	Y	Group	X1	X2	D1	D2	C1	C2	M
1	10	1	1	0	0	0	0.5	1	9
2	9	1	1	0	0	0	0.5	1	9
3	8	1	1	0	0	0	0.5	1	9
4	12	2	0	1	1	0	0.5	-1	11
5	11	2	0	1	1	0	0.5	-1	11
6	10	2	0	1	1	0	0.5	-1	11
7	8	3	0	0	0	1	-1.0	0	7
8	7	3	0	0	0	1	-1.0	0	7
9	6	3	0	0	0	1	-1.0	0	7

Report

Y

Group	Mean	N	Std. Deviation
Treatment 1 (Group=1) (X1 = 1)(X2 = 0) (D1 = 0)(D2 = 0) (C1 = 0.5)(C2 = 1)	9.0000	3	1.0000
Treatment 2 (Group=2) (X1 = 0)(X2 = 1) (D1 = 0)(D2 = 1) (C1 = 0.5)(C2 = -1)	11.0000	3	1.0000
Control (Group=3) (X1 = 0)(X2 = 0) (D1 = 0)(D2 = 1) (C1 = -1)(C2 = 0)	7.0000	3	1.0000
Total	9.0000	9	1.9365

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.447	.200	.086	1.8516

a Predictors: (Constant), Group

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.000	1	6.000	1.750	.227[a]
	Residual	24.000	7	3.429		
	Total	30.000	8			

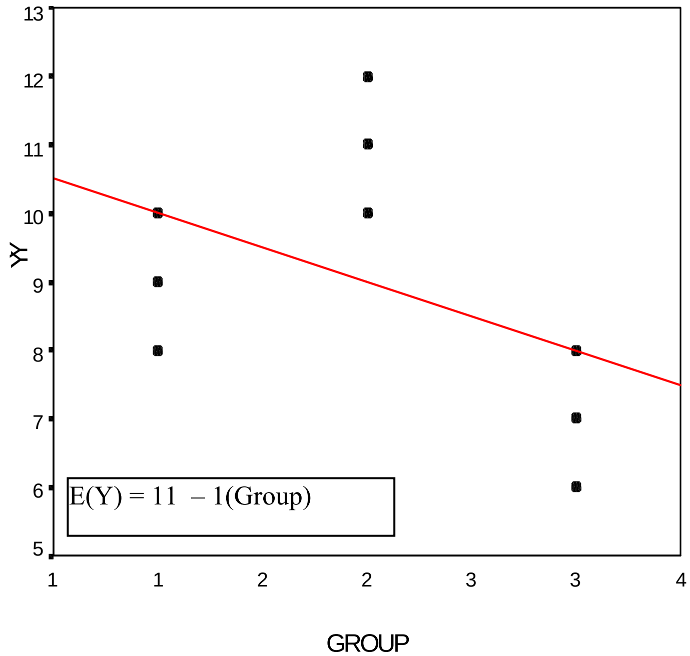
a Predictors: (Constant), Group
b Dependent Variable: Y

$R^2 = 6/30$
$R^2 = 0.200$

Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	11.000	1.633		6.736	.000	7.139	14.861
	Group	-1.000	.756	-.447	-1.323	.227	-2.787	.787

a Dependent Variable: Y



Report

Y

Group	Mean	N	Std. Deviation
Treatment 1 (Group=1) (X1 = 1)(X2 = 0) (D1 = 0)(D2 = 0) (C1 = 0.5)(C2 = 1)	9.0000	3	1.0000
Treatment 2 (Group=2) (X1 = 0)(X2 = 1) (D1 = 0)(D2 = 1) (C1 = 0.5)(C2 = -1)	11.0000	3	1.0000
Control (Group=3) (X1 = 0)(X2 = 0) (D1 = 0)(D2 = 1) (C1 = -1)(C2 = 0)	7.0000	3	1.0000
Total	9.0000	9	1.9365

ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
Y * X	Between Groups	24.000	2	12.000	12.000	.008
	Within Groups	6.000	6	1.000		
	Total	30.000	8			

