STAT 430

Repeated Measures Designs
==========================

ssh UserID@umeg.umd.edu, tap sas913, sas
https://www.statlab.umd.edu/sasdoc/sashtml/onldoc.htm

Subjects are measured at every level of a factor. For example, every subjects gets all possible treatments. Previously, every subjects received only one treatment. We'll make this clear in the following.

Ex1. One-Factor Repeated Experiment

Have 2 factors: SUBJECT and DRUG.

Each subjects is given all 4 treatments 1,2,3,4 for pain relief. Then the subject's pain tolerance is measured. Enough time is allowed to pass between treatments to prevent residual effects, and thus guarantee independence between measurements.

Subject	Drug1	Drug2	Drug3	Drug4	
1	5	9	6	11	
2	7	12	8	9	NOTE: ONE OBS/CELL
3	11	12	10	14	
4	3	8	5	8	

```
DATA PAIN;
INPUT SUBJECT DRUG PAIN;
1 1 5
1 2 9
1 3 6
1 4 11
2 1 7
2 2 12
2 3 8
ETC.
```

Better way to read the data using a do loop.

```
OPTION PS=35 LS=70;

DATA PAIN;
INPUT SUBJ @;
DO DRUG=1 TO 4;
INPUT PAIN @;
OUTPUT;
END;
DATALINES;
1  5  9  6  11
2  7 12  8   9
3 11 12 10  14
4  3  8  5   8
;

PROC PRINT DATA=PAIN;
RUN;
```

Obs	SUBJ	DRUG	PAIN
1	1	1	5
2	1	2	9
3	1	3	6
4	1	4	11
5	2	1	7
6	2	2	12
7	2	3	8
8	2	4	9
9	3	1	11
10	3	2	12
11	3	3	10
12	3	4	14
13	4	1	3
14	4	2	8
15	4	3	5
16	4	4	8

Now do 2-way ANOVA with 1 obs/cell (i.e. no interaction).

y_ij = mu + a_i + b_j + epsilon_ij

```
PROC ANOVA DATA=PAIN;
CLASS SUBJ DRUG;
MODEL PAIN=SUBJ DRUG;
MEANS DRUG/SNK;
RUN;
```

The ANOVA Procedure

Class Level Information

Class	Levels	Values
SUBJ	4	1 2 3 4
DRUG	4	1 2 3 4

Number of Observations Read	16
Number of Observations Used	16

Dependent Variable: PAIN

Source	DF	Sum of Squares	Mean Square	F Value
Model	6	120.5000000	20.0833333	13.64
Error	9	13.2500000	1.4722222	
Corrected Total	15	133.7500000		

Source	Pr > F
Model	0.0005
Error	
Corrected Total	

R-Square	Coeff Var	Root MSE	PAIN Mean
0.900935	14.06785	1.213352	8.625000

Source	DF	Anova SS	Mean Square	F Value
SUBJ	3	70.25000000	23.41666667	15.91
DRUG	3	50.25000000	16.75000000	11.38

Source	Pr > F
SUBJ	0.0006
DRUG	0.0020

Therefore DRUG effects are not all zero: The 4 DRUGS not equally effective in treating pain.

NOTE: Denominator df=9 comes from ERROR df in the first table.

Student-Newman-Keuls Test for PAIN

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha	0.05
Error Degrees of Freedom	9
Error Mean Square	1.472222

Number of Means	2	3	4
Critical Range	1.9407923	2.3954582	2.6784122

Means with the same letter are not significantly different.

SNK Grouping	Mean	N	DRUG
A	10.5000	4	4
A			
A	10.2500	4	2
B	7.2500	4	3
B			
B	6.5000	4	1

We see that DRUGS 4,2 and 3,1 are "same". Assuming a higher mean
indicates greater pain, DRUGS 1,3 more effective in treating pain.

