

# Chapter 17

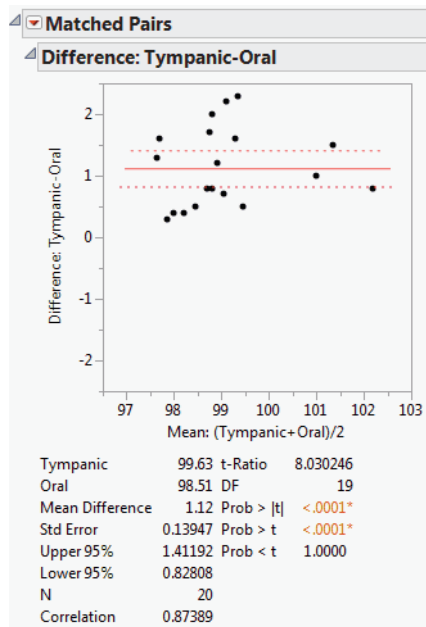
## Matched Pairs Analysis

### Compare Measurements on the Same Subject

The Matched Pairs platform compares the means between two or more correlated variables and assesses the differences. For example, you might compare a blood pressure measurement taken on the same subject before a treatment and again after the treatment. A statistical method called the *paired t-test* takes the correlated responses into account.

The platform produces a graph of the paired differences by the paired means, and the paired *t-test* results for all three alternative hypotheses. Additional features provide for more than two matched responses and for a grouping column to test across samples, in a simple version of repeated measures analysis.

Figure 17.1 Example of Matched Pairs Analysis



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## Overview of the Matched Pairs Platform

The Matched Pairs platform compares row-by-row differences between two response columns using a paired  $t$ -test. Often, the two columns represent measurements on the same subject before and after some treatment. Alternatively, the measurements could represent data taken on the same subject with two different instruments.

If you have paired data arranged in two data table columns, then you are ready to use the Matched Pairs platform. However, if all of your measurements are in a single column, then perform one of the following tasks:

- Use the **Split** option in the **Tables** menu to split the column of measurements into two columns. Then you can use the Matched Pairs platform.
- For two response columns, create a third column that calculates the difference between the two responses. Then test that the mean of the difference column is zero with the Distribution platform.
- For the two responses stored in a single column, you can do a two-way analysis of variance. One factor (the ID variable) identifies the two responses and the other factor identifies the subject. Use the Fit Y by X Oneway platform with a blocking variable (the subject column), or use the Fit Model platform to do a two-way ANOVA. The test on the ID factor is equivalent to the paired  $t$ -test.

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**Note:** If the data are paired, do not do a regular independent  $t$ -test. Do not stack the data into one column and use the Fit Y by X One-way ANOVA on the ID without specifying a block variable. To do this has the effect of ignoring the correlation between the responses. This causes the test to overestimate the effect if responses are negatively correlated, or to underestimate the effect if responses are positively correlated.

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## Example of Comparing Matched Pairs

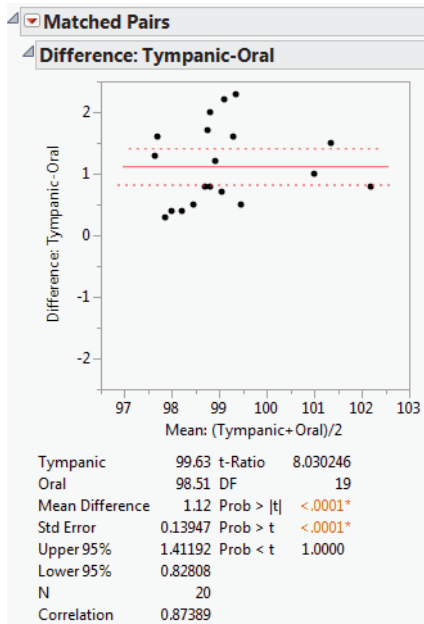
This example uses the Therm.jmp sample data table. The data contains temperature measurements on 20 people. Temperature is measured using two types of thermometers: oral and tympanic (ear). You want to determine whether the two types of thermometers produce equal temperature readings. Note that the differences in temperature between the different people are not important. The matched pairs analysis is testing the differences between the thermometers.