Measures of Association

	Eta	Eta Squared
Y * X	.894	.800

$R^2 = 24/30 = 0.800$

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Y

	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	-2.0000	.8165	.109	-4.5052	.5052
		3.00	2.0000	.8165	.109	-.5052	4.5052
	2.00	1.00	2.0000	.8165	.109	-.5052	4.5052
		3.00	4.0000*	.8165	.006	1.4948	6.5052
	3.00	1.00	-2.0000	.8165	.109	-4.5052	.5052
		2.00	-4.0000*	.8165	.006	-6.5052	-1.4948
LSD	1.00	2.00	-2.0000*	.8165	.050	-3.9979	-.002105
		3.00	2.0000*	.8165	.050	.002105	3.9979
	2.00	1.00	2.0000*	.8165	.050	.002105	3.9979
		3.00	4.0000*	.8165	.003	2.0021	5.9979
	3.00	1.00	-2.0000*	.8165	.050	-3.9979	-002105
		2.00	-4.0000*	.8165	.003	-5.9979	-2.0021

* The mean difference is significant at the .05 level.

Homogeneous Subsets

Y

	GROUP	N	Subset for alpha = .05: 1	2
Tukey HSD	3.00	3	7.0000	
	1.00	3	9.0000	9.0000
	2.00	3		11.0000
	Sig.		.109	.109

Means for groups in homogeneous subsets are displayed.

Descriptive Statistics

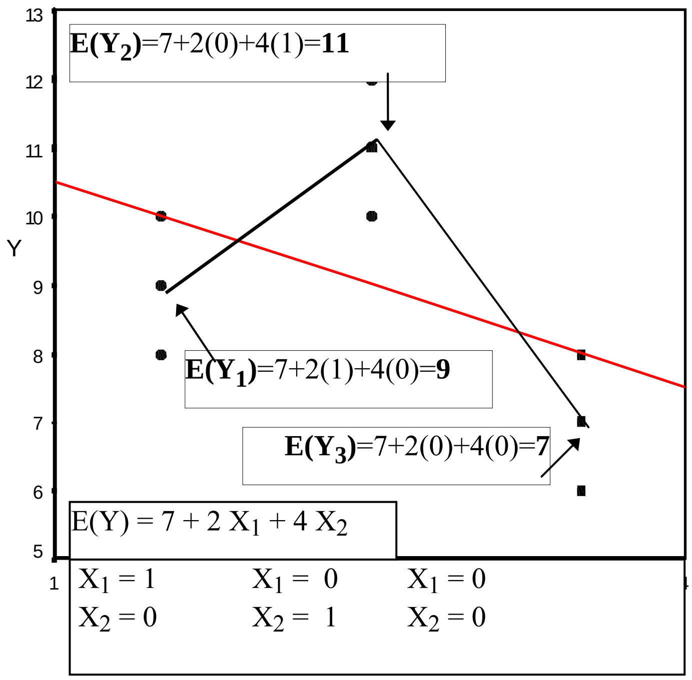
	Mean	Std. Deviation	N
Y	9.0000	1.9365	9
Group	2.0000	.8660	9
X1	.3333	.5000	9
X2	.3333	.5000	9
D1	.3333	.5000	9
D2	.3333	.5000	9
C1	.0000	.7500	9
C2	.0000	.8660	9
M	9.000	1..7321	9

	Y	Group	X1	X2	D1	D2	C1	C2	M
1	10	1	1	0	0	0	0.5	1	9
2	9	1	1	0	0	0	0.5	1	9
3	8	1	1	0	0	0	0.5	1	9
4	12	2	0	1	1	0	0.5	-1	11
5	11	2	0	1	1	0	0.5	-1	11
6	10	2	0	1	1	0	0.5	-1	11
7	8	3	0	0	0	1	-1.0	0	7
8	7	3	0	0	0	1	-1.0	0	7
9	6	3	0	0	0	1	-1.0	0	7

