

```
/******HW11Cartoon.sas *****/
title 'STA441s16 HW 11 Check';
proc format; /* value labels used in data step below */
  value cfmt 0 = 'Black & White' 1 = 'Colour';
  value efmt 0 = 'Pre-professional' 1 = 'Professional' 2 = 'Student';
  value lfmt 1 = 'Hospital A ' 2 = 'Hospital B'
           3 = 'Hospital C' 4 = 'Penn State';
data Walt;
  infile '/folders/myfolders/cartoon.data.txt';
  input id colour educ location otis cartoon1 reall1 cartoon2 real2;
  label
    colour = 'Colour versus Black & white'
    educ = 'Education'
    location = 'Where did respondent come from?'
    otis = 'Otis Mental Ability Test'
    cartoon1 = 'Cartoon test score at time 1'
    reall1 = 'Realistic test score at time 1'
    cartoon2 = 'Cartoon test score at time 2'
    real2 = 'Realistic test score at time 2'
    memory = 'Recall of training materials'
    type = 'Training materials: Cartoon versus realistic ';
  format colour cfmt.;
  format educ efmt.;
  format location lfmt.;
proc freq;
  tables location*educ / norow nocol nopercnt missing;

data disney;
  set walt;
  if educ=2; /* Just the students */
  time = 1; type = 'Real'; memory = reall1; output;
  time = 1; type = 'Cartoon'; memory = cartoon1; output;
  time = 2; type = 'Real'; memory = real2; output;
  time = 2; type = 'Cartoon'; memory = cartoon2; output;
  keep id otis colour time type memory;

/* There were 70 students from Penn State. */

proc freq;
  tables time*colour*type / norow nocol nopercnt missing;

proc print data=disney(obs=16);
  var id otis colour time type memory;

proc mixed;
  title2 'Proc Mixed repeated measures';
  class colour time type;
  model memory = otis time|colour|type;
  repeated / type=un subject=id r;
  lsmeans time type colour*time; /* Look at significant effects. */
```

## The FREQ Procedure

Frequency

| Table of location by educ                 |                  |              |         |       |
|---|------------------|--------------|---------|-------|
| location(Where did respondent come from?) | educ(Education)  |              |         |       |
|   | Pre-professional | Professional | Student | Total |
| Hospital A                                | 3                | 12           | 0       | 15    |
| Hospital B                                | 7                | 21           | 0       | 28    |
| Hospital C                                | 46               | 20           | 0       | 66    |
| Penn State                                | 0                | 0            | 70      | 70    |
| Total                                     | 56               | 53           | 70      | 179   |

## The FREQ Procedure

Frequency

| Table 1 of colour by type                 |      |      |       |
|---|------|------|-------|
| Controlling for time=1                    |      |      |       |
| colour(Colour<br>versus<br>Black & white) | type |      |       |
|   | Cart | Real | Total |
| Black & White                             | 36   | 36   | 72    |
| Colour                                    | 34   | 34   | 68    |
| Total                                     | 70   | 70   | 140   |

Frequency

| Table 2 of colour by type                 |      |      |       |
|---|------|------|-------|
| Controlling for time=2                    |      |      |       |
| colour(Colour<br>versus<br>Black & white) | type |      |       |
|   | Cart | Real | Total |
| Black & White                             | 36   | 36   | 72    |
| Colour                                    | 34   | 34   | 68    |
| Total                                     | 70   | 70   | 140   |

| Obs | id  | otis | colour        | time | type | memory |
|-----|-----|------|---------------|------|------|--------|
| 1   | 110 | 132  | Black & White | 1    | Real | 9      |
| 2   | 110 | 132  | Black & White | 1    | Cart | 9      |
| 3   | 110 | 132  | Black & White | 2    | Real | .      |
| 4   | 110 | 132  | Black & White | 2    | Cart | .      |
| 5   | 111 | 113  | Black & White | 1    | Real | 8      |
| 6   | 111 | 113  | Black & White | 1    | Cart | 7      |
| 7   | 111 | 113  | Black & White | 2    | Real | .      |
| 8   | 111 | 113  | Black & White | 2    | Cart | .      |
| 9   | 112 | 130  | Black & White | 1    | Real | 7      |
| 10  | 112 | 130  | Black & White | 1    | Cart | 9      |
| 11  | 112 | 130  | Black & White | 2    | Real | 4      |
| 12  | 112 | 130  | Black & White | 2    | Cart | 1      |
| 13  | 113 | 122  | Black & White | 1    | Real | 9      |
| 14  | 113 | 122  | Black & White | 1    | Cart | 9      |
| 15  | 113 | 122  | Black & White | 2    | Real | 4      |
| 16  | 113 | 122  | Black & White | 2    | Cart | 6      |

