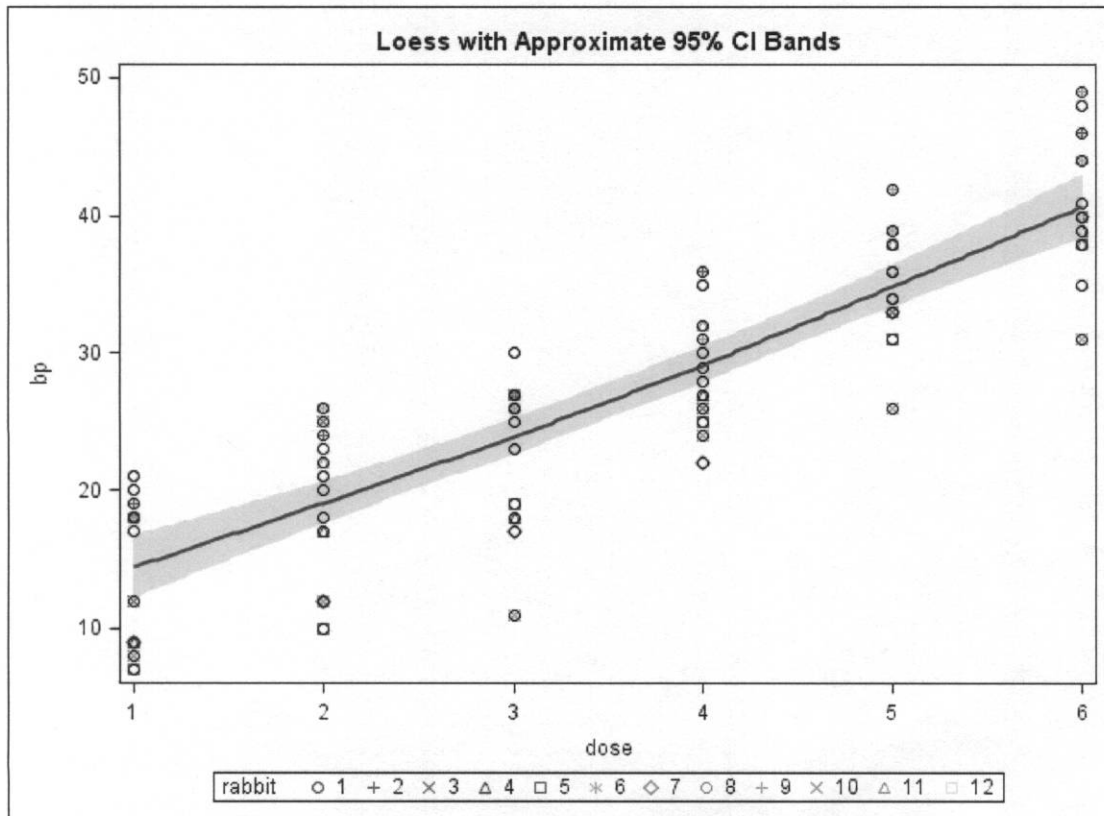
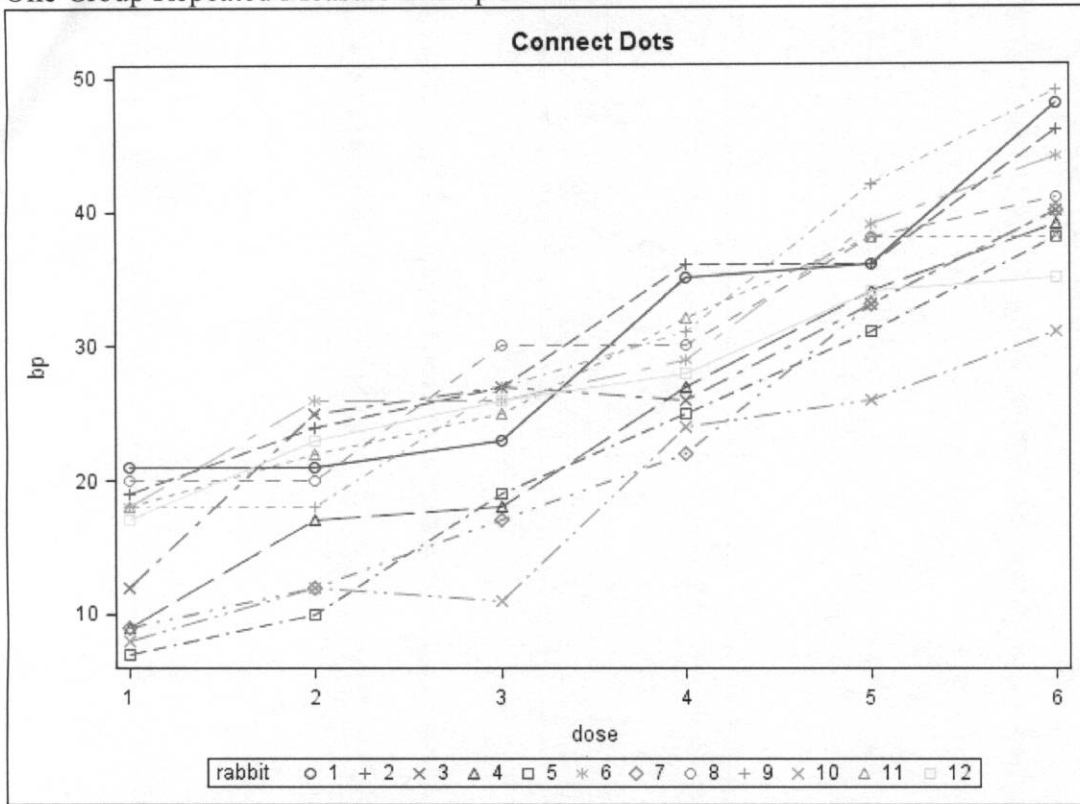