1. Select **Help > Sample Data Library** and open Therm.jmp.
2. Select **Analyze > Specialized Modeling > Matched Pairs**.
3. Select Oral and Tympanic and click **Y, Paired Response**.

4. Click **OK**.

The report window appears.

**Figure 17.2** The Matched Pairs Report Window



The results show that, on average, the tympanic thermometer measures 1.12 degrees higher than the oral thermometer. The small p-value (Prob > |t|) indicates that this difference is statistically significant, and not due to chance.

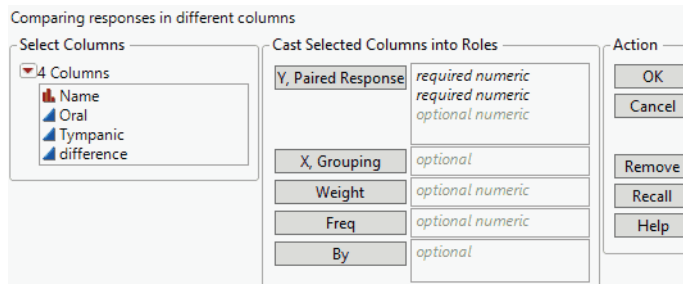
Note that this matched pairs analysis does not indicate which thermometer is correct (if either), but indicates only that there is a difference between the thermometers.

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## Launch the Matched Pairs Platform

Launch the Matched Pairs platform by selecting **Analyze > Specialized Modeling > Matched Pairs**.

**Figure 17.3** The Matched Pairs Launch Window



**Y, Paired Response** Provide the two response columns. For information about analyzing more than two responses, see [“Multiple Y Columns”](#) on page 351.

**X, Grouping** Provide a grouping variable to compare the differences across groups. For more information, see [“Across Groups”](#) on page 353.

**Weight** Identifies one column whose numeric values assign a weight to each row in the analysis.

**Freq** Identifies one column whose numeric values assign a frequency to each row in the analysis.

**By** Performs a separate matched pairs analysis for each level of the By variable.

After you click **OK**, the Matched Pairs report window appears. See [“The Matched Pairs Report”](#) on page 352.

## Multiple Y Columns

You can have more than two responses. If the number of responses is odd, all possible pairs are analyzed. The following table shows an example for three responses.

Y1 by Y2	Y1 by Y3
	Y2 by Y3

If the number of responses is even, the Matched Pairs platform asks whether you want to do all possible pairs. If you do not do all possible pairs, adjacent responses are analyzed as a pair. The following table shows the arrangement of analyses for four responses.

Y1 by Y2

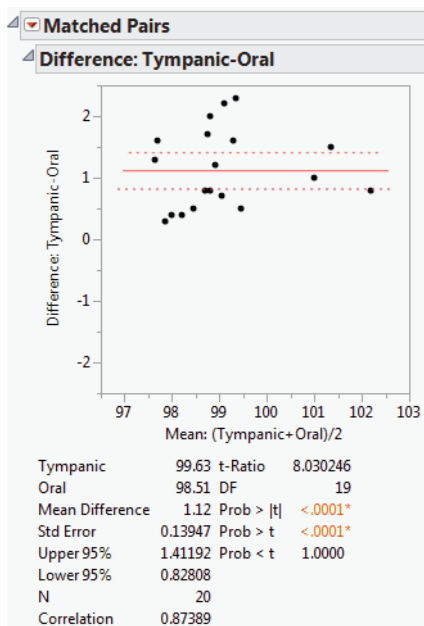
Y3 by Y4

## The Matched Pairs Report

Follow the instructions in “[Example of Comparing Matched Pairs](#)” on page 349 to produce the report window shown in Figure 17.4.

