

1-way Independent ANOVA

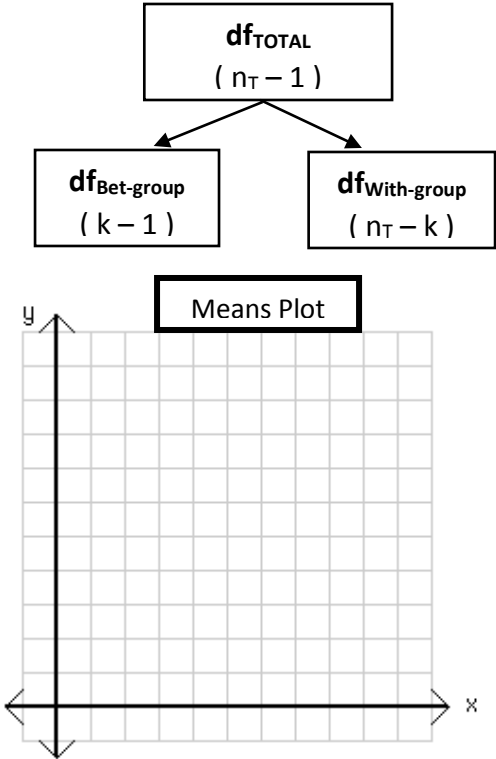
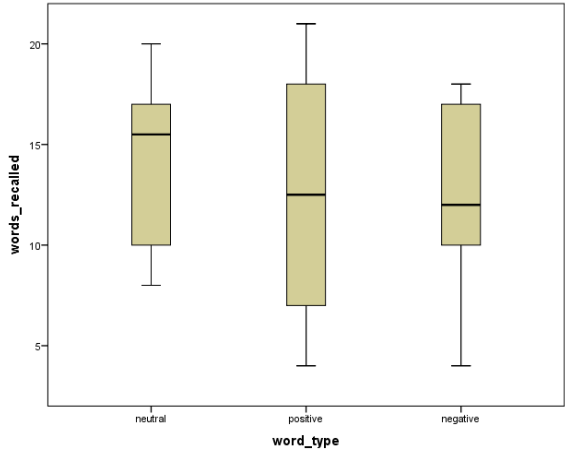
n = \_\_\_\_\_

K = \_\_\_\_\_

n<sub>T</sub> = \_\_\_\_\_

Setup: Started with 18 subjects, randomly divided them into three groups of six. Each group was given a type of word list to later recall.

| Neutral                  | Positive                | Negative                 |
|--------------------------|-------------------------|--------------------------|
| 20                       | 21                      | 17                       |
| 16                       | 18                      | 11                       |
| 8                        | 7                       | 4                        |
| 17                       | 15                      | 18                       |
| 15                       | 10                      | 13                       |
| 10                       | 4                       | 10                       |
| M <sub>Neu</sub> = 14.33 | M <sub>Pos</sub> = 12.5 | M <sub>Neg</sub> = 12.17 |
| S <sub>Neu</sub> = 4.50  | S <sub>Pos</sub> = 6.60 | S <sub>Neg</sub> = 5.12  |



| Source                            | SS | df | MS | F | p |
|-----------------------------------|----|----|----|---|---|
| Between-Groups                    |    |    |    |   |   |
| Within-Groups ( <b>Residual</b> ) |    |    |    |   |   |
| Total                             |    |    |    |   |   |

