336968	-0.05973661	8.54865974
0.00000000	0.00	0.09413908	0.06795130	0.00000000

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 198vs213 Effect
H = Contrast SSCP Matrix for 198vs213
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.10663090	41.89	3	15	<.0001
Pillai's Trace	0.89336910	41.89	3	15	<.0001
Hotelling-Lawley Trace	8.37814494	41.89	3	15	<.0001
Roy's Greatest Root	8.37814494	41.89	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 198vs221
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
22.0105563	100.00	0.64741347	-0.02553362	1.58073457
0.0000000	0.00	-0.03830267	-0.05541060	8.42889500
0.0000000	0.00	0.14575955	0.06697998	0.00000000

With constrasts and multiple comparisons

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 198vs221 Effect
H = Contrast SSCP Matrix for 198vs221
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.04345831	110.05	3	15	<.0001
Pillai's Trace	0.95654169	110.05	3	15	<.0001
Hotelling-Lawley Trace	22.01055628	110.05	3	15	<.0001
Roy's Greatest Root	22.01055628	110.05	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 198vs223
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
11.2483252	100.00	0.63578429	0.01541956	0.68165998
0.0000000	0.00	0.03125046	-0.06058497	8.54870355
0.0000000	0.00	-0.19146512	0.06557680	0.00000000

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 198vs223 Effect
H = Contrast SSCP Matrix for 198vs223
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.08164382	56.24	3	15	<.0001
Pillai's Trace	0.91835618	56.24	3	15	<.0001
Hotelling-Lawley Trace	11.24832517	56.24	3	15	<.0001
Roy's Greatest Root	11.24832517	56.24	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 198vs225
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
11.6990058	100.00	0.66311830	-0.01321791	1.39221550
0.0000000	0.00	0.03791416	0.06847526	0.00592425
0.0000000	0.00	-0.02633971	-0.05783636	8.46207384

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 198vs225 Effect
H = Contrast SSCP Matrix for 198vs225
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.07874632	58.50	3	15	<.0001
Pillai's Trace	0.92125368	58.50	3	15	<.0001
Hotelling-Lawley Trace	11.69900583	58.50	3	15	<.0001
Roy's Greatest Root	11.69900583	58.50	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 205vs213
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
0.64323466	100.00	0.63401380	-0.03126855	1.69308351
0.00000000	0.00	-0.04435548	-0.05405842	8.40704829
0.00000000	0.00	0.19472094	0.06563980	0.00000000

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 205vs213 Effect
H = Contrast SSCP Matrix for 205vs213
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.60855581	3.22	3	15	0.0531
Pillai's Trace	0.39144419	3.22	3	15	0.0531
Hotelling-Lawley Trace	0.64323466	3.22	3	15	0.0531
Roy's Greatest Root	0.64323466	3.22	3	15	0.0531

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 205vs221
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight

7.27620295	100.00	0.58278929	-0.04891974	4.08373187
0.00000000	0.00	0.22344819	0.06333498	0.19836003
0.00000000	0.00	-0.22865846	-0.04247538	7.53848659

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 205vs221 Effect
H = Contrast SSCP Matrix for 205vs221
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.12082836	36.38	3	15	<.0001
Pillai's Trace	0.87917164	36.38	3	15	<.0001
Hotelling-Lawley Trace	7.27620295	36.38	3	15	<.0001
Roy's Greatest Root	7.27620295	36.38	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 205vs223
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
2.68452724	100.00	0.40709209	0.02413783	3.59225697
0.00000000	0.00	-0.09783215	-0.07629448	7.78721276
0.00000000	0.00	-0.51629647	0.04248690	0.00000000

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 205vs223 Effect
H = Contrast SSCP Matrix for 205vs223
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.27140524	13.42	3	15	0.0002
Pillai's Trace	0.72859476	13.42	3	15	0.0002
Hotelling-Lawley Trace	2.68452724	13.42	3	15	0.0002
Roy's Greatest Root	2.68452724	13.42	3	15	0.0002

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 205vs225
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
2.15228255	100.00	0.54720904	-0.03910971	5.69944621
0.00000000	0.00	0.00047266	0.06866844	-0.00802559
0.00000000	0.00	-0.37738468	-0.04431359	6.40790459

One-way multivariate analysis of tubes data
With constrasts and multiple comparisons

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 205vs225 Effect
H = Contrast SSCP Matrix for 205vs225
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.31723045	10.76	3	15	0.0005
Pillai's Trace	0.68276955	10.76	3	15	0.0005
Hotelling-Lawley Trace	2.15228255	10.76	3	15	0.0005
Roy's Greatest Root	2.15228255	10.76	3	15	0.0005

