

BIOS6643. L09 Specifying both G and R

The RANDOM statement may be used with TYPE=UN and possibly the GROUP= option to specify the among-individual covariance matrix G (possibly different by levels of GROUP).

The REPEATED statement may be used with various TYPE= specifications, and possibly the GROUP = option with SUBJECT = to specify the within-individual covariance matrix R_i.

```
proc import DATAFILE='C:\Users\juarezce\OneDrive - The University of Colorado Denver\BIOS6643\BIOS6643_1.csv' replace out=dental0 dbms=csv; run;
```

```
data dental;
  set dental0;
  time=age;
run;
```

```
proc print data=dental(obs=2);run;
```

```
title '(a) DIAGONAL WITHIN-CHILD COVARIANCE MATRIX Ri';
title2 'WITH CONSTANT VARIANCE SAME FOR EACH GENDER';
title3 'SAME G MATRIX FOR BOTH GENDERS';
proc mixed method=ml data=dental;
  class gender id;
  model distance = gender gender*age / noint solution;
  random intercept age / type=un subject=id g gcorr v vcorr;
run;
```

```
/*****
```

MODEL (b)

Fit the same model as (a) but with a separate diagonal R_i matrix for each gender. Thus, there are 2 separate variances $\sigma^2_{(G \text{ and } B)}$ specified using GROUP=GENDER in the REPEATED statement

D still = (2x2) unstructured matrix same for both genders as in (a) (specified in the RANDOM statement)

```
*****/
```

```
title '(b) DIAGONAL WITHIN-CHILD COVARIANCE MATRIX Ri';
title2 'WITH SEPARATE CONSTANT VARIANCE FOR EACH GENDER';
title3 'SAME D MATRIX FOR BOTH GENDERS';
```

```

proc mixed method=ml data=dental;
  class id gender;
  model distance = gender gender*age / noint solution;
  repeated / group=gender subject=id r=1,4 rcorr=1,4;
  random intercept age / type=un subject=id g gcorr v=1,4 vcorr=1,4;
run;

/*****
MODEL (b2)

*****/

title '(c) COMMON AR(1) WITHIN-CHILD REALIZATION COMPONENT AND';
title2 'COMMON WITHIN-CHILD COMPONENT FOR R_i';
title3 'SAME G MATRIX FOR BOTH GENDERS';
proc mixed method=ml data=dental;
  class gender id time;
  model distance = gender gender*age / noint solution ;
  random intercept age / type=un subject=id g gcorr v vcorr;
  repeated / type=ar(1) subject=id rcorr r;
run;

/*****

*****/

title '(d) COMMON AR(1) WITHIN-CHILD REALIZATION COMPONENT AND';
title2 'COMMON WITHIN-CHILD COMPONENT FOR R_i';
title3 'USING EXPONENTIAL MODEL; SAME G MATRIX FOR BOTH GENDERS';
proc mixed method=ml data=dental;
  class gender id age;
  model distance = gender gender*age / noint solution ;
  * random intercept age / type=un subject=id g gcorr v vcorr;
  repeated age / type=sp(exp)(age) subject=id rcorr r;
run;

/*****

MODEL (b2)

Fit the same model as (b) but now with D a (2x2) unstructured
matrix different across genders, so there are two matrices G_Girls and G_Boys
This is specified in the RANDOM statement by the GROUP=GENDER option

*****/

title '(b2) DIAGONAL WITHIN-CHILD COVARIANCE MATRIX R_i';
title2 'WITH SEPARATE CONSTANT VARIANCE FOR EACH GENDER';
title3 'DIFFERENT G MATRIX FOR BOTH GENDERS';

```

```

proc mixed method=ml data=dental;
  class id gender;
  model distance = gender gender*age / noint solution;
  repeated / group=gender subject=id;
  random intercept age / type=un group=gender subject=id g gcorr v=1,12 vcorr=1,12;
run;

```

```
/* */
```

Obs	id	age	distance	gender	time
1	1	8	21	Girls	8
2	1	10	20	Girls	10

(a) DIAGONAL WITHIN-CHILD COVARIANCE MATRIX R_i
 WITH CONSTANT VARIANCE SAME FOR EACH GENDER
 SAME G MATRIX FOR BOTH GENDERS