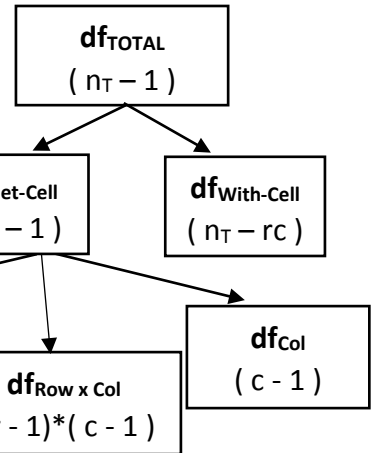
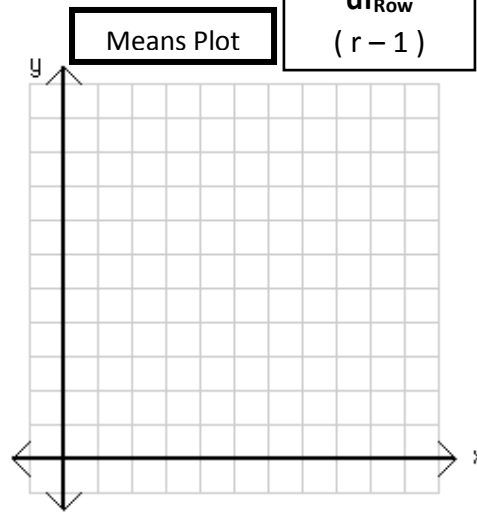
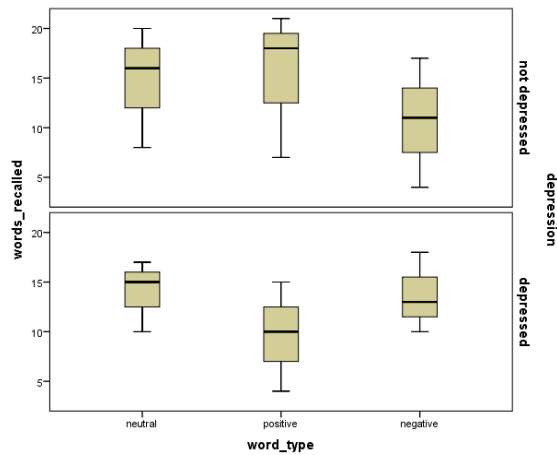
$F_{crit}(\_, \_) = \_$

## 2-way Independent ANOVA

Setup: Started with 18 subjects, 9 with preexisting depression & 9 without. Randomly divided each set of 9 them into three groups of three. Each group was given a type of word list to later recall.

n = \_\_\_\_  
c = \_\_\_\_  
r = \_\_\_\_  
n<sub>T</sub> = \_\_\_\_

|               | Neutral                                 | Positive                               | Negative                                |                          |
|---------------|---|--|---|--------------------------|
| Depressed     | 20<br>16<br>8<br>M = 14.67<br>S = 6.11  | 21<br>18<br>7<br>M = 15.33<br>S = 7.37 | 17<br>11<br>4<br>M = 10.67<br>S = 6.51  | M <sub>Dep</sub> = 13.56 |
| Not depressed | 17<br>15<br>10<br>M = 14.00<br>S = 3.61 | 15<br>10<br>4<br>M = 9.67<br>S = 5.51  | 18<br>13<br>10<br>M = 13.67<br>S = 4.04 | M <sub>Not</sub> = 12.44 |
|               | M <sub>Neu</sub> = 14.33                | M <sub>Pos</sub> = 12.5                | M <sub>Neg</sub> = 12.17                | M <sub>Grand</sub> = 13  |



| Source                           | SS | Df | MS | F | p |
|----------------------------------|----|----|----|---|---|
| Between-Cells                    |    |    |    |   |   |
| Row Groups                       |    |    |    |   |   |
| Column Groups                    |    |    |    |   |   |
| INTER (Row x Col)                |    |    |    |   |   |
| Within-Cells ( <b>Residual</b> ) |    |    |    |   |   |
| Total                            |    |    |    |   |   |

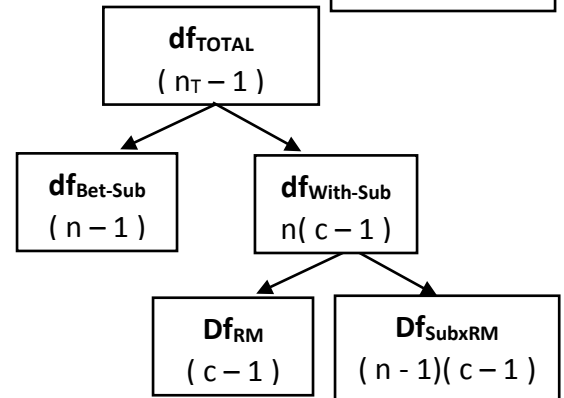
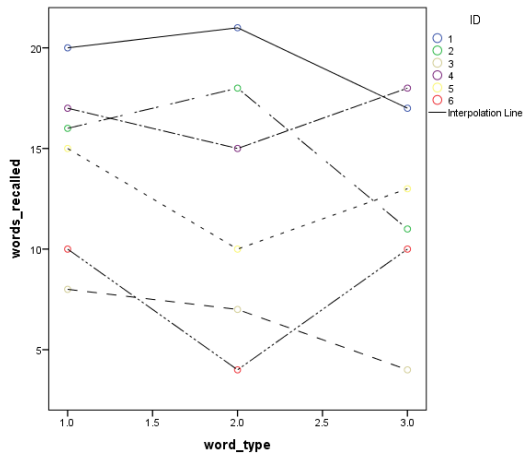
$F_{crit}(\_, \_) = \_$   
 $F_{crit}(\_, \_) = \_$