Now: Suppose the data were the results of assigning the 4 drugs
at random to 16 subjects, then 1-Way ANOVA gives:

```
PROC ANOVA DATA=PAIN;
CLASS SUBJ DRUG;
MODEL PAIN=DRUG;
MEANS DRUG/SNK;
RUN;
```

The ANOVA Procedure

Class Level Information

Class	Levels	Values
SUBJ	4	1 2 3 4
DRUG	4	1 2 3 4

Number of Observations Read	16
Number of Observations Used	16

Dependent Variable: PAIN

Source	DF	Sum of Squares	Mean Square	F Value
Model	3	50.2500000	16.7500000	2.41
Error	12	83.5000000	6.9583333	
Corrected Total	15	133.7500000		

Source	Pr > F
Model	0.1180
Error	
Corrected Total	

R-Square	Coeff Var	Root MSE	PAIN Mean
0.375701	30.58395	2.637865	8.625000

Source	DF	Anova SS	Mean Square	F Value
DRUG	3	50.25000000	16.75000000	2.41

Source	Pr > F
DRUG	0.1180

Student-Newman-Keuls Test for PAIN

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha	0.05
Error Degrees of Freedom	12
Error Mean Square	6.958333

Number of Means	2	3	4
Critical Range	4.0640501	4.9760399	5.5375686

Means with the same letter are not significantly different.

SNK Grouping	Mean	N	DRUG
A	10.500	4	4
A			
A	10.250	4	2
A			
A	7.250	4	3
A			
A	6.500	4	1

```
We see: Before with only 4 subjects, the ERROR SS was only  13.25
with df=9, and the drugs effects were significant. But now with 16
subjects, the ERROR SS absorbed the SUBJ SS 70.25 and is equal to
13.25 + 70.25 = 83.5 with df=12, and the drug effects are not significant.


We see: Controlling for between-subject variability reduces the error
SS, and allows us to identify small treatment differences with
relatively fewer subjects.


Now: use REPEATED option
-------------------------

Data must have the form: SUBJ PAIN1 PAIN2 PAIN3 PAIN4,
where PAIN1-PAIN4 are the dependent obs from each drug.
Notice: The reference to the DRUG factor is through its levels.


DATA REPEAT1;
INPUT SUBJ PAIN1-PAIN4;
DATALINES;
1  5  9  6  11
2  7 12  8   9
3 11 12 10  14
4  3  8  5   8
;

PROC PRINT DATA=REPEAT1;
ID SUBJ;
RUN;


           SUBJ    PAIN1    PAIN2    PAIN3    PAIN4

             1        5        9        6       11
             2        7       12        8        9
             3       11       12       10       14
             4        3        8        5        8
```

```
PROC ANOVA DATA=REPEAT1;
MODEL PAIN1-PAIN4 = /NOUNI;<--No univariate analysis for each pain variable.
REPEATED DRUG 4 (1 2 3 4);<--DRUG has 4 levels, labeled 1,2,3,4
RUN;
```

```
                              The SAS System


                           The ANOVA Procedure

               Number of Observations Read           4
               Number of Observations Used           4

                Repeated Measures Analysis of Variance

                 Repeated Measures Level Information

      Dependent Variable       PAIN1    PAIN2    PAIN3    PAIN4

           Level of DRUG           1        2        3        4


              MANOVA Test Criteria and Exact F Statistics
                  for the Hypothesis of no DRUG Effect
                     H = Anova SSCP Matrix for DRUG
                         E = Error SSCP Matrix

                         S=1    M=0.5    N=-0.5

Statistic                        Value  F Value  Num DF  Den DF  Pr > F

Wilks' Lambda               0.00909295    36.33       3       1  0.1212
Pillai's Trace              0.99090705    36.33       3       1  0.1212
Hotelling-Lawley Trace    108.97530864    36.33       3       1  0.1212
Roy's Greatest Root       108.97530864    36.33       3       1  0.1212
```

```
                    The ANOVA Procedure
           Repeated Measures Analysis of Variance
     Univariate Tests of Hypotheses for Within Subject Effects

Source                      DF       Anova SS    Mean Square   F Value

DRUG                         3    50.25000000    16.75000000     11.38
Error(DRUG)                  9    13.25000000     1.47222222

                                             Adj Pr > F
          Source                 Pr > F     G - G     H - F

          DRUG                   0.0020    0.0123    0.0020
          Error(DRUG)


                 Greenhouse-Geisser Epsilon    0.5998 <--GG-epsilon
                 Huynh-Feldt Epsilon           1.4433 <--HF-epsilon
```

Note:
The F test for DRUG is identical to the one from 2-Way ANOVA.

The adjusted p-valued G-G (Greenhouse-Geisser correction) and H-F (Huynh-Feldt correction) take into account correlation among the repeated measures and resort to the so called "sphericity assumption" where numerator and denominator degrees of freedom are multiplied by "epsilon", and the significance of the F ratio is evaluated with the new degrees of freedoms. Greenhouse-Geisser correction is more Conservative.

