Consider an experiment investigating how well children and adults remember.
There are three factors in the experiment:

Type of test: Subjects are either asked to recall or to recognize the stimuli.

Age: 10-year old children and adults are compared.

Type of stimulus: The stimuli to be remembered are presented either as pictures or as words.

The experiment can therefore be described as an Age (2) x Type of stimulus (2) x Type of test (2) factorial design.
There were five subjects in each of the eight conditions.

Recognition				Recall			
Children		Adults		Children		Adults	
Pictures	Words	Pictures	Words	Pictures	Words	Pictures	Words
92	70	90	87	66	62	88	85
90	70	90	82	65	59	88	85
92	71	92	81	67	58	83	82
91	70	94	84	69	60	82	84
90	72	91	85	71	59	88	83

All main effects and interactions are significant.

General Linear Model: y versus task, age, stimulus

```
Factor     Type    Levels  Values
task       fixed      2  Recall, Recognition
age        fixed      2  Adults, Children
stimulus   fixed      2  Pictures, Words


Analysis of Variance for y, using Adjusted SS for Tests

Source              DF    Seq SS    Adj SS    Adj MS       F       P
task                 1   1000.00   1000.00   1000.00  273.04   0.000
age                  1   1960.00   1960.00   1960.00  535.15   0.000
stimulus             1    902.50    902.50    902.50  246.42   0.000
task*age             1    518.40    518.40    518.40  141.54   0.000
task*stimulus        1    202.50    202.50    202.50   55.29   0.000
age*stimulus         1    220.90    220.90    220.90   60.31   0.000
task*age*stimulus    1     28.90     28.90     28.90    7.89   0.008
Error               32    117.20    117.20      3.66
Total               39   4950.40


S = 1.91377   R-Sq = 97.63%   R-Sq(adj) = 97.11%
```

Results for task = Recall, age = Adults

```
Variable   stimulus     Mean
y          Pictures    85.80
           Words       83.800
```

Results for task = Recall, age = Children

```
Variable   stimulus     Mean
y          Pictures    67.60
           Words       59.600
```
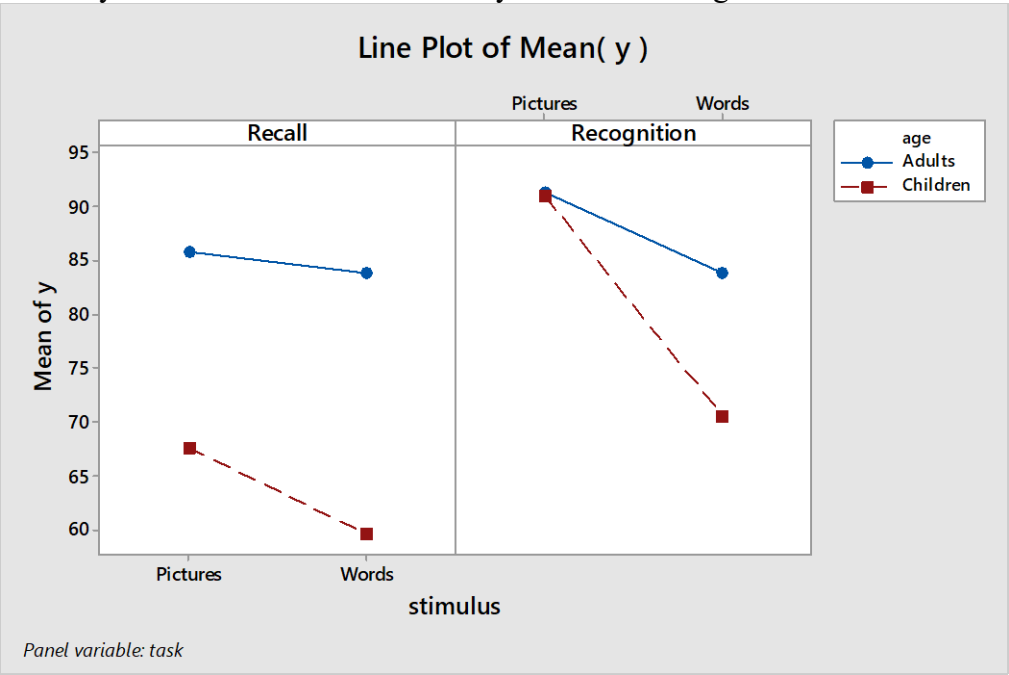
Results for task = Recognition, age = Adults

```
Variable   stimulus     Mean
y          Pictures    91.400
           Words       83.80
```