# 1-way Repeated Measures ANOVA

Setup: Started with 6 subjects, were each given all 3 type of word list to later recall.  
The words were actually all randomly included on the same list.

n = \_\_\_\_  
c = \_\_\_\_  
n<sub>T</sub> = \_\_\_\_

|   | Neutral                  | Positive                | Negative                 |                         |
|---|--------------------------|-------------------------|--------------------------|-------------------------|
| 1 | 20                       | 21                      | 17                       | M <sub>1</sub> = 19.33  |
| 2 | 16                       | 18                      | 11                       | M <sub>2</sub> = 15.00  |
| 3 | 7                        | 7                       | 4                        | M <sub>3</sub> = 6.33   |
| 4 | 15                       | 15                      | 18                       | M <sub>4</sub> = 16.67  |
| 5 | 10                       | 10                      | 13                       | M <sub>5</sub> = 12.67  |
| 6 | 4                        | 4                       | 10                       | M <sub>6</sub> = 8.00   |
|   | M <sub>Neu</sub> = 14.33 | M <sub>Pos</sub> = 12.5 | M <sub>Neg</sub> = 12.17 | M <sub>Grand</sub> = 13 |



Sphericity violated? Now what?

| Source                           | SS | df | MS | F | p |
|----------------------------------|----|----|----|---|---|
| Between-Subjects                 |    |    |    |   |   |
| Within-Subjects                  |    |    |    |   |   |
| RM                               |    |    |    |   |   |
| <b>Residual: INTER(RM x Sub)</b> |    |    |    |   |   |
| Total                            |    |    |    |   |   |

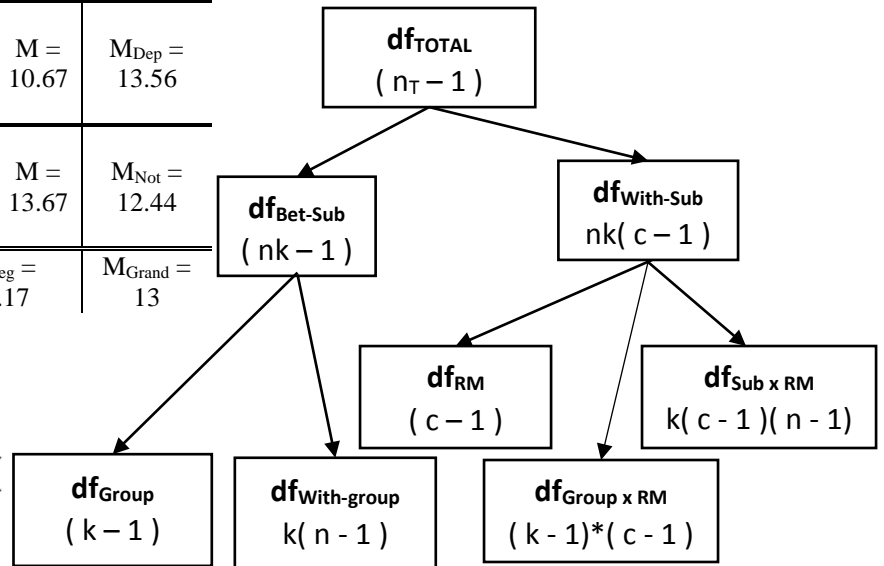
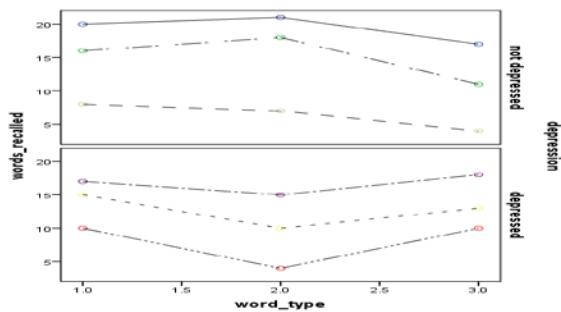
$F_{crit}(\_, \_) = \_$

## 2-way Mixed Design ANOVA

Setup: Started with 6 subjects, 3 with preexisting depression & 3 without.  
All were each given all 3 type of word list to later recall.