The Mixed Procedure

Model Information

Data Set	WORK.DENTAL
Dependent Variable	distance
Covariance Structure	Unstructured
Subject Effect	id
Estimation Method	ML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
gender	2	Boys Girls
id	27	1 10 11 12 13 14 15 16 17 18 19 2 20 21 22 23 24 25 26 27 3 4 5 6 7 8 9

Dimensions

Covariance Parameters	4
Columns in X	4
Columns in Z per Subject	2
Subjects	27
Max Obs per Subject	4

Number of Observations

Number of Observations Read	108
Number of Observations Used	108
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Log Like	Criterion
0	1	478.24175986	
1	1	427.80595080	0.00000000

Convergence criteria met.

Estimated G Matrix

Row Effect	id	Col1	Col2
1 Intercept	1	4.5569	-0.1983
2 age	1	-0.1983	0.02376

Estimated G Correlation Matrix

Row Effect	id	Col1	Col2
1 Intercept	1	1.0000	-0.6025
2 age	1	-0.6025	1.0000

Estimated V Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	4.6216	2.8891	2.8727	2.8563
2	2.8891	4.6839	3.0464	3.1251
3	2.8727	3.0464	4.9363	3.3938
4	2.8563	3.1251	3.3938	5.3788

Estimated V Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.0000	0.6209	0.6014	0.5729
2	0.6209	1.0000	0.6335	0.6226
3	0.6014	0.6335	1.0000	0.6586
4	0.5729	0.6226	0.6586	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
UN(1,1)	id	4.5569
UN(2,1)	id	-0.1983
UN(2,2)	id	0.02376
Residual		1.7162

Fit Statistics

-2 Log Likelihood	427.8
AIC (Smaller is Better)	443.8
AICC (Smaller is Better)	445.3
BIC (Smaller is Better)	454.2

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
3	50.44	<.0001

Solution for Fixed Effects

Effect	gender	Estimate	Standard Error	DF	t Value	Pr > t
gender	Boys	16.3406	0.9801	54	16.67	<.0001
gender	Girls	17.3727	1.1820	54	14.70	<.0001
age*gender	Boys	0.7844	0.08275	54	9.48	<.0001
age*gender	Girls	0.4795	0.09980	54	4.80	<.0001

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
gender	2	54	247.00	<.0001
age*gender	2	54	56.46	<.0001

(b) DIAGONAL WITHIN-CHILD COVARIANCE MATRIX R_i
WITH SEPARATE CONSTANT VARIANCE FOR EACH GENDER
SAME D MATRIX FOR BOTH GENDERS

The Mixed Procedure

Model Information

Data Set	WORK.DENTAL
Dependent Variable	distance
Covariance Structures	Unstructured, Variance Components
Subject Effects	id, id
Group Effect	gender
Estimation Method	ML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
id	27	1 10 11 12 13 14 15 16 17 18 19 2 20 21 22 23 24 25 26 27 3 4 5 6 7 8 9
gender	2	Boys Girls

Dimensions

Covariance Parameters	5
Columns in X	4
Columns in Z per Subject	2
Subjects	27
Max Obs per Subject	4

Number of Observations

Number of Observations Read	108
Number of Observations Used	108
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Log Like	Criterion
0	1	478.24175986	
1	2	418.92503842	1.16632499
2	1	416.18869903	1.23326209
3	1	407.89638533	0.01954268
4	2	406.88264563	0.00645800
5	1	406.10632159	0.00056866
6	1	406.04318997	0.00000764
7	1	406.04238894	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	0.4449			
2		0.4449		
3			0.4449	
4				0.4449

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.0000			
2		1.0000		
3			1.0000	
4				1.0000

Estimated G Matrix

Row Effect	id	Col1	Col2
1 Intercept	1	3.1978	-0.1103
2 age	1	-0.1103	0.01976

Estimated G Correlation Matrix

Row Effect	id	Col1	Col2
1 Intercept	1	1.0000	-0.4388
2 age	1	-0.4388	1.0000

Estimated V Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	3.1426	2.7933	2.8889	2.9845
2	2.7933	3.4128	3.1426	3.3172
3	2.8889	3.1426	3.8411	3.6499
4	2.9845	3.3172	3.6499	4.4275