Correlations

		Y	Group	X1	X2	D1	D2	C1	C2	M
Y	Pearson Correlation	1.000	-.447	.000	.775*	.775*	-.775*	.775*	-.447	.894*
	Sig. (2-tailed)	.	.227	1.000	.014	.014	.014	.014	.227	.001
	N	9	9	9	9	9	9	9	9	9
Group	Pearson Correlation	-.447	1.000	-.866*	.000	.000	.866*	-.866*	-.500	-.500
	Sig. (2-tailed)	.227	.	.003	1.000	1.000	.003	.003	.170	.170
	N	9	9	9	9	9	9	9	9	9
X1	Pearson Correlation	.000	-.866*	1.000	-.500	-.500	-.500	.500	.866*	.000
	Sig. (2-tailed)	1.000	.003	.	.170	.170	.170	.170	.003	1.000
	N	9	9	9	9	9	9	9	9	9
X2	Pearson Correlation	.775*	.000	-.500	1.000	1.000	-.500	.500	-.866*	.866*
	Sig. (2-tailed)	.014	1.000	.170	.	.000	.170	.170	.003	.003
	N	9	9	9	9	9	9	9	9	9
D1	Pearson Correlation	.775*	.000	-.500	1.000	1.000	-.500	.500	-.866*	.866*
	Sig. (2-tailed)	.014	1.000	.170	.000	.	.170	.170	.003	.003
	N	9	9	9	9	9	9	9	9	9
D2	Pearson Correlation	-.775*	.866*	-.500	-.500	-.500	1.000	-1.000	.000	-.866*
	Sig. (2-tailed)	.014	.003	.170	.170	.170	.	.000	1.000	.003
	N	9	9	9	9	9	9	9	9	9
C1	Pearson Correlation	.775*	-.866*	.500	.500	.500	-1.000	1.000	.000	.866*
	Sig. (2-tailed)	.014	.003	.170	.170	.170	.000	.	1.000	.003
	N	9	9	9	9	9	9	9	9	9
C2	Pearson Correlation	-.447	-.500	.866*	-.866*	-.866*	.000	.000	1.000	-.500
	Sig. (2-tailed)	.227	.170	.003	.003	.003	1.000	1.000	.	.170
	N	9	9	9	9	9	9	9	9	9
M	Pearson Correlation	.894*	-.500	.000	.866*	.866*	-.866*	.866*	-.500	1.000
	Sig. (2-tailed)	.001	.170	1.000	.003	.003	.003	.003	.170	.
	N	9	9	9	9	9	9	9	9	9

* Correlation is significant at the 0.05 level (2-tailed).



Report

Y

Group	Mean	N	Std. Deviation
Treatment 1 (Group=1) (X1 = 1)(X2 = 0) (D1 = 0)(D2 = 0) (C1 = 0.5)(C2 = 1)	9.0000	3	1.0000
Treatment 2 (Group=2) (X1 = 0)(X2 = 1) (D1 = 0)(D2 = 1) (C1 = 0.5)(C2 = -1)	11.0000	3	1.0000
Control (Group=3) (X1 = 0)(X2 = 0) (D1 = 0)(D2 = 1) (C1 = -1)(C2 = 0)	7.0000	3	1.0000
Total	9.0000	9	1.9365

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.894	.800	.733	1.0000

a Predictors: (Constant), X2, X1

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.000	2	12.000	12.000	.008[a]
	Residual	6.000	6	1.000		
	Total	30.000	8			