n = \_\_\_\_  
k = \_\_\_\_  
c = \_\_\_\_  
n<sub>T</sub> = \_\_\_\_

|               |   | Neutral                  |           | Positive                |           | Negative                 |                         |
|---------------|---|--------------------------|-----------|-------------------------|-----------|--------------------------|-------------------------|
| Depressed     | 1 | 20                       | M = 14.67 | 21                      | M = 15.33 | 17                       | M = 10.67               |
|               | 2 | 16                       |           | 18                      |           | 11                       |                         |
|               | 3 | 8                        |           | 7                       |           | 4                        |                         |
| Not depressed | 4 | 17                       | M = 14.00 | 15                      | M = 9.67  | 18                       | M = 13.67               |
|               | 5 | 15                       |           | 10                      |           | 13                       |                         |
|               | 6 | 10                       |           | 4                       |           | 10                       |                         |
|               |   | M <sub>Neu</sub> = 14.33 |           | M <sub>Pos</sub> = 12.5 |           | M <sub>Neg</sub> = 12.17 | M <sub>Grand</sub> = 13 |



| Source                           | SS | df | MS | F | p |
|----------------------------------|----|----|----|---|---|
| Between-Subjects                 |    |    |    |   |   |
| Groups                           |    |    |    |   |   |
| <b>Residual: Within-Groups</b>   |    |    |    |   |   |
| Within-Subjects                  |    |    |    |   |   |
| RM                               |    |    |    |   |   |
| INTER: Group x RM                |    |    |    |   |   |
| <b>Residual: INTER(Sub x RM)</b> |    |    |    |   |   |
| Total                            |    |    |    |   |   |

$F_{crit}(\_, \_) = \_$   
 $F_{crit}(\_, \_) = \_$

# Compare ANOVA Method Results: by hand

## 1-way Independent ANOVA

| Source                            | SS     | df | MS           | F           | p               |
|-----------------------------------|--------|----|--------------|-------------|-----------------|
| Between-Groups                    | 16.26  | 2  | 8.13         | <b>0.27</b> | <b>&gt; .05</b> |
| Within-Groups ( <b>Residual</b> ) | 450.15 | 15 | <b>30.01</b> |             |                 |
| Total                             | 466    | 17 |              |             |                 |

$F_{crit}(2, 15) = 4.54$

## 2-way Independent ANOVA

| Source                           | SS     | Df | MS           | F           | p               |
|----------------------------------|--------|----|--------------|-------------|-----------------|
| Between-Cells                    | 78.51  | 5  |              |             |                 |
| Row Groups                       | 5.64   | 1  | 5.64         | <b>0.17</b> | <b>&gt; .05</b> |
| Column Groups                    | 16.26  | 2  | 8.13         | <b>0.25</b> | <b>&gt; .05</b> |
| INTER (Row x Col)                | 56.6   | 2  | 28.31        | <b>0.88</b> | <b>&gt; .05</b> |
| Within-Cells ( <b>Residual</b> ) | 387.49 | 12 | <b>23.29</b> |             |                 |
| Total                            | 466    | 17 |              |             |                 |

$F_{crit}(1, 12) = 4.75$   
 $F_{crit}(2, 12) = 3.89$

## 1-way Repeated Measures ANOVA

| Source                           | SS     | df | MS          | F           | p               |
|----------------------------------|--------|----|-------------|-------------|-----------------|
| Between-Subjects                 | 381.42 | 5  |             |             |                 |
| Within-Subjects                  | 84.58  | 12 |             |             |                 |
| RM                               | 16.26  | 2  | 8.13        | <b>1.19</b> | <b>&gt; .05</b> |
| <b>Residual: INTER(Sub x RM)</b> | 68.32  | 10 | <b>6.83</b> |             |                 |
| Total                            | 466    | 17 |             |             |                 |

$F_{crit}(2, 10) = 4.10$

## 2-way Mixed Design ANOVA

| Source                           | SS     | df | MS           | F            | p               |
|----------------------------------|--------|----|--------------|--------------|-----------------|
| Between-Subjects                 | 381.42 | 5  |              |              |                 |
| Groups                           | 5.64   | 1  | 5.64         | <b>0.06</b>  | <b>&gt; .05</b> |
| <b>Residual: Within-Groups</b>   | 375.78 | 4  | <b>93.95</b> |              |                 |
| Within-Subjects                  | 84.58  | 12 |              |              |                 |
| RM                               | 16.26  | 2  | 8.13         | <b>5.57</b>  | <b>&lt; .05</b> |
| INTER: Group x RM                | 56.64  | 2  | 28.32        | <b>19.40</b> | <b>&lt; .05</b> |
| <b>Residual: INTER(Sub x RM)</b> | 11.68  | 8  | <b>1.46</b>  |              |                 |
| Total                            | 466    | 17 |              |              |                 |