Estimated V Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.0000	0.8529	0.8315	0.8001
2	0.8529	1.0000	0.8680	0.8534
3	0.8315	0.8680	1.0000	0.8851
4	0.8001	0.8534	0.8851	1.0000

Estimated R Matrix for id 12

Row	Col1	Col2	Col3	Col4
1	2.6294			
2		2.6294		
3			2.6294	
4				2.6294

Estimated R Correlation Matrix for id 12

Row	Col1	Col2	Col3	Col4
1	1.0000			
2		1.0000		
3			1.0000	
4				1.0000

Estimated V Matrix for id 12

Row	Col1	Col2	Col3	Col4
-----	------	------	------	------

1	5.3271	2.7933	2.8889	2.9845
2	2.7933	5.5973	3.1426	3.3172
3	2.8889	3.1426	6.0256	3.6499
4	2.9845	3.3172	3.6499	6.6120

Estimated V Correlation Matrix for id 12

Row	Col1	Col2	Col3	Col4
1	1.0000	0.5115	0.5099	0.5029
2	0.5115	1.0000	0.5411	0.5453
3	0.5099	0.5411	1.0000	0.5782
4	0.5029	0.5453	0.5782	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Group	Estimate
UN(1,1)	id		3.1978
UN(2,1)	id		-0.1103
UN(2,2)	id		0.01976
Residual	id	gender Boys	2.6294
Residual	id	gender Girls	0.4449

Fit Statistics

-2 Log Likelihood	406.0
AIC (Smaller is Better)	424.0
AICC (Smaller is Better)	425.9
BIC (Smaller is Better)	435.7

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
4	72.20	<.0001

Solution for Fixed Effects

Effect	gender	Estimate	Standard Error	DF	t Value	Pr > t
gender	Boys	16.3406	1.1114	54	14.70	<.0001
gender	Girls	17.3727	0.7386	54	23.52	<.0001
age*gender	Boys	0.7844	0.09722	54	8.07	<.0001
age*gender	Girls	0.4795	0.06180	54	7.76	<.0001

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
gender	2	54	384.72	<.0001

age*gender	2	54	62.66	<.0001
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(c) COMMON AR(1) WITHIN-CHILD REALIZATION COMPONENT AND
COMMON WITHIN-CHILD COMPONENT FOR R_i
SAME G MATRIX FOR BOTH GENDERS

The Mixed Procedure

Model Information

Data Set	WORK.DENTAL
Dependent Variable	distance
Covariance Structures	Unstructured, Autoregressive
Subject Effects	id, id
Estimation Method	ML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
gender	2	Boys Girls
id	27	1 10 11 12 13 14 15 16 17 18 19 2 20 21 22 23 24 25 26 27 3 4 5 6 7 8 9
time	4	8 10 12 14

Dimensions

Covariance Parameters	5
Columns in X	4
Columns in Z per Subject	2
Subjects	27
Max Obs per Subject	4

Number of Observations

Number of Observations Read	108
Number of Observations Used	108
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Log Like	Criterion
0	1	478.24175986	
1	2	424.08934703	0.00028001
2	1	424.05684775	0.00000096
3	1	424.05673965	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.1940	-0.5588	0.2615	-0.1224
2	-0.5588	1.1940	-0.5588	0.2615
3	0.2615	-0.5588	1.1940	-0.5588
4	-0.1224	0.2615	-0.5588	1.1940

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.0000	-0.4680	0.2190	-0.1025
2	-0.4680	1.0000	-0.4680	0.2190
3	0.2190	-0.4680	1.0000	-0.4680
4	-0.1025	0.2190	-0.4680	1.0000

Estimated G Matrix

Row Effect	id	Col1	Col2
1 Intercept	1	10.1459	-0.7198
2 age	1	-0.7198	0.07508

Estimated G Correlation Matrix

Row Effect	id	Col1	Col2
1 Intercept	1	1.0000	-0.8248
2 age	1	-0.8248	1.0000

Estimated V Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	4.6275	2.6363	3.2182	2.5959
2	2.6363	4.4510	2.7601	3.6423
3	3.2182	2.7601	4.8751	3.4846
4	2.5959	3.6423	3.4846	5.8999