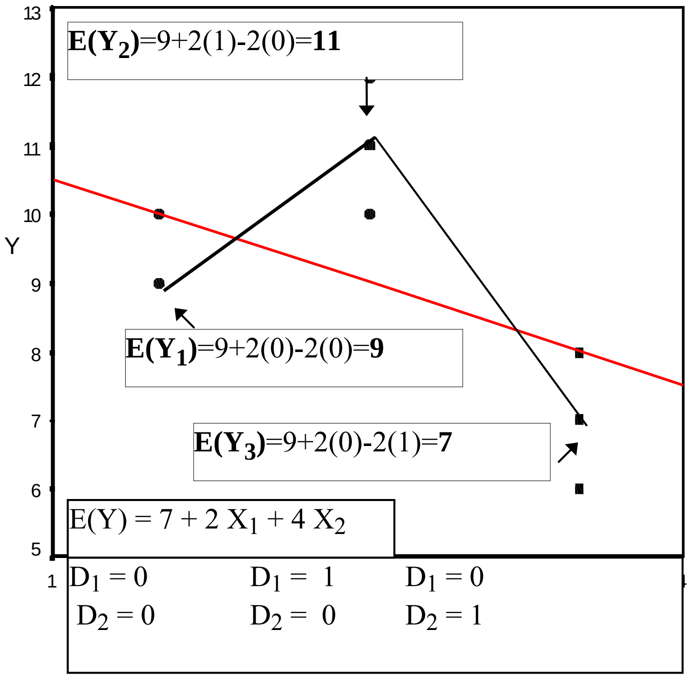
a Predictors: (Constant), X2, X1
b Dependent Variable: Y

$R^2 = 24/30$
$R^2 = 0.800$

Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound	Correlations Zero order	Correlations Partial	Correlations Part
1	(Constant)	7.000	.577		12.124	.000	5.587	8.413			
	X1	2.000	.816	.516	2.449	.050	.002	3.998	.000	.707	.447
	X2	4.000	.816	1.033	4.899	.005	2.002	5.998	.775	.894	.894

a Dependent Variable: Y



Report

Y

Group	Mean	N	Std. Deviation
Treatment 1 (Group=1) (X1 = 1)(X2 = 0) (D1 = 0)(D2 = 0) (C1 = 0.5)(C2 = 1)	9.0000	3	1.0000
Treatment 2 (Group=2) (X1 = 0)(X2 = 1) (D1 = 0)(D2 = 1) (C1 = 0.5)(C2 = -1)	11.0000	3	1.0000
Control (Group=3) (X1 = 0)(X2 = 0) (D1 = 0)(D2 = 1) (C1 = -1)(C2 = 0)	7.0000	3	1.0000
Total	9.0000	9	1.9365

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.894	.800	.733	1.0000

a Predictors: (Constant), X2, X1

ANOVAb

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.000	2	12.000	12.000	.008a
	Residual	6.000	6	1.000		
	Total	30.000	8			

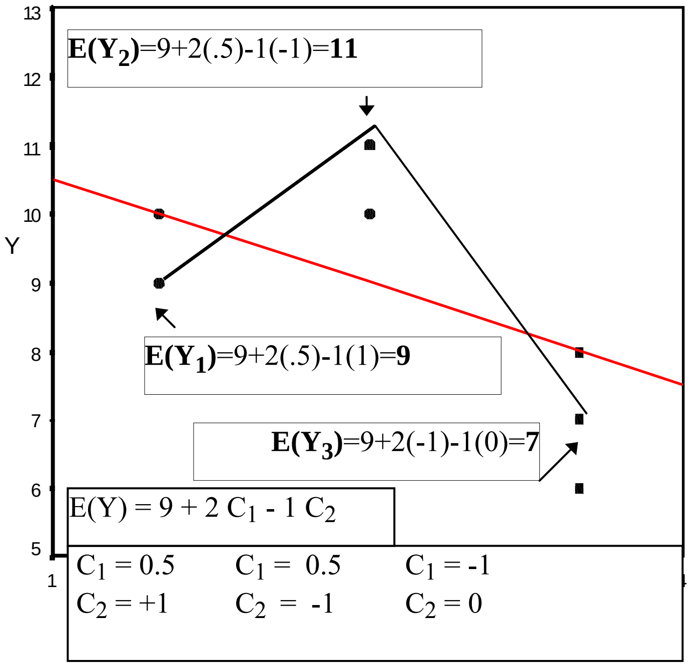
a Predictors: (Constant), X2, X1
b Dependent Variable: Y