One Group Repeated Measure Example 4-26 -10



```
data rabbit;  
input bp rabbit dose;  
cards;  
21.0 1 1  
21.0 1 2  
23.0 1 3  
35.0 1 4  
36.0 1 5  
48.0 1 6  
19.0 2 1  
24.0 2 2  
27.0 2 3  
36.0 2 4  
36.0 2 5  
46.0 2 6  
12.0 3 1  
25.0 3 2  
27.0 3 3  
26.0 3 4  
33.0 3 5  
40.0 3 6  
9.0 4 1  
17.0 4 2  
18.0 4 3  
27.0 4 4  
34.0 4 5  
39.0 4 6  
7.0 5 1  
10.0 5 2  
19.0 5 3  
25.0 5 4  
31.0 5 5  
38.0 5 6  
18.0 6 1  
26.0 6 2  
26.0 6 3  
29.0 6 4  
39.0 6 5  
44.0 6 6  
9.0 7 1  
12.0 7 2  
17.0 7 3  
22.0 7 4  
33.0 7 5  
40.0 7 6  
20.0 8 1  
20.0 8 2  
30.0 8 3  
30.0 8 4  
38.0 8 5  
41.0 8 6  
18.0 9 1  
18.0 9 2  
27.0 9 3
```

31.0	9	4
42.0	9	5
49.0	9	6
8.0	10	1
12.0	10	2
11.0	10	3
24.0	10	4
26.0	10	5
31.0	10	6
18.0	11	1
22.0	11	2
25.0	11	3
32.0	11	4
38.0	11	5
38.0	11	6
17.0	12	1
23.0	12	2
26.0	12	3
28.0	12	4
34.0	12	5
35.0	12	6

```

;
run;
title "Independent Subjects Approach";
proc mixed data=rabbit ;
class rabbit dose;
model bp=dose;
repeated/type=vc subject=rabbit r rcorr;
lsmeans dose/ pdiff=control cl adjust=bon;
run; quit;
title;
title "Repeated Measure Approach Unstructured Covariance";
proc mixed data=rabbit ;
class rabbit dose;
model bp=dose;
repeated/type=un subject=rabbit r rcorr;
lsmeans dose/ pdiff=control cl adjust=bon ;
run; quit;
title;

```

```

proc sort data=rabbit out=rabbit;
by dose;
run;
title "Connect Dots";
proc sgplot data=rabbit;
scatter x=dose y=bp/ group=rabbit ;
series x=dose y=bp / group=rabbit ;
run;
title;
title "Loess with Approximate 95% CI Bands";
proc sgplot data=rabbit;
scatter x=dose y=bp/ group=rabbit ;
loess x=dose y=bp/clm ;
run;
title;

```

Here we decide to perform 5 contrasts. All levels 2-6 will be compared to level 1

α familywise = .05

$$\frac{\alpha^*}{5} = \frac{.05}{5} = .01 \text{ so we would need to look up } t \text{ (df error, } \frac{.01}{2} \text{)}$$

Independent Subjects Approach

The Mixed Procedure

Model Information

Data Set	WORK.RABBIT
Dependent Variable	bp
Covariance Structure	Variance Components
Subject Effect	rabbit
Estimation Method	REML
Residual Variance Method	Parameter
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

All subjects independent,
same variance estimate
of all doses.