The Mixed Procedure

| Model Information         |                |
|---------------------------|----------------|
| Data Set                  | WORK.DISNEY    |
| Dependent Variable        | memory         |
| Covariance Structure      | Unstructured   |
| Subject Effect            | id             |
| 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               |
| colour                  | 2      | Black & White Colour |
| time                    | 2      | 1 2                  |
| type                    | 2      | Cart Real            |

| Dimensions            |    |
|-----------------------|----|
| Covariance Parameters | 10 |
| Columns in X          | 28 |
| Columns in Z          | 0  |
| Subjects              | 70 |
| Max Obs per Subject   | 4  |

| Number of Observations          |     |
|---------------------------------|-----|
| Number of Observations Read     | 280 |
| Number of Observations Used     | 248 |
| Number of Observations Not Used | 32  |

| Iteration History |             |                 |            |
|-------------------|-------------|-----------------|------------|
| Iteration         | Evaluations | -2 Res Log Like | Criterion  |
| 0                 | 1           | 992.11585938    |            |
| 1                 | 2           | 878.84090396    | 0.00088763 |
| 2                 | 1           | 878.62963131    | 0.00001784 |
| 3                 | 1           | 878.62565365    | 0.00000001 |

Convergence criteria met.

The Mixed Procedure

| Estimated R Matrix for Subject 1 |        |        |
|----------------------------------|--------|--------|
| Row                              | Col1   | Col2   |
| 1                                | 2.8138 | 1.5488 |
| 2                                | 1.5488 | 1.8275 |

| Covariance Parameter Estimates |         |          |
|--------------------------------|---------|----------|
| Cov Parm                       | Subject | Estimate |
| UN(1,1)                        | id      | 2.8138   |
| UN(2,1)                        | id      | 1.5488   |
| UN(2,2)                        | id      | 1.8275   |
| UN(3,1)                        | id      | 2.2201   |
| UN(3,2)                        | id      | 0.7904   |
| UN(3,3)                        | id      | 4.7494   |
| UN(4,1)                        | id      | 1.6059   |
| UN(4,2)                        | id      | 1.1289   |
| UN(4,3)                        | id      | 2.1091   |
| UN(4,4)                        | id      | 3.5541   |

| Fit Statistics           |       |
|--------------------------|-------|
| -2 Res Log Likelihood    | 878.6 |
| AIC (Smaller is Better)  | 898.6 |
| AICC (Smaller is Better) | 899.6 |
| BIC (Smaller is Better)  | 921.1 |

| Null Model Likelihood Ratio Test |            |            |
|----------------------------------|------------|------------|
| DF                               | Chi-Square | Pr > ChiSq |
| 9                                | 113.49     | <.0001     |

| Type 3 Tests of Fixed Effects |        |        |         |        |
|-------------------------------|--------|--------|---------|--------|
| Effect                        | Num DF | Den DF | F Value | Pr > F |
| otis                          | 1      | 67     | 11.51   | 0.0012 |
| time                          | 1      | 67     | 95.73   | <.0001 |
| colour                        | 1      | 67     | 0.39    | 0.5325 |
| colour*time                   | 1      | 67     | 7.96    | 0.0063 |

The Mixed Procedure

| Type 3 Tests of Fixed Effects |        |        |         |        |
|-------------------------------|--------|--------|---------|--------|
| Effect                        | Num DF | Den DF | F Value | Pr > F |
| type                          | 1      | 67     | 11.67   | 0.0011 |
| time*type                     | 1      | 67     | 1.13    | 0.2926 |
| colour*type                   | 1      | 67     | 1.68    | 0.1993 |
| colour*time*type              | 1      | 67     | 0.08    | 0.7774 |

Question 4

| Least Squares Means |      |                             |      |          |                |    |         |         |
|---------------------|------|-----------------------------|------|----------|----------------|----|---------|---------|
| Effect              | type | Colour versus Black & white | time | Estimate | Standard Error | DF | t Value | Pr >  t |
| time                |      |                             | 1    | 7.3599   | 0.1663         | 67 | 44.25   | <.0001  |
| time                |      |                             | 2    | 5.4256   | 0.2291         | 67 | 23.68   | <.0001  |
| type                | Cart |                             |      | 6.6916   | 0.1733         | 67 | 38.61   | <.0001  |
| type                | Real |                             |      | 6.0939   | 0.2142         | 67 | 28.45   | <.0001  |
| colour*time         |      | Black & White               | 1    | 7.7493   | 0.2336         | 67 | 33.17   | <.0001  |
| colour*time         |      | Black & White               | 2    | 5.2572   | 0.3272         | 67 | 16.07   | <.0001  |
| colour*time         |      | Colour                      | 1    | 6.9705   | 0.2400         | 67 | 29.05   | <.0001  |
| colour*time         |      | Colour                      | 2    | 5.5941   | 0.3228         | 67 | 17.33   | <.0001  |