$R^2 = 24/30$
$R^2 = 0.800$

Coefficients

		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero order	Partial	Part
1	(Constant)	9.000	.577		15.588	.000	7.587	10.413			
	D1	2.000	.816	.516	2.449	.050	.002	3.998	.775	.707	.447
	D2	-2.000	.816	-.516	-2.449	.050	-3.998	-.002	-.775	-.707	-.447

a Dependent Variable: Y



Report

Y

Group	Mean	N	Std. Deviation
Treatment 1 (Group=1) (X1 = 1)(X2 = 0) (D1 = 0)(D2 = 0) (C1 = 0.5)(C2 = 1)	9.0000	3	1.0000
Treatment 2 (Group=2) (X1 = 0)(X2 = 1) (D1 = 0)(D2 = 1) (C1 = 0.5)(C2 = -1)	11.0000	3	1.0000
Control (Group=3) (X1 = 0)(X2 = 0) (D1 = 0)(D2 = 1) (C1 = -1)(C2 = 0)	7.0000	3	1.0000
Total	9.0000	9	1.9365

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.894	.800	.733	1.0000

a Predictors: (Constant), C2, C1

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.000	2	12.000	12.000	.008[a]
	Residual	6.000	6	1.000		
	Total	30.000	8			

a Predictors: (Constant), C2, C1
b Dependent Variable: Y

$R^2 = 24/30$
$R^2 = 0.800$

Coefficients

		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero order	Partial	Part
1	(Constant)	9.000	.333		27.000	.000	8.184	9.816			
	C1	2.000	.471	.775	4.243	.005	.847	3.153	.775	.866	.775
	C2	-1.000	.408	-.447	-2.449	.050	-1.999	-.001	-.447	-.707	-.447

a Dependent Variable: Y

$\Sigma r^2 =$ .800 $\Sigma r^2 =$ .800

For Dummy Codes Xs = 1 or 0 General Linear Model: $Y_{ij} = \mu^* + \alpha_j + \varepsilon_{ij}$

Statistical Model	Y_i =	a	$+b_1X_{1i}$	$+b_2X_{2i}$	$+ e_i$	Y_{ij} =	$\bar{Y}*$	$+ a_j$	$+ e_{ij}$
	10 =	7	+2(1)	+ 4(0)	+ 1	10 =	9	+ 0	+ 1
	9 =	7	+2(1)	+ 4(0)	+ 0	9 =	9	+ 0	+ 0
	8 =	7	+2(1)	+ 4(0)	- 1	8 =	9	+ 0	- 1
	12 =	7	+2(0)	+ 4(1)	+ 1	12 =	9	+ 2	+ 1
	11 =	7	+2(0)	+ 4(1)	+ 0	11 =	9	+ 2	+ 0
	10 =	7	+2(0)	+ 4(1)	- 1	10 =	9	+ 2	- 1
	8 =	7	+2(0)	+ 4(0)	+ 1	8 =	9	- 2	+ 1
	7 =	7	+2(0)	+ 4(0)	+ 0	7 =	9	- 2	+ 0
	6 =	7	+2(0)	+ 4(0)	- 1	6 =	9	- 2	- 1
							Σa_j =	**0**	**0** = Σe_{ij}
							Σa^2_j =	**24**	**6** = Σe^2_{ij}

Variance Components	SS_Y =	$\Sigma\alpha^2$ +	$\Sigma\varepsilon^2$
Parameter Model	$\Sigma(Y_{ij} - \mu*)^2$	$= \Sigma(\mu_j - \mu*)^2$	$+ \Sigma(Y_{ij} - \mu_j)^2$
Statistical Model	$\Sigma(Y_{ij} - \bar{Y}*)^2$	$= \Sigma(\bar{Y}_j - \bar{Y}*)^2$	$+ \Sigma(Y_{ij} - \bar{Y}_j)^2$
	$(10 - 9)^2$	$= (9 - 9)^2$	$+ (10 - 9)^2$
	$(9 - 9)^2$	$= (9 - 9)^2$	$+ (9 - 9)^2$
	$(8 - 9)^2$	$= (9 - 9)^2$	$+ (8 - 9)^2$
	$(12 - 9)^2$	$= (11 - 9)^2$	$+ (12 - 11)^2$
	$(11 - 9)^2$	$= (11 - 9)^2$	$+ (11 - 11)^2$
	$(10 - 9)^2$	$= (11 - 9)^2$	$+ (10 - 11)^2$
	$(8 - 9)^2$	$= (7 - 9)^2$	$+ (8 - 7)^2$
	$(7 - 9)^2$	$= (7 - 9)^2$	$+ (7 - 7)^2$
	$(6 - 9)^2$	$= (7 - 9)^2$	$+ (6 - 7)^2$
	(SS_Y **= 30**)	= (SS_A = **24**)	+ (SS_E **= 6**)