With REPEATED statement, to get pairwise comparisons use: CONTRAST(n).
In our case
DRUG CONTRAST(1) gives comparisons of 1 vs 2,3,4
DRUG CONTRAST(2) gives comparisons of 2 vs 1,3,4
DRUG CONTRAST(3) gives comparisons of 3 vs 1,2,4
This is equivalent to multiple t-tests.

For example:

```
PROC ANOVA DATA=REPEAT1;
MODEL PAIN1-PAIN4 = /NOUNI;
REPEATED DRUG 4 CONTRAST(1)/NOM SUMMARY; <--No Multivariate stats.
RUN;                                       SUMMARY requests ANOVA
```

```
                        The ANOVA Procedure

              Number of Observations Read          4
              Number of Observations Used          4

                        The ANOVA Procedure
               Repeated Measures Analysis of Variance

                Repeated Measures Level Information

      Dependent Variable       PAIN1    PAIN2    PAIN3    PAIN4

           Level of DRUG           1        2        3        4

                        The ANOVA Procedure
               Repeated Measures Analysis of Variance
      Univariate Tests of Hypotheses for Within Subject Effects

Source                     DF        Anova SS    Mean Square   F Value

DRUG                        3     50.25000000    16.75000000     11.38
Error(DRUG)                 9     13.25000000     1.47222222

                                                  Adj Pr > F
          Source                 Pr > F      G - G     H - F

          DRUG                   0.0020    0.0123    0.0020
          Error(DRUG)


                 Greenhouse-Geisser Epsilon    0.5998
                 Huynh-Feldt Epsilon           1.4433
```

The ANOVA Procedure
Repeated Measures Analysis of Variance
Analysis of Variance of Contrast Variables

DRUG_N represents the contrast between the nth level of DRUG and the 1st

Contrast Variable: DRUG_2

Source	DF	Anova SS	Mean Square	F Value
Mean	1	56.25000000	56.25000000	15.70
Error	3	10.75000000	3.58333333	

Source	Pr > F
Mean	0.0287 <-- 1 and 2 not "same"
Error	

NOTE: Apparently SAS is doing matched pair comparison with df=n-1=4-1=3
which makes sense if "wash-out" period is perceived too short.

Contrast Variable: DRUG_3

Source	DF	Anova SS	Mean Square	F Value
Mean	1	2.25000000	2.25000000	1.42
Error	3	4.75000000	1.58333333	

Source	Pr > F
Mean	0.3189 <--1 and 3 are "same"
Error	

```
                     The ANOVA Procedure
           Repeated Measures Analysis of Variance
         Analysis of Variance of Contrast Variables

DRUG_N represents the contrast between the nth level of DRUG and the
1st

Contrast Variable: DRUG_4


Source                     DF        Anova SS    Mean Square   F Value

Mean                        1     64.00000000    64.00000000     19.20
Error                       3     10.00000000     3.33333333

                    Source                Pr > F

                    Mean                  0.0220 <--1 and 4 are not "same"
                   Error
```

```
Now PROC MIXED
--------------
```

The previous analysis assumes the interest focuses on the 4 subjects only. But if we think of the subjects as being a sample from a large population of subjects, then we deal with subject random effects. Many would say this is the best way to analyze our data. We can judge this by AIC, BIC!!!

```
DATA PAIN;
INPUT SUBJ @;
DO DRUG=1 TO 4;
INPUT PAIN @;
OUTPUT;
END;
DATALINES;
1  5  9  6  11
2  7 12  8   9
3 11 12 10  14
4  3  8  5   8
;
```

```
PROC MIXED DATA=PAIN;
CLASS SUBJ DRUG;
MODEL PAIN=DRUG;
RANDOM SUBJ; <---Random component. Random effects.
RUN;
QUIT;
```

```
                          The SAS System

                       The Mixed Procedure

                        Model Information

        Data Set                     WORK.PAIN
        Dependent Variable           PAIN
        Covariance Structure         Variance Components
        Estimation Method            REML  <-----@@@@@ The default method.
        Residual Variance Method     Profile
        Fixed Effects SE Method      Model-Based
        Degrees of Freedom Method    Containment


                     Class Level Information

          Class    Levels    Values

          SUBJ          4    1 2 3 4
          DRUG          4    1 2 3 4

                           Dimensions

                 Covariance Parameters           2
                 Columns in X                    5
                 Columns in Z                    4
                 Subjects                        1
                 Max Obs Per Subject            16
```

```
                 Number of Observations

     Number of Observations Read              16
     Number of Observations Used              16
     Number of Observations Not Used           0

                   The Mixed Procedure

                    Iteration History

Iteration    Evaluations    -2 Res Log Like       Criterion

        0              1        62.87898203
        1              1        52.54100308      0.00000000


                 Convergence criteria met.


                 Covariance Parameter
                       Estimates

                 Cov Parm     Estimate

                 SUBJ           5.4861  <--Subject variance.
                 Residual       1.4722  <--Resid variance.


                    Fit Statistics

        -2 Res Log Likelihood           52.5
        AIC (smaller is better)         56.5
        AICC (smaller is better)        57.9
        BIC (smaller is better)         55.3
```

```
                    Type 3 Tests of Fixed Effects

                      Num     Den
        Effect         DF      DF    F Value    Pr > F

        DRUG            3       9      11.38    0.0020 <--Same as brfore
```

