

Manova on Math Data

```

/* mathmanova.sas */
%include 'mathexread3.sas';
title2 'Three-way Manova';

proc glm;
  class sex tongue ethnic;
  model hscalc totscore grade = sex|tongue|ethnic;
  manova h = _all_; /* Like MSE */
  means tongue; /* Based on examination of output */

```

Math Diagnostic Study: Exploratory data 1
 Three-way Manova
 00:04 Monday, November 21, 2005

The GLM Procedure

Class Level Information

Class	Levels	Values
sex	2	Female Male
tongue	2	English Other
ethnic	5	Asian East Indian European Middle-Eastern Other or unknown

Number of observations 579

NOTE: Observations with missing values will not be included in this analysis.
 Thus, only 295 observations can be used in this analysis.

Math Diagnostic Study: Exploratory data 2
 Three-way Manova
 00:04 Monday, November 21, 2005

The GLM Procedure

Dependent Variable: hscalc Mark in HS Calculus

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	3786.62677	222.74275	1.81	0.0263
Error	277	34032.74272	122.86189		
Corrected Total	294	37819.36949			

R-Square	Coeff Var	Root MSE	hscalc Mean
0.100124	14.13631	11.08431	78.41017

Source	DF	Type I SS	Mean Square	F Value	Pr > F
sex	1	360.175783	360.175783	2.93	0.0880
tongue	1	1328.943359	1328.943359	10.82	0.0011
sex*tongue	1	64.881023	64.881023	0.53	0.4680
ethnic	4	1171.034253	292.758563	2.38	0.0517
sex*ethnic	4	486.834015	121.708504	0.99	0.4130
tongue*ethnic	3	202.723127	67.574376	0.55	0.6485
sex*tongue*ethnic	3	172.035214	57.345071	0.47	0.7057

Math Diagnostic Study: Exploratory data 3
 Three-way Manova
 00:04 Monday, November 21, 2005

The GLM Procedure

Dependent Variable: hscalc Mark in HS Calculus

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	22.4649732	22.4649732	0.18	0.6693
tongue	1	503.8037425	503.8037425	4.10	0.0438
sex*tongue	1	142.1419594	142.1419594	1.16	0.2830
ethnic	4	574.9451545	143.7362886	1.17	0.3243
sex*ethnic	4	511.9521375	127.9880344	1.04	0.3860
tongue*ethnic	3	156.1098452	52.0366151	0.42	0.7363
sex*tongue*ethnic	3	172.0352138	57.3450713	0.47	0.7057

Now just the Type III F tests for the other two.

Dependent Variable: totscore Total # right on diagnostic test

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	75.74269889	75.74269889	6.54	0.0111
tongue	1	62.38090341	62.38090341	5.39	0.0210
sex*tongue	1	10.21733422	10.21733422	0.88	0.3484
ethnic	4	37.51109977	9.37777494	0.81	0.5199
sex*ethnic	4	66.22423122	16.55605780	1.43	0.2244
tongue*ethnic	3	53.54436987	17.84812329	1.54	0.2042
sex*tongue*ethnic	3	45.64655500	15.21551833	1.31	0.2702

Dependent Variable: grade Mark in university calculus

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	12.366377	12.366377	0.04	0.8424
tongue	1	2098.937720	2098.937720	6.72	0.0100
sex*tongue	1	178.226822	178.226822	0.57	0.4506
ethnic	4	1411.222825	352.805706	1.13	0.3426
sex*ethnic	4	1190.786710	297.696677	0.95	0.4335
tongue*ethnic	3	94.759002	31.586334	0.10	0.9593
sex*tongue*ethnic	3	1208.889366	402.963122	1.29	0.2779

Math Diagnostic Study: Exploratory data 8
 Three-way Manova
 00:04 Monday, November 21, 2005

The GLM Procedure
 Multivariate Analysis of Variance

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

Characteristic Root	Percent	Characteristic Vector V'EV=1		
		hscalc	totscore	grade
0.02740776	100.00	-0.00070225	0.01987047	-0.00115221
0.00000000	0.00	0.00559745	-0.00312155	0.00018101
0.00000000	0.00	-0.00335915	0.00022032	0.00398226

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

S=1 M=0.5 N=136.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.97332339	2.51	3	275	0.0589
Pillai's Trace	0.02667661	2.51	3	275	0.0589
Hotelling-Lawley Trace	0.02740776	2.51	3	275	0.0589
Roy's Greatest Root	0.02740776	2.51	3	275	0.0589

Only the test for tongue was significant.

MANOVA Test Criteria and Exact F Statistics for
 the Hypothesis of No Overall tongue Effect
 H = Type III SSCP Matrix for tongue

E = Error SSCP Matrix

S=1 M=0.5 N=136.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.96937875	2.90	3	275	0.0356
Pillai's Trace	0.03062125	2.90	3	275	0.0356
Hotelling-Lawley Trace	0.03158853	2.90	3	275	0.0356
Roy's Greatest Root	0.03158853	2.90	3	275	0.0356

Math Diagnostic Study: Exploratory data 15
 Three-way Manova

00:04 Monday, November 21, 2005

The GLM Procedure

Level of tongue	N	-----hscalc-----		-----totscore-----	
		Mean	Std Dev	Mean	Std Dev
English	235	77.3404255	11.6356301	8.57021277	3.55878082
Other	60	82.6000000	9.0351479	9.71666667	3.50346882

Level of tongue	N	-----grade-----	
		Mean	Std Dev
English	235	58.7914894	18.4591004
Other	60	67.3166667	15.7517733