One-Way ANOVA

	A_1		A_2		A_3		Total
		$(Y-\bar{Y}_1)^2$		$(Y-\bar{Y}_2)^2$		$(Y-\bar{Y}_3)^2$	
	10	$(10 - 9)^2$	12	$(12-11)^2$	8	$(8 - 7)^2$	
	9	$(9 - 9)^2$	11	$(11-11)^2$	7	$(7 - 7)^2$	
	8	$(8 - 9)^2$	10	$(10-11)^2$	6	$(6 - 7)^2$	
Total	$\bar{Y}_1$ = **9** $n_1 = 3$	$SS_{W(1)}=2$	$\bar{Y}_2$ = **11** $n_2 = 3$	$SS_{W(2)}=2$	$\bar{Y}_3$ = **7** $n_3 = 3$	$SS_{W(3)}=2$	$\bar{Y}_*$ =**9** $N = 9$

ANOVA MODEL: $Y_{ij} = \mu^* + \alpha_j + \varepsilon_{ij}$

Factor A has three group means, $\bar{Y}_1$, $\bar{Y}_2$, and $\bar{Y}_3$, and (A-1=3-1=2) *df*s.
The null hypothesis for Factor A is $H_0: \mu_1 = \mu_2 = \mu_3$
or $H_0: \Sigma\alpha^2_j = 0$.

Computation of the One-Way ANOVA Source Table with a Between-Subject Factors

The Sums of Squares (SS) for the main effect of Factor A (SS_A) are computed by subtracting Marginal Means from the Grand Mean, squaring, weighting by the marginal sample size, and summing.

Source		Sum of Squares	*df*	Mean Square	*F*	$\eta 2$
Between- Groups One-Way Model	$(\Sigma\alpha^2_j)$ $a_1 = 0$ $a_2 = 2$ $a_3 = -2$	$\Sigma n_A(\bar{Y}_a - \bar{Y}_*)^2$ $3(9 - 9)^2$ $+ 3(11 - 9)^2$ $+ 3(7 - 9)^2 =$ **24**	$(A - 1)$ (3 - 1)=**2**	$SS_A/(A\text{-}1)$ 24/2=**12**	MS_A/MS_W 12/1 = **12**	SS_A/SS_T 24/30 = **.80**
Within Groups (Error)	$(\Sigma\varepsilon^2_{ijk})$	$\Sigma(Y_i - \bar{Y}_a)^2$ 2 + 2 + 2 = **6**	$N - A$ 24-6 = **6**	SS_W/df_W 6/6 = **1**	)	
Total Variance		$\Sigma(Y_i - \bar{Y}_*)^2$ = **30**	N - 1 9 -1 = **8**	($s^2 = S_T/N$-1	= **3.75**)	