Class Level Information

Class	Levels	Values
rabbit	12	1 2 3 4 5 6 7 8 9 10 11 12
dose	6	1 2 3 4 5 6

Dimensions

Covariance Parameters	1
Columns in X	7
Columns in Z	0
Subjects	12
Max Obs Per Subject	6

Number of Observations

Number of Observations Read	72
Number of Observations Used	72
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	415.24581293	
1	1	415.24581293	0.00000000

Convergence criteria met.

Independent Subjects Approach

The Mixed Procedure

Estimated R Matrix for rabbit 1

Variance
Covariance matrix

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	25.2247					
2		25.2247				
3			25.2247			
4				25.2247		
5					25.2247	
6						25.2247

Estimated R Correlation Matrix for rabbit 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000					
2		1.0000				
3			1.0000			
4				1.0000		
5					1.0000	
6						1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
Residual	rabbit	25.2247

Fit Statistics

-2 Res Log Likelihood	415.2
AIC (smaller is better)	417.2
AICC (smaller is better)	417.3
BIC (smaller is better)	417.7

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
0	0.00	1.0000

Independent Subjects Approach

The Mixed Procedure

Type 3 Tests of Fixed Effects

$H_0: \mu_{d_1} = \mu_{d_2} = \dots = \mu_{d_6}$

$$\sqrt{\frac{S^2}{n}} = \sqrt{\frac{25.2247}{12}} = 1.4498$$

Effect	Num DF	Den DF	F Value	Pr > F
dose	5	55	46.19	<.0001

Least Squares Means

Effect	dose	Estimate	Standard Error	DF	t Value	Pr > t	Alpha	Lower	Upper
dose	1	14.6667	1.4498	55	10.12	<.0001	0.05	11.7611	17.5722
dose	2	19.1667	1.4498	55	13.22	<.0001	0.05	16.2611	22.0722
dose	3	23.0000	1.4498	55	15.86	<.0001	0.05	20.0944	25.9056
dose	4	28.7500	1.4498	55	19.83	<.0001	0.05	25.8444	31.6556
dose	5	35.0000	1.4498	55	24.14	<.0001	0.05	32.0944	37.9056
dose	6	40.7500	1.4498	55	28.11	<.0001	0.05	37.8444	43.6556

Differences of Least Squares Means

Effect	dose	_dose	Estimate	Standard Error	DF	t Value	Pr > t	Adjustment	Adj P	Alpha
dose	2	1	4.5000	2.0504	55	2.19	0.0324	Bonferroni	0.1621	0.05
dose	3	1	8.3333	2.0504	55	4.06	0.0002	Bonferroni	0.0008	0.05
dose	4	1	14.0833	2.0504	55	6.87	<.0001	Bonferroni	<.0001	0.05
dose	5	1	20.3333	2.0504	55	9.92	<.0001	Bonferroni	<.0001	0.05
dose	6	1	26.0833	2.0504	55	12.72	<.0001	Bonferroni	<.0001	0.05

not significant
significant

$t(.005, 55) \approx 2.576$

Differences of Least Squares Means

Effect	dose	_dose	Lower	Upper	Adj Lower	Adj Upper
dose	2	1	0.3909	8.6091	-0.9709	9.9709
dose	3	1	4.2242	12.4424	2.8624	13.8042
dose	4	1	9.9742	18.1924	8.6124	19.5542
dose	5	1	16.2242	24.4424	14.8624	25.8042
dose	6	1	21.9742	30.1924	20.6124	31.5542

$$\sqrt{S^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)} = \sqrt{25.2247 \left(\frac{1}{12} + \frac{1}{12} \right)}$$

$= 2.0504$

compare to 1.32 for repeated

Repeated Measure Approach Unstructured Covariance

The Mixed Procedure

Model Information

Data Set	WORK.RABBIT
Dependent Variable	bp
Covariance Structure	Unstructured
Subject Effect	rabbit
Estimation Method	REML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information

Class	Levels	Values
rabbit	12	1 2 3 4 5 6 7 8 9 10 11 12
dose	6	1 2 3 4 5 6

Dimensions

Covariance Parameters	21
Columns in X	7
Columns in Z	0
Subjects	12
Max Obs Per Subject	6

Number of Observations

Number of Observations Read	72
Number of Observations Used	72
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	415.24581293	
1	1	350.44432161	0.00000000

Convergence criteria met.