Estimated V Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.0000	0.5809	0.6776	0.4968
2	0.5809	1.0000	0.5925	0.7108
3	0.6776	0.5925	1.0000	0.6497
4	0.4968	0.7108	0.6497	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
UN(1,1)	id	10.1459
UN(2,1)	id	-0.7198
UN(2,2)	id	0.07508
AR(1)	id	-0.4680
Residual		1.1940

Fit Statistics

-2 Log Likelihood	424.1
AIC (Smaller is Better)	442.1
AICC (Smaller is Better)	443.9
BIC (Smaller is Better)	453.7

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
4	54.19	<.0001

Solution for Fixed Effects

Effect	gender	Estimate	Standard Error	DF	t Value	Pr > t
gender	Boys	16.1544	0.9607	54	16.82	<.0001
gender	Girls	17.4166	1.1586	54	15.03	<.0001
age*gender	Boys	0.7978	0.08374	54	9.53	<.0001
age*gender	Girls	0.4757	0.1010	54	4.71	<.0001

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
gender	2	54	254.37	<.0001
age*gender	2	54	56.48	<.0001

(d) COMMON AR(1) WITHIN-CHILD REALIZATION COMPONENT AND
COMMON WITHIN-CHILD COMPONENT FOR R_i
USING EXPONENTIAL MODEL; SAME G MATRIX FOR BOTH GENDERS

The Mixed Procedure

Model Information

Data Set	WORK.DENTAL
Dependent Variable	distance
Covariance Structure	Spatial Exponential
Subject Effect	id

Estimation Method	ML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information

Class	Levels	Values
gender	2	Boys Girls
id	27	1 10 11 12 13 14 15 16 17 18 19 2 20 21 22 23 24 25 26 27 3 4 5 6 7 8 9
age	4	8 10 12 14

Dimensions

Covariance Parameters	2
Columns in X	10
Columns in Z	0
Subjects	27
Max Obs per Subject	4

Number of Observations

Number of Observations Read	108
Number of Observations Used	108
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Log Like	Criterion
0	1	477.48183083	
1	2	438.79243893	0.00121826
2	2	438.66811911	0.00004451
3	1	438.66266205	0.00000005
4	1	438.66265649	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	4.8578	2.9889	1.8389	1.1314
2	2.9889	4.8578	2.9889	1.8389
3	1.8389	2.9889	4.8578	2.9889
4	1.1314	1.8389	2.9889	4.8578

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
-----	------	------	------	------

1	1.0000	0.6153	0.3786	0.2329
2	0.6153	1.0000	0.6153	0.3786
3	0.3786	0.6153	1.0000	0.6153
4	0.2329	0.3786	0.6153	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
SP(EXP)	id	4.1178
Residual		4.8578

Fit Statistics

-2 Log Likelihood	438.7
AIC (Smaller is Better)	458.7
AICC (Smaller is Better)	460.9
BIC (Smaller is Better)	471.6

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
1	38.82	<.0001

Solution for Fixed Effects

Effect	gender	age	Estimate	Standard Error	DF	t Value
gender	Boys		27.4687	0.5510	25	49.85
gender	Girls		24.0909	0.6645	25	36.25
gender*age	Boys	8	-4.5937	0.6825	75	-6.73
gender*age	Boys	10	-3.6562	0.6143	75	-5.95
gender*age	Boys	12	-1.7500	0.4833	75	-3.62
gender*age	Boys	14	0	.	.	.
gender*age	Girls	8	-2.9091	0.8231	75	-3.53
gender*age	Girls	10	-1.8636	0.7409	75	-2.52
gender*age	Girls	12	-1.0000	0.5829	75	-1.72
gender*age	Girls	14	0	.	.	.

Solution for Fixed Effects

Effect	gender	age	Pr > t
gender	Boys		<.0001
gender	Girls		<.0001
gender*age	Boys	8	<.0001
gender*age	Boys	10	<.0001
gender*age	Boys	12	0.0005
gender*age	Boys	14	.
gender*age	Girls	8	0.0007
gender*age	Girls	10	0.0140
gender*age	Girls	12	0.0904

gender*age Girls 14 .