$F_{crit}(1, 4) = 7.71$   
 $F_{crit}(2, 8) = 3.89$

# Compare ANOVA Method Results: by SPSS

## 1-way independent ANOVA: just word type

ONEWAY words\_recalled BY word\_type.

| words_recalled |                |    |             |      |      |
|----------------|----------------|----|-------------|------|------|
|                | Sum of Squares | df | Mean Square | F    | Sig. |
| Between Groups | 16.333         | 2  | 8.167       | .272 | .765 |
| Within Groups  | 449.667        | 15 | 29.978      |      |      |
| Total          | 466.000        | 17 |             |      |      |

UNIANOVA words\_recalled BY word\_type

/PLOT=PROFILE(word\_type)

/PRINT=ETASQ DESCRIPTIVE

/DESIGN=word\_type.

### Tests of Between-Subjects Effects

Dependent Variable: words\_recalled

| Source          | Type III Sum of Squares | df | Mean Square | F       | Sig. | Partial Eta Squared |
|-----------------|-------------------------|----|-------------|---------|------|---------------------|
| Corrected Model | 16.333 <sup>a</sup>     | 2  | 8.167       | .272    | .765 | .035                |
| Intercept       | 3042.000                | 1  | 3042.000    | 101.475 | .000 | .871                |
| word_type       | 16.333                  | 2  | 8.167       | .272    | .765 | .035                |
| Error           | 449.667                 | 15 | 29.978      |         |      |                     |
| Total           | 3508.000                | 18 |             |         |      |                     |
| Corrected Total | 466.000                 | 17 |             |         |      |                     |

a. R Squared = .035 (Adjusted R Squared = -.094)

## 2-way independent ANOVA: depression & word type

UNIANOVA words\_recalled BY depression word\_type

/PLOT=PROFILE(word\_type\*depression)

/PRINT=ETASQ DESCRIPTIVE

/DESIGN=depression word\_type depression\*word\_type.

### Tests of Between-Subjects Effects

Dependent Variable: words\_recalled

| Source                 | Type III Sum of Squares | df | Mean Square | F      | Sig. | Partial Eta Squared |
|------------------------|-------------------------|----|-------------|--------|------|---------------------|
| Corrected Model        | 78.667 <sup>a</sup>     | 5  | 15.733      | .487   | .780 | .169                |
| Intercept              | 3042.000                | 1  | 3042.000    | 94.244 | .000 | .887                |
| depression             | 5.556                   | 1  | 5.556       | .172   | .686 | .014                |
| word_type              | 16.333                  | 2  | 8.167       | .253   | .780 | .040                |
| depression * word_type | 56.778                  | 2  | 28.389      | .880   | .440 | .128                |
| Error                  | 387.333                 | 12 | 32.278      |        |      |                     |
| Total                  | 3508.000                | 18 |             |        |      |                     |
| Corrected Total        | 466.000                 | 17 |             |        |      |                     |

a. R Squared = .169 (Adjusted R Squared = -.178)

# 1-way RM ANOVA: just word type

GLM neutral positive negative

/PLOT=PROFILE(type)

/PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY

/WSDESIGN=type.

Measure: MEASURE\_1

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon <sup>b</sup> |             |             |
|------------------------|-------------|--------------------|----|------|----------------------|-------------|-------------|
|                        |             |                    |    |      | Greenhouse-Geisser   | Huynh-Feldt | Lower-bound |
| type                   | .213        | 6.178              | 2  | .046 | .560                 | .608        | .500        |

## Tests of Within-Subjects Effects

Measure: MEASURE\_1

| Source      |                    | Type III Sum of Squares | df    | Mean Square | F     | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power <sup>a</sup> |
|-------------|--------------------|-------------------------|-------|-------------|-------|------|---------------------|--------------------|-----------------------------|
| type        | Sphericity Assumed | 16.333                  | 2     | 8.167       | 1.195 | .342 | .193                | 2.390              | .205                        |
|             | Greenhouse-Geisser | 16.333                  | 1.119 | 14.591      | 1.195 | .328 | .193                | 1.338              | .154                        |
|             | Huynh-Feldt        | 16.333                  | 1.215 | 13.438      | 1.195 | .331 | .193                | 1.453              | .160                        |
|             | Lower-bound        | 16.333                  | 1.000 | 16.333      | 1.195 | .324 | .193                | 1.195              | .146                        |
| Error(type) | Sphericity Assumed | 68.333                  | 10    | 6.833       |       |      |                     |                    |                             |
|             | Greenhouse-Geisser | 68.333                  | 5.597 | 12.208      |       |      |                     |                    |                             |
|             | Huynh-Feldt        | 68.333                  | 6.077 | 11.244      |       |      |                     |                    |                             |
|             | Lower-bound        | 68.333                  | 5.000 | 13.667      |       |      |                     |                    |                             |