Results for task = Recognition, age = Children

```
Variable   stimulus     Mean
y          Pictures    91.000
           Words       70.600
```

Because of the 3-way interaction consider the 2-way interaction of age*stimulus at each level of task …

The Age x Type of stimulus interaction was larger for the recognition task than for the recall task.

With the recall task, the difference between children and adults was only slightly smaller for pictures than for words.

With the recognition task, the difference between children and adults was much smaller for pictures than for words. There was essentially no difference between children and adults for the pictures …

… whereas there was a large difference between children and adults for the words.

Results for task = Recall

```
Variable  age          Mean
y         Adults      84.800
          Children    63.60
```

Results for task = Recognition

```
Variable  age          Mean
y         Adults      87.60
          Children    80.80
```

Results for task = Recall

```
Variable  stimulus    Mean
y         Pictures    76.70
          Words       71.70
```
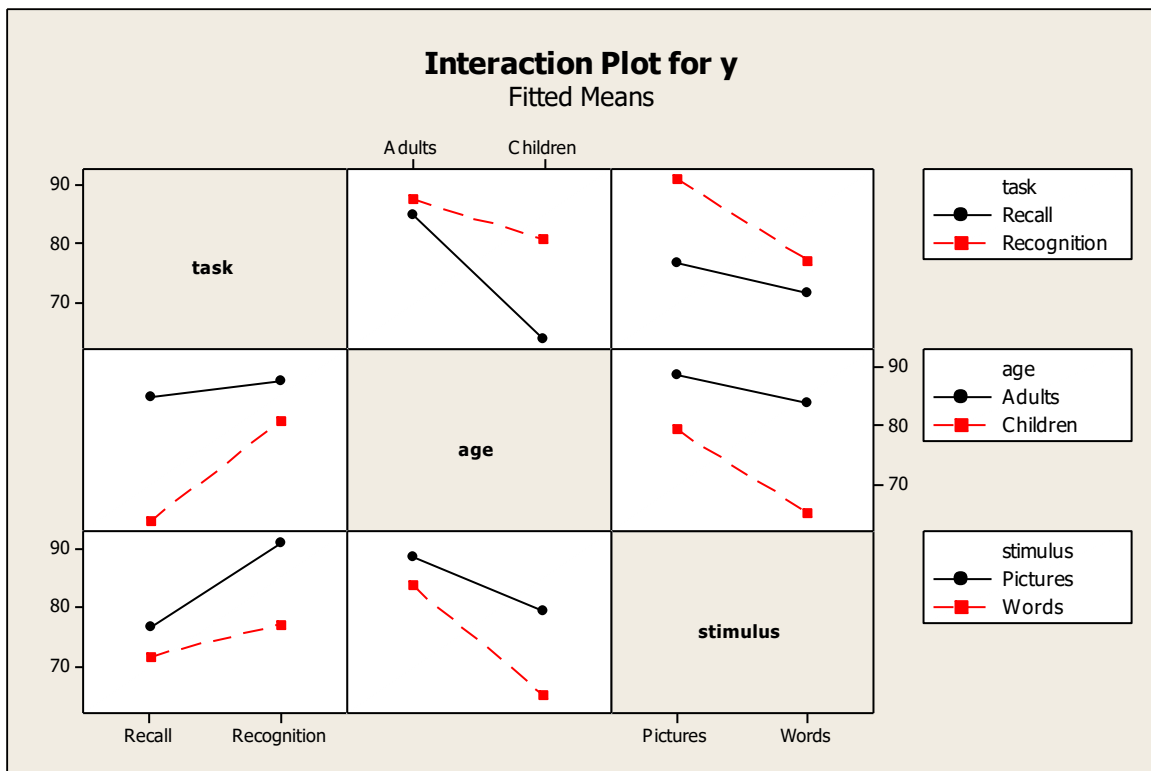
Results for task = Recognition

```
Variable  stimulus    Mean
y         Pictures    91.200
          Words       77.20
```