where, N = total number of cases, A= number of groups for Factor A, $\bar{Y}_*$ = the grand mean of Y across all groups. Y_i = each individual score on Y, n_A = the number of cases in each group of Factor A. Treatment magnitude for each effect can calculated for each effect. For example, the eta-squared for Factor A is $R^2 = \eta^2 = SS_A/SS_T = .80$.

```
data group3;
```

```
input id Y Group X1 X2 D1 D2 C1 C2 M;
cards;
1 10 1 1 0 0 0  0.5  1  9
2  9 1 1 0 0 0  0.5  1  9
3  8 1 1 0 0 0  0.5  1  9
4 12 2 0 1 1 0  0.5 -1 11
5 11 2 0 1 1 0  0.5 -1 11
6 10 2 0 1 1 0  0.5 -1 11
7  8 3 0 0 0 1 -1.0  0  7
8  7 3 0 0 0 1 -1.0  0  7
9  6 3 0 0 0 1 -1.0  0  7
;
proc glm data=group3;class group;
model y = group;lsmeans group /adjust=t tdiff pdiff;
means group / lsd cldiff;
contrast 'pair13' group  1  0 -1;
contrast 'pair23' group  0  1 -1;
contrast 'pair12' group  1 -1  0;
run;
```

```
            The GLM Procedure
         Class Level Information
      Class         Levels    Values
      Group              3    1 2 3
 Number of Observations Used          9

Dependent Variable: Y

                              Sum of
Source                 DF      Squares        Mean Square     F Value    Pr > F
Model                  2     24.00000000     12.00000000       12.00    0.0080
Error                  6      6.00000000      1.00000000
Corrected Total        8     30.00000000

R-Square     Coeff Var      Root MSE       Y Mean
0.800000      11.11111      1.000000      9.000000


        Least Squares Means
                              LSMEAN
 Group          Y LSMEAN      Number
 1             9.0000000           1
 2            11.0000000           2
 3             7.0000000           3
```

Least Squares Means for Effect Group
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: Y

i/j	1	2	3
1		-2.44949	2.44949
		0.0498	0.0498
2	2.44949		4.898979
	0.0498		0.0027
3	-2.44949	-4.89898	
	0.0498	0.0027	

NOTE: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

t Tests (LSD) for Y

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	1
Critical Value of t	2.44691
Least Significant Difference	1.9979

Comparisons significant at the 0.05 level are indicated by ***.

Group Comparison	Difference Between Means	95% Confidence Limits		
2 - 1	2.0000	0.0021	3.9979	***
2 - 3	4.0000	2.0021	5.9979	***
1 - 2	-2.0000	-3.9979	-0.0021	***
1 - 3	2.0000	0.0021	3.9979	***
3 - 2	-4.0000	-5.9979	-2.0021	***
3 - 1	-2.0000	-3.9979	-0.0021	***

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Dependent Variable: Y

Contrast	**DF**	**Contrast SS**	**Mean Square**	**F Value**	**Pr > F**
pair13	1	6.00000000	6.00000000	6.00	0.0498
pair23	1	24.00000000	24.00000000	24.00	0.0027
pair12	1	6.00000000	6.00000000	6.00	0.0498

```
proc reg data=group3;
model y = x1 x2;
omnibs: test x1=0,x2=0;
pair13: test x1=0;
pair23: test x2=0;
pair12: test x1=x2;
run;
```

omnibs: Tests $H_0: \beta_1 = \beta_2 = 0 \rightarrow H_0: (\mu_3 - \mu_1) = (\mu_3 - \mu_2) = 0$
$\rightarrow H_0: \mu_1 = \mu_2 = \mu_3$

pair13: Tests $H_0: \beta_1 = 0 \rightarrow H_0: (\mu_3 - \mu_1) = 0$

pair23: Tests $H_0: \beta_2 = 0 \rightarrow H_0: (\mu_3 - \mu_2) = 0$

pair12: Tests $H_0: \beta_1 = \beta_2 \rightarrow H_0: (\mu_3 - \mu_1) = (\mu_3 - \mu_2)$
$\rightarrow H_0: (\mu_1 - \mu_2) = 0$

The REG Procedure Dependent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	24.00000	12.00000	12.00	0.0080
Error	6	6.00000	1.00000		
Corrected Total	8	30.00000			

Root MSE	1.00000	R-Square	0.8000
Dependent Mean	9.00000	Adj R-Sq	0.7333
Coeff Var	11.11111		

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	7.00000	0.57735	12.12	<.0001
X1	1	2.00000	0.81650	2.45	0.0498
X2	1	4.00000	0.81650	4.90	0.0027

Test omnibs Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	12.00000	12.00	0.0080
Denominator	6	1.00000		

Test pair13 Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	6.00000	6.00	0.0498
Denominator	6	1.00000		

Test pair23 Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	24.00000	24.00	0.0027
Denominator	6	1.00000		

Test pair12 Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	6.00000	6.00	0.0498
Denominator	6	1.00000		