a. Computed using alpha = .05

Measure: MEASURE\_1

Transformed Variable: Average

| Source    | Type III Sum of Squares | df | Mean Square | F      | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power <sup>a</sup> |
|-----------|-------------------------|----|-------------|--------|------|---------------------|--------------------|-----------------------------|
| Intercept | 3042.000                | 1  | 3042.000    | 39.886 | .001 | .889                | 39.886             | .998                        |
| Error     | 381.333                 | 5  | 76.267      |        |      |                     |                    |                             |

a. Computed using alpha = .05

## 2-way Mixed Design ANOVA: depression & word type

GLM neutral positive negative BY depression

/PLOT=PROFILE(type\*depression)

/PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY

/WSDESIGN=type

/DESIGN=depression.

### Mauchly's Test of Sphericity<sup>a</sup>

Measure: MEASURE\_1

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon <sup>b</sup> |             |             |
|------------------------|-------------|--------------------|----|------|----------------------|-------------|-------------|
|                        |             |                    |    |      | Greenhouse-Geisser   | Huynh-Feldt | Lower-bound |
| type                   | .817        | .608               | 2  | .738 | .845                 | 1.000       | .500        |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + depression  
Within Subjects Design: type

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

### Tests of Within-Subjects Effects

Measure: MEASURE\_1

| Source            |                    | Type III Sum of Squares | df    | Mean Square | F      | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power <sup>a</sup> |
|-------------------|--------------------|-------------------------|-------|-------------|--------|------|---------------------|--------------------|-----------------------------|
| type              | Sphericity Assumed | 16.333                  | 2     | 8.167       | 5.654  | .029 | .586                | 11.308             | .696                        |
|                   | Greenhouse-Geisser | 16.333                  | 1.690 | 9.665       | 5.654  | .039 | .586                | 9.555              | .630                        |
|                   | Huynh-Feldt        | 16.333                  | 2.000 | 8.167       | 5.654  | .029 | .586                | 11.308             | .696                        |
|                   | Lower-bound        | 16.333                  | 1.000 | 16.333      | 5.654  | .076 | .586                | 5.654              | .442                        |
| type * depression | Sphericity Assumed | 56.778                  | 2     | 28.389      | 19.654 | .001 | .831                | 39.308             | .997                        |
|                   | Greenhouse-Geisser | 56.778                  | 1.690 | 33.596      | 19.654 | .002 | .831                | 33.215             | .991                        |
|                   | Huynh-Feldt        | 56.778                  | 2.000 | 28.389      | 19.654 | .001 | .831                | 39.308             | .997                        |
|                   | Lower-bound        | 56.778                  | 1.000 | 56.778      | 19.654 | .011 | .831                | 19.654             | .904                        |
| Error(type)       | Sphericity Assumed | 11.556                  | 8     | 1.444       |        |      |                     |                    |                             |
|                   | Greenhouse-Geisser | 11.556                  | 6.760 | 1.709       |        |      |                     |                    |                             |
|                   | Huynh-Feldt        | 11.556                  | 8.000 | 1.444       |        |      |                     |                    |                             |
|                   | Lower-bound        | 11.556                  | 4.000 | 2.889       |        |      |                     |                    |                             |

a. Computed using alpha = .05

### Tests of Between-Subjects Effects

Measure: MEASURE\_1

Transformed Variable: Average

| Source     | Type III Sum of Squares | df | Mean Square | F      | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power <sup>a</sup> |
|------------|-------------------------|----|-------------|--------|------|---------------------|--------------------|-----------------------------|
| Intercept  | 3042.000                | 1  | 3042.000    | 32.381 | .005 | .890                | 32.381             | .985                        |
| depression | 5.556                   | 1  | 5.556       | .059   | .820 | .015                | .059               | .054                        |
| Error      | 375.778                 | 4  | 93.944      |        |      |                     |                    |                             |

a. Computed using alpha = .05