Results for age = Adults

```
Variable  stimulus    Mean
y         Pictures    88.60
          Words       83.800
```

Results for age = Children

```
Variable  stimulus    Mean
y         Pictures    79.30
          Words       65.10
```

Interaction Plot for y
Fitted Means

Task x Age interaction: The effect of age was greater for the recall task than for the recognition task.

Task x Type of stimulus interaction:
The difference between pictures and words was larger for the recognition task than for the recall task.

Age x Type of stimulus interaction: The effect of age was larger for the words than it was for the pictures.

```
Variable   task           Mean
y          Recall         74.20
           Recognition    84.20

Variable   age            Mean
y          Adults         86.200
           Children       72.20

Variable   stimulus       Mean
y          Pictures       83.95
           Words          74.45
```
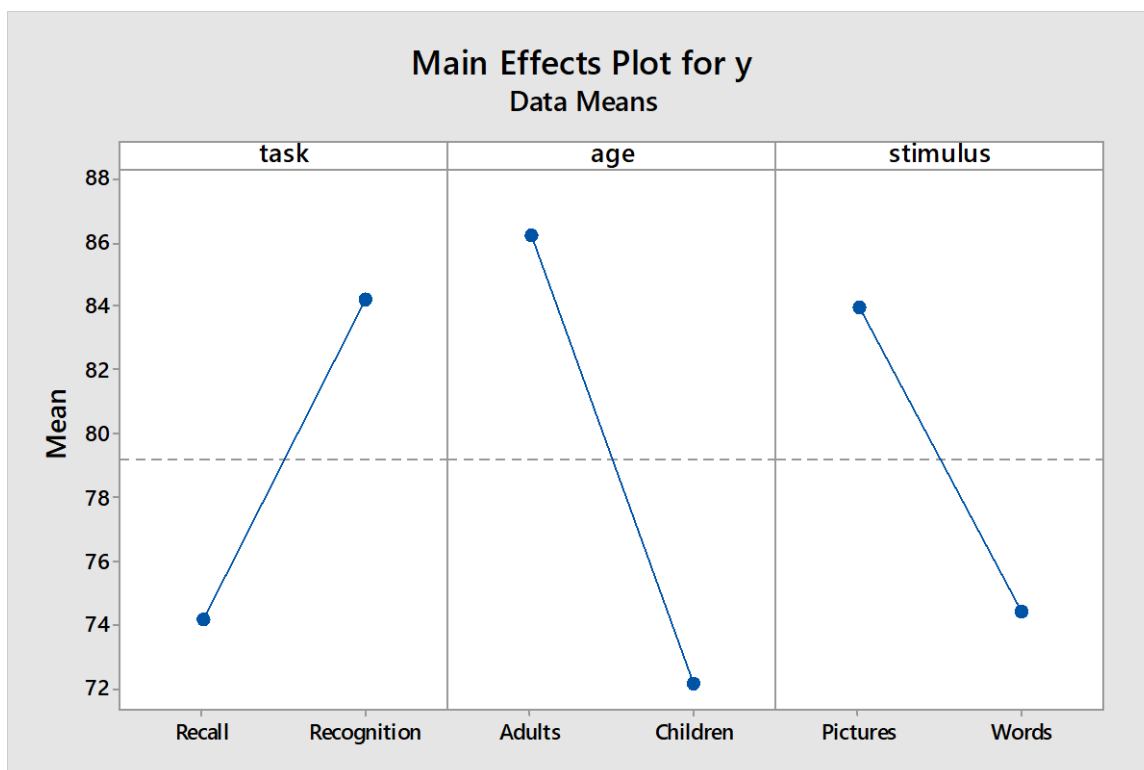

Task: The percent correct was higher for the recognition task than for the recall task.