If we use fixed effects as in two-way ANOVA as before we get better
AIC and BIC(!!!) as we see next.

```
PROC MIXED DATA=PAIN;
   CLASS SUBJ DRUG;
   MODEL PAIN=SUBJ DRUG;   <--No RANDOM component!!!
   RUN;
   QUIT;
```

```
                         The Mixed Procedure

                          Model Information

        Data Set                     WORK.PAIN
        Dependent Variable           PAIN
        Covariance Structure         Diagonal
        Estimation Method            REML <-----@@@@@
        Residual Variance Method     Profile
        Fixed Effects SE Method      Model-Based
        Degrees of Freedom Method    Residual


                       Class Level Information

          Class    Levels    Values

          SUBJ          4    1 2 3 4
          DRUG          4    1 2 3 4
```

```
                 Dimensions

     Covariance Parameters            1
     Columns in X                     9
     Columns in Z                     0
     Subjects                         1
     Max Obs Per Subject             16


            Covariance Parameter
                  Estimates

            Cov Parm     Estimate

            Residual       1.4722


               Fit Statistics

    -2 Res Log Likelihood           37.3
    AIC (smaller is better)         39.3 <--Smaller
    AICC (smaller is better)        39.9
    BIC (smaller is better)         39.5 <--Smaller


          Type 3 Tests of Fixed Effects

                 Num     Den
Effect            DF      DF    F Value    Pr > F

SUBJ               3       9      15.91    0.0006
DRUG               3       9      11.38    0.0020
```

NOTE: This ANOVA is identical to 2-Way above.

==

Now compare with NON-RESTRICTED ML:

Recall the mixed effects model from above:

y_{ij}=mu + a_i + beta_j + epsilon_{ij}, i,j=1,2,3,4

```
OPTION PS=35 LS=70;

 DATA PAIN;
 INPUT SUBJ @;
 DO DRUG=1 TO 4;
 INPUT PAIN @;
 OUTPUT;
 END;
 DATALINES;
 1  5  9  6  11
 2  7 12  8   9
 3 11 12 10  14
 4  3  8  5   8
 ;

 PROC MIXED DATA=PAIN METHOD=ML; <--Default is REML.
 CLASS SUBJ DRUG;
 MODEL PAIN=DRUG;
 RANDOM SUBJ;
 RUN;
 QUIT;
```

```
                          The SAS System
                        The Mixed Procedure

                         Model Information

        Data Set                     WORK.PAIN
        Dependent Variable           PAIN
        Covariance Structure         Variance Components
        Estimation Method            ML  (Before it was REML)
        Residual Variance Method     Profile
        Fixed Effects SE Method      Model-Based
```

Degrees of Freedom Method   Containment

Class Level Information

Class	Levels	Values
SUBJ	4	1 2 3 4
DRUG	4	1 2 3 4

Dimensions

Covariance Parameters	2
Columns in X	5
Columns in Z	4
Subjects	1
Max Obs Per Subject	16

The Mixed Procedure

Number of Observations

Number of Observations Read	16
Number of Observations Used	16
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Log Like	Criterion
0	1	71.84215962	
1	1	58.05818768	0.00000000

Convergence criteria met.