Repeated Measure Approach Unstructured Covariance

The Mixed Procedure

Estimated R Matrix for rabbit 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	27.3333	20.8788	23.0909	19.1818	16.7273	17.0909
2	20.8788	29.4242	23.4545	14.3182	12.6364	11.0455
3	23.0909	23.4545	30.9091	14.7273	18.2727	16.4545
4	19.1818	14.3182	14.7273	18.3864	11.1818	15.0227
5	16.7273	12.6364	18.2727	11.1818	17.4545	16.8182
6	17.0909	11.0455	16.4545	15.0227	16.8182	27.8409

Covariances

different variance estimates

Estimated R Correlation Matrix for rabbit 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.7362	0.7944	0.8556	0.7658	0.6196
2	0.7362	1.0000	0.7777	0.6156	0.5576	0.3859
3	0.7944	0.7777	1.0000	0.6178	0.7867	0.5609
4	0.8556	0.6156	0.6178	1.0000	0.6242	0.6640
5	0.7658	0.5576	0.7867	0.6242	1.0000	0.7629
6	0.6196	0.3859	0.5609	0.6640	0.7629	1.0000

Correlations

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
UN(1,1)	rabbit	27.3333
UN(2,1)	rabbit	20.8788
UN(2,2)	rabbit	29.4242
UN(3,1)	rabbit	23.0909
UN(3,2)	rabbit	23.4545
UN(3,3)	rabbit	30.9091
UN(4,1)	rabbit	19.1818
UN(4,2)	rabbit	14.3182
UN(4,3)	rabbit	14.7273
UN(4,4)	rabbit	18.3864
UN(5,1)	rabbit	16.7273
UN(5,2)	rabbit	12.6364
UN(5,3)	rabbit	18.2727
UN(5,4)	rabbit	11.1818
UN(5,5)	rabbit	17.4545
UN(6,1)	rabbit	17.0909
UN(6,2)	rabbit	11.0455
UN(6,3)	rabbit	16.4545
UN(6,4)	rabbit	15.0227
UN(6,5)	rabbit	16.8182
UN(6,6)	rabbit	27.8409

Repeated Measure Approach Unstructured Covariance

The Mixed Procedure

Fit Statistics

-2 Res Log Likelihood	350.4
AIC (smaller is better)	392.4
AICC (smaller is better)	413.4
BIC (smaller is better)	402.6

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
20	64.80	<.0001

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
dose	5	11	120.60	<.0001

Least Squares Means

Effect	dose	Estimate	Standard Error	DF	t Value	Pr > t	Alpha	Lower	Upper
dose	1	14.6667	1.5092	11	9.72	<.0001	0.05	11.3449	17.9885
dose	2	19.1667	1.5659	11	12.24	<.0001	0.05	15.7202	22.6132
dose	3	23.0000	1.6049	11	14.33	<.0001	0.05	19.4676	26.5324
dose	4	28.7500	1.2378	11	23.23	<.0001	0.05	26.0256	31.4744
dose	5	35.0000	1.2060	11	29.02	<.0001	0.05	32.3455	37.6545
dose	6	40.7500	1.5232	11	26.75	<.0001	0.05	37.3975	44.1025

↑
 notice all different

$$\sqrt{\frac{9^2 s_i^2}{n_i}} = \sqrt{\frac{27.8409}{12}} = 1.5232$$

Repeated Measure Approach Unstructured Covariance

The Mixed Procedure

Differences of Least Squares Means

Effect	dose	_dose	Estimate	Standard Error	DF	t Value	Pr > t	Adjustment	Adj P	Alpha
dose	2	1	4.5000	1.1180	11	4.02	0.0020	Bonferroni	0.0100	0.05
dose	3	1	8.3333	1.0025	11	8.31	<.0001	Bonferroni	<.0001	
dose	4	1	14.0833	0.7829	11	17.99	<.0001	Bonferroni	<.0001	
dose	5	1	20.3333	0.9718	11	20.92	<.0001	Bonferroni	<.0001	
dose	6	1	26.0833	1.3226	11	19.72	<.0001	Bonferroni	<.0001	

All significant

Differences of Least Squares Means

Effect	dose	_dose	Lower	Upper	Adj Lower	Adj Upper
dose	2	1	2.0392	6.9608	1.0276	7.9724
dose	3	1	6.1268	10.5399	5.2197	11.4470
dose	4	1	12.3601	15.8066	11.6517	16.5150
dose	5	1	18.1944	22.4723	17.3150	23.3516
dose	6	1	23.1722	28.9944	21.9755	30.1912

Notice a different conclusion than with non repeated design.

$t(11, .005) = 3.106$

$26.0833 \pm 3.106(1.3226)$

1 vs 6

$$\sqrt{\frac{\text{var } 1}{12} + \frac{\text{var } 6}{12} - (2) \frac{\text{covar } 1,6}{12}}$$

$$= \sqrt{\frac{27.3333}{12} + \frac{27.8409}{12} - \frac{17.0909}{12}} = 1.32$$

Compare to 2.05 for non repeated