Age: Adults performed better than children.

Type of stimulus: Memory was better for pictures than for words.

Primary Question --- the effect of age … HOWEVER a 3-way interaction and 2-way interactions exist!!!

… should not look at the effect of age at the main effect level but at a more detailed analysis …

Multiple Comparison for Age – Child vs. Adult at the levels of Task and Type…

		Child	Adult	
Recall	Pictures	67.60	85.80	***
Recall	Words	59.60	83.80	***
Recognition	Pictures	91.00	91.40	
Recognition	Words	70.60	83.80	***

Tukey's W = 2.882 sqrt(3.66/5) = 2.47

===

a three-way interaction means that one, or more, two-way interactions differ across the levels of a third variable.

Meaning
Main Effects
A Comparison of marginal means of Factor A, averaging over levels of B and C

B Comparison of marginal means of Factor B, averaging over levels of A and C

C Comparison of marginal means of Factor C, averaging over levels of A and B

Two-way Interactions
A*B Examines whether the A effect is the same at every level of B, averaging over levels of C
Equivalently, examines whether the B effect is the same at every level of A, averaging over levels of C

A*C Examines whether the A effect is the same at every level of C, averaging over levels of B
Equivalently, examines whether the C effect is the same at every level of A, averaging over levels of B

B*C Examines whether the B effect is the same at every level of C, averaging over levels of A
Equivalently, examines whether the C effect is the same at every level of B, averaging over levels of A

Three-way Interaction
A*B*C Examines whether the two-way A*B interaction is the same at every level of C
Equivalently, examines whether the two-way A*C interaction is the same at every level of B
Equivalently, examines whether the two-way B*C interaction is the same at every level of A
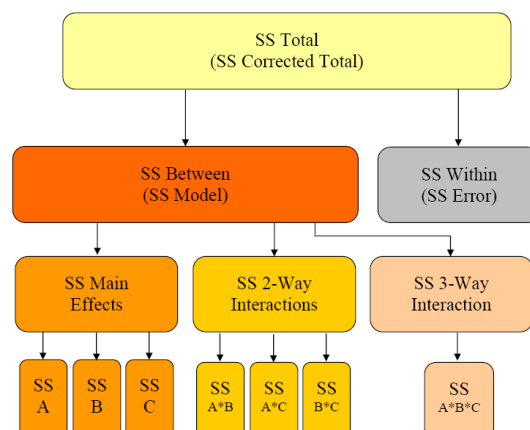
More Resources:

Interpreting Three-way Interactions Using SAS®
http://analytics.ncsu.edu/sesug/2008/ST-139.pdf

When factors such as treatment group, sex, or race are in interaction with a continuous variable, testing for homogeneity of slopes is straightforward. However, when there is a significant 3-way interaction between two continuous variables and a categorical variable for analysis of a continuous dependent variable, the interpretations become complex. The next step should be to look at the parameter estimates to look for trends for interpretation purposes but this is a daunting task since the interaction involves multiple continuous values. This paper will present an approach that will dichotomize one of the continuous variables at the median, obtain the parameter estimates of the slopes for the all combinations of categorical variables, and then graphically represent the separate trends across the levels of the continuous variable. The technique is then repeated for the other continuous variable. The method requires assessing two different graphs where the dependent variable is regressed over a different continuous variable in each graph. This has proven to be an easier approach for interpretation and graphically reporting of the outcomes.

Abstract:

Consider the three-way ANOVA, shown below, with a significant three-way interaction. There are 24 observations in this analysis. In this model **a** has two levels, **b** two levels and **c** has three levels. You will note the significant three-way interaction. Basically, a three-way interaction means that one, or more, two-way interactions differ across the levels of a third variable. In this page, we will show you the steps that are involved and work through them manually.