Covariance Parameter
Estimates

```
                    Cov Parm     Estimate

                    SUBJ           4.1146 (With REML get 5.4861)
                    Residual       1.1042 (With REML get 1.4722)

                       Fit Statistics

            -2 Log Likelihood              58.1 (With REML get 52.5)
            AIC (smaller is better)        70.1 (With REML get 56.5)
            AICC (smaller is better)       79.4
            BIC (smaller is better)        66.4


            Type 3 Tests of Fixed Effects

                             Num     Den
    Effect         DF      DF    F Value    Pr > F

    DRUG            3       9      15.17    0.0007 (With REML get 0.002)
=====================================================================
```

```
Ex2. Two-Factor Repeated Experiment:
     Repeated measure on one factor.
--------------------------------------
```

Subjects are randomly assigned to control or treatment group. Then each subject is measured befored (PRE) and after (POST) treatment. The treatment for the conrol group is a placebo or no treatment at all.

```
GROUP     SUBJ    PRE  POST
----------------------------
          1       80    83
Control   2       85    86
          3       83    88
----------------------------   NOTE: Subject nested within group!
          4       82    94
Treatment 5       87    93
```

```
           6      84    98
----------------------------

Method I: Two-Sample t-test applied to the difference scores
          of POST-PRE to compare the difference means of the
          two groups. NOTE: Data assumed normal with equal variance.

For Control  : D1=3,  D2=1, D3=5
For Treatment: D1=12, D2=6, D3=14

H_0: mu_C = mu_T,      H_1: mu_C not equal mu_T


DATA PREPOST;
INPUT SUBJ  GROUP $ PRE POST;
DIFF = POST-PRE;
DATALNES;
1 C 80 83
2 C 85 86
3 C 83 88
4 T 82 94
5 T 87 93
6 T 84 98
;



PROC TTEST DATA=PREPOST;
CLASS GROUP;
VAR DIFF;
RUN;


                               The SAS System


                            The TTEST Procedure

                                Statistics
```

```
                                      Lower CL            Upper CL  Lower CL
 Variable  GROUP              N          Mean      Mean      Mean   Std Dev

 DIFF      C                  3        -1.968         3    7.9683    1.0413
 DIFF      T                  3        0.3244    10.667    21.009    2.1677
 DIFF      Diff (1-2)                  -15.07    -7.667    -0.263    1.9568

                                   Statistics

                                        Upper CL
 Variable  GROUP            Std Dev    Std Dev   Std Err   Minimum   Maximum

 DIFF      C                      2     12.569    1.1547         1         5
 DIFF      T                 4.1633     26.165    2.4037         6        14
 DIFF      Diff (1-2)         3.266      9.385    2.6667


                                    T-Tests

Variable     Method           Variances      DF     t Value     Pr > |t|

DIFF         Pooled           Equal           4       -2.88       0.0452 <--
DIFF         Satterthwaite    Unequal      2.88       -2.88       0.0671


                            Equality of Variances

    Variable     Method       Num DF    Den DF    F Value     Pr > F

    DIFF         Folded F          2         2       4.33     0.3750


Check:
-------
Bar(Diff_C) - Bar(Diff_T) = 3-10.667 = -7.667
StdError(Bar(Diff_C) - Bar(Diff_T)) = 2.6667 with 4 df

> -7.667/2.6667
[1] -2.875089 approx -2.88 OK.
```

```
> pt(-2.87508,4)*2
[1] 0.04523655 approx 0.0452 OK.
```

Thus, at alpha=0.05, the treatment mean difference is significantly different from the control mean difference.