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
gender	2	25	2659.19	<.0001
gender*age	6	75	10.05	<.0001

(b2) DIAGONAL WITHIN-CHILD COVARIANCE MATRIX R_i
WITH SEPARATE CONSTANT VARIANCE FOR EACH GENDER
DIFFERENT G MATRIX FOR BOTH GENDERS

The Mixed Procedure

Model Information

Data Set	WORK.DENTAL
Dependent Variable	distance
Covariance Structures	Unstructured, Variance Components
Subject Effects	id, id
Group Effects	gender, gender
Estimation Method	ML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
id	27	1 10 11 12 13 14 15 16 17 18 19 2 20 21 22 23 24 25 26 27 3 4 5 6 7 8 9
gender	2	Boys Girls

Dimensions

Covariance Parameters	8
Columns in X	4
Columns in Z per Subject	4
Subjects	27
Max Obs per Subject	4

Number of Observations

Number of Observations Read	108
Number of Observations Used	108
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Log Like	Criterion
0	1	478.24175986	
1	1	405.11800674	0.00000000

Convergence criteria met.

Estimated G Matrix

Row Effect	id	gender	Col1	Col2	Col3	Col4
1 Intercept	1	Boys	5.6468	-0.2827		
2 age	1	Boys	-0.2827	0.02530		
3 Intercept	1	Girls			2.9716	-0.07539
4 age	1	Girls			-0.07539	0.02151

Estimated G Correlation Matrix

Row Effect	id	gender	Col1	Col2	Col3	Col4
1 Intercept	1	Boys	1.0000	-0.7480		
2 age	1	Boys	-0.7480	1.0000		
3 Intercept	1	Girls			1.0000	-0.2982
4 age	1	Girls			-0.2982	1.0000

Estimated V Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	3.5889	3.3357	3.5292	3.7226
2	3.3357	4.0618	3.8947	4.1742
3	3.5292	3.8947	4.7069	4.6258
4	3.7226	4.1742	4.6258	5.5240

Estimated V Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4
1	1.0000	0.8737	0.8587	0.8361
2	0.8737	1.0000	0.8907	0.8812
3	0.8587	0.8907	1.0000	0.9072
4	0.8361	0.8812	0.9072	1.0000

Estimated V Matrix for id 2

Row	Col1	Col2	Col3	Col4
1	3.5889	3.3357	3.5292	3.7226
2	3.3357	4.0618	3.8947	4.1742
3	3.5292	3.8947	4.7069	4.6258
4	3.7226	4.1742	4.6258	5.5240

Estimated V Correlation Matrix for id 2

Row	Col1	Col2	Col3	Col4
1	1.0000	0.8737	0.8587	0.8361
2	0.8737	1.0000	0.8907	0.8812
3	0.8587	0.8907	1.0000	0.9072
4	0.8361	0.8812	0.9072	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Group	Estimate
UN(1,1)	id	gender Boys	5.6468
UN(2,1)	id	gender Boys	-0.2827
UN(2,2)	id	gender Boys	0.02530
UN(1,1)	id	gender Girls	2.9716
UN(2,1)	id	gender Girls	-0.07539
UN(2,2)	id	gender Girls	0.02151
Residual	id	gender Boys	2.5891
Residual	id	gender Girls	0.4466

Fit Statistics

-2 Log Likelihood	405.1
AIC (Smaller is Better)	429.1
AICC (Smaller is Better)	432.4
BIC (Smaller is Better)	444.7

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
7	73.12	<.0001

Solution for Fixed Effects

Effect	gender	Estimate	Standard Error	DF	t Value	Pr > t
gender	Boys	16.3406	1.1715	25	13.95	<.0001
gender	Girls	17.3727	0.7252	25	23.96	<.0001
age*gender	Boys	0.7844	0.09835	25	7.98	<.0001
age*gender	Girls	0.4795	0.06313	25	7.60	<.0001

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
gender	2	25	384.22	<.0001
age*gender	2	25	60.65	<.0001