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 213vs221
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
3.05552567	100.00	0.54172365	-0.05554422	5.05754095
0.00000000	0.00	0.22438268	0.06089228	0.54637876
0.00000000	0.00	-0.31312146	-0.03762431	6.90418298

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 213vs221 Effect
H = Contrast SSCP Matrix for 213vs221
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.24657716	15.28	3	15	<.0001
Pillai's Trace	0.75342284	15.28	3	15	<.0001
Hotelling-Lawley Trace	3.05552567	15.28	3	15	<.0001
Roy's Greatest Root	3.05552567	15.28	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 213vs223
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
1.95523216	100.00	0.07797481	0.04412009	2.92588512
0.00000000	0.00	0.65576510	-0.00318779	-0.21140245
0.00000000	0.00	0.07582358	-0.07906880	8.05850470

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 213vs223 Effect
H = Contrast SSCP Matrix for 213vs223
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.33838289	9.78	3	15	0.0008
Pillai's Trace	0.66161711	9.78	3	15	0.0008
Hotelling-Lawley Trace	1.95523216	9.78	3	15	0.0008
Roy's Greatest Root	1.95523216	9.78	3	15	0.0008

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 213vs225
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
0.67742599	100.00	0.28521598	-0.03407091	7.75561206
0.00000000	0.00	-0.11454703	0.08037937	-2.12770747
0.00000000	0.00	0.58939628	0.02422703	-2.97797501

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 213vs225 Effect
H = Contrast SSCP Matrix for 213vs225
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.59615149	3.39	3	15	0.0460
Pillai's Trace	0.40384851	3.39	3	15	0.0460
Hotelling-Lawley Trace	0.67742599	3.39	3	15	0.0460
Roy's Greatest Root	0.67742599	3.39	3	15	0.0460

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 221vs223
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
5.99909609	100.00	0.36950896	-0.07002270	2.09442823
0.00000000	0.00	-0.00882263	-0.04337999	8.31615074
0.00000000	0.00	0.55248750	0.03773085	0.00000000

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 221vs223 Effect
H = Contrast SSCP Matrix for 221vs223
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.14287559	30.00	3	15	<.0001
Pillai's Trace	0.85712441	30.00	3	15	<.0001
Hotelling-Lawley Trace	5.99909609	30.00	3	15	<.0001
Roy's Greatest Root	5.99909609	30.00	3	15	<.0001

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 221vs225
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight

2.04790097	100.00	0.53754250	-0.05211683	1.85470500
0.00000000	0.00	-0.03540517	-0.04905730	8.37287657
0.00000000	0.00	0.38942481	0.05555030	0.00000000

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 221vs225 Effect
H = Contrast SSCP Matrix for 221vs225
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.32809465	10.24	3	15	0.0006
Pillai's Trace	0.67190535	10.24	3	15	0.0006
Hotelling-Lawley Trace	2.04790097	10.24	3	15	0.0006
Roy's Greatest Root	2.04790097	10.24	3	15	0.0006

Characteristic Roots and Vectors of: E Inverse * H, where
H = Contrast SSCP Matrix for 223vs225
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 length10	pmscl10	weight
1.46809720	100.00	-0.11207077	0.07999437	-2.04326268
0.00000000	0.00	0.05661628	-0.04129763	8.32886969
0.00000000	0.00	0.65275714	0.01019933	0.00000000

The GLM Procedure
Multivariate Analysis of Variance

MANOVA Test Criteria and Exact F Statistics for
the Hypothesis of No Overall 223vs225 Effect
H = Contrast SSCP Matrix for 223vs225
E = Error SSCP Matrix

S=1 M=0.5 N=6.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.40517043	7.34	3	15	0.0030
Pillai's Trace	0.59482957	7.34	3	15	0.0030
Hotelling-Lawley Trace	1.46809720	7.34	3	15	0.0030
Roy's Greatest Root	1.46809720	7.34	3	15	0.0030

Scheffe follow-ups for a significant multivariate test

Initial test has 3 (possibly transformed) dependent variables.

Initial null hypothesis imposes 5 (sets of) constraints,
using significance level alpha = 0.05

F approximation for initial Wilks' lambda has 15 and 41.809794
degrees of freedom.

Based on the F approximation, critical value of Wilks' lambda is 0.236342

For multivariate follow-ups, reject if Lambda is LESS THAN the critical value.

For univariate follow-ups, use the table below

Number of Constraints in followup test	Scheffe Critical Value of F
1	54.929661
2	27.464831
3	18.309887
4	13.732415
5	10.985932