Method II: Two-way ANOVA with factors GROUP and TIME, with TIME as a repeated measure.

```
DATA PREPOST;
INPUT SUBJ  GROUP $ PRE POST;
DIFF = POST-PRE;
DATALNES;
1 C 80 83
2 C 85 86
3 C 83 88
4 T 82 94
5 T 87 93
6 T 84 98
;

PROC ANOVA DATA=PREPOST;
CLASS GROUP;
MODEL PRE POST = GROUP/NOUNI;
REPEATD TIME 2 (0 1);
MEANS GROUP;
RUN;
```

```
                         The ANOVA Procedure

                       Class Level Information

                    Class         Levels    Values
                    GROUP              2    C T


               Number of Observations Read           6
               Number of Observations Used           6
```

```
              Repeated Measures Analysis of Variance

               Repeated Measures Level Information

             Dependent Variable         PRE     POST

                  Level of TIME           0        1

           MANOVA Test Criteria and Exact F Statistics
               for the Hypothesis of no TIME Effect
                  H = Anova SSCP Matrix for TIME
                      E = Error SSCP Matrix

                       S=1    M=-0.5    N=1

Statistic                        Value  F Value  Num DF  Den DF  Pr > F

Wilks' Lambda               0.13216314    26.27       1       4  0.0069
Pillai's Trace              0.86783686    26.27       1       4  0.0069
Hotelling-Lawley Trace      6.56640625    26.27       1       4  0.0069
Roy's Greatest Root         6.56640625    26.27       1       4  0.0069



                       The ANOVA Procedure
              Repeated Measures Analysis of Variance

           MANOVA Test Criteria and Exact F Statistics
            for the Hypothesis of no TIME*GROUP Effect
               H = Anova SSCP Matrix for TIME*GROUP
                      E = Error SSCP Matrix

                       S=1    M=-0.5    N=1

Statistic                        Value  F Value  Num DF  Den DF  Pr > F

Wilks' Lambda               0.32611465     8.27       1       4  0.0452
Pillai's Trace              0.67388535     8.27       1       4  0.0452
```

```
Hotelling-Lawley Trace    2.06640625     8.27        1        4  0.0452
Roy's Greatest Root       2.06640625     8.27        1        4  0.0452


                         The ANOVA Procedure
                Repeated Measures Analysis of Variance
           Tests of Hypotheses for Between Subjects Effects

Source                     DF        Anova SS    Mean Square   F Value

GROUP                       1     90.75000000    90.75000000     11.84
Error                       4     30.66666667     7.66666667

                    Source                 Pr > F

                    GROUP                  0.0263 <---Groups are different.
                    Error

                         The ANOVA Procedure
                Repeated Measures Analysis of Variance
      Univariate Tests of Hypotheses for Within Subject Effects

Source                     DF        Anova SS    Mean Square   F Value

TIME                        1     140.0833333    140.0833333     26.27
TIME*GROUP                  1      44.0833333     44.0833333      8.27
Error(TIME)                 4      21.3333333      5.3333333

                    Source                 Pr > F

                    TIME                   0.0069
                    TIME*GROUP             0.0452<--Interaction significant
                    Error(TIME)

                         The ANOVA Procedure

 Level of     ------------PRE-----------  -----------POST-----------
 GROUP     N          Mean       Std Dev          Mean       Std Dev

 C         3    82.6666667    2.51661148    85.6666667    2.51661148
```

```
 T         3    84.3333333    2.51661148    95.0000000    2.64575131
```

Interesting to compare with simple TWO-WAY ANOVA with GROUP at 2 levels and TIME at 2 levels as factors, and 3 obs/cell.

```
DATA PREPOST;
INPUT GROUP $ TIME $ Y @@;
DATALNES;
C PRE 80 C POST 83
C PRE 85 C POST 86
C PRE 83 C POST 88
T PRE 82 T POST 94
T PRE 87 T POST 93
T PRE 84 T POST 98
;

PROC ANOVA DATA=PREPOST;
CLASS GROUP TIME;
MODEL Y = GROUP TIME GROUP*TIME;
RUN;
```

```
                         The ANOVA Procedure

                       Class Level Information

                  Class         Levels    Values

                  GROUP              2    C T
                  TIME               2    POST PRE

               Number of Observations Read          12
               Number of Observations Used          12


Dependent Variable: Y

                                           Sum of
Source                     DF         Squares    Mean Square   F Value
```

```
Model                  1+1+1=3    274.9166667     91.6388889     14.10
Error              2*2*(3-1)=8     52.0000000      6.5000000
Corrected Total        12-1=11    326.9166667

                    Source                 Pr > F

                    Model                  0.0015
                    Error
                    Corrected Total


          R-Square     Coeff Var      Root MSE        Y Mean

          0.840938      2.933281      2.549510      86.91667


Source                      DF        Anova SS    Mean Square   F Value

GROUP                        1      90.7500000     90.7500000     13.96
TIME                         1     140.0833333    140.0833333     21.55

                    Source                 Pr > F

                    GROUP                  0.0057 <--Sig
                    TIME                   0.0017 <--Sig


Dependent Variable: Y

Source                      DF        Anova SS    Mean Square   F Value

GROUP*TIME        (2-1)(2-1)=1      44.0833333     44.0833333      6.78

                    Source                 Pr > F

                    GROUP*TIME             0.0314 <--Sig
```