The Matched Pairs report shows a Tukey mean-difference plot, summary statistics, and the results of the paired t-test. See “[Difference Plot and Report](#)” on page 353. If you specified an **X, Grouping** variable, the report also includes the Across Groups report. See “[Across Groups](#)” on page 353.

**Figure 17.4** Example of Matched Pairs Report



**Note:** The red triangle menu provides additional options that can add reports to the initial report window. See “[Matched Pairs Platform Options](#)” on page 353.

## Difference Plot and Report

The Difference plot shows differences by means. In the Difference plot, note the following:

- The mean difference is shown as the horizontal line, with the 95% confidence interval above and below shown as dotted lines. If the confidence region includes zero, then the means are not significantly different at the 0.05 level. In this example, the difference is significant.
- If you add a reference frame, the mean of pairs is shown by the vertical line. For details about a reference frame, see [“Matched Pairs Platform Options”](#) on page 353.

The Difference report shows the mean of each response, the difference of the means, and a confidence interval for the difference. The Difference report also shows the results of the paired t-test.

## Across Groups

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**Note:** The Across Groups report appears only if you have specified an **X, Grouping** variable.

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The Across Groups analysis corresponds to a simple repeated measures analysis. (You can get the same test results using the **Manova** personality of the Fit Model platform.)

**Mean Difference** Shows the mean of the difference across rows in each group between the two paired columns. In other words, this is the within-subject by across-subject interaction, or split-plot by whole-plot interaction.

**Mean Mean** Shows the mean of the mean across rows in each group across the two paired columns. In other words, this is the across-subject or whole-plot effect.

**Test Across Groups** Two *F*-tests determine whether the across-groups values are different:

**Mean Difference** Tests that the change across the pair of responses is different in different groups.

**Mean Mean** Tests that the average response for a subject is different in different groups

### Related Information

- [“Example Comparing Matched Pairs across Groups”](#) on page 355

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## Matched Pairs Platform Options

The Matched Pairs red triangle menu contains the following options:

**Plot Dif by Mean** Shows or hides the plot of the paired differences by paired means. For a detailed description of this plot, see [“Difference Plot and Report”](#) on page 353.

**Plot Dif by Row** Shows or hides the plot of paired differences by row number.

**Reference Frame** Shows or hides the reference frame on the Plot Dif by Mean plot. A rectangle showing where a plot of Y2 by Y1 would be located inside the plot, tilted and possibly squished. A vertical red line is shown representing the mean of means. The reference frame is shown initially when the range of the differences is greater than half the range of the data.

**Wilcoxon Signed Rank** Shows or hides the Wilcoxon signed rank test. The Wilcoxon signed rank test is applied to the paired differences. It is a nonparametric test that compares the sizes of the positive differences to the sizes of the negative differences. The test uses the Pratt method to address zero differences. The test also assumes that the distribution of differences is symmetric. For details, see the Distributions chapter in the *Basic Analysis* book. See also Lehman (2006), Conover (1999, p. 350), and Cureton (1967).

**Sign Test** Shows or hides the sign test. This is a nonparametric version of the paired t-test that uses only the sign (positive or negative) of the difference for the test.

**Set  $\alpha$  Level** Changes the alpha level used in the analyses. Affects the confidence intervals in the report and on the plot.

See the JMP Reports chapter in the *Using JMP* book for more information about the following options:

**Local Data Filter** Shows or hides the local data filter that enables you to filter the data used in a specific report.

**Redo** Contains options that enable you to repeat or relaunch the analysis. In platforms that support the feature, the Automatic Recalc option immediately reflects the changes that you make to the data table in the corresponding report window.

**Save Script** Contains options that enable you to save a script that reproduces the report to several destinations.

**Save By-Group Script** Contains options that enable you to save a script that reproduces the platform report for all levels of a By variable to several destinations. Available only when a By variable is specified in the launch window.



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## Example Comparing Matched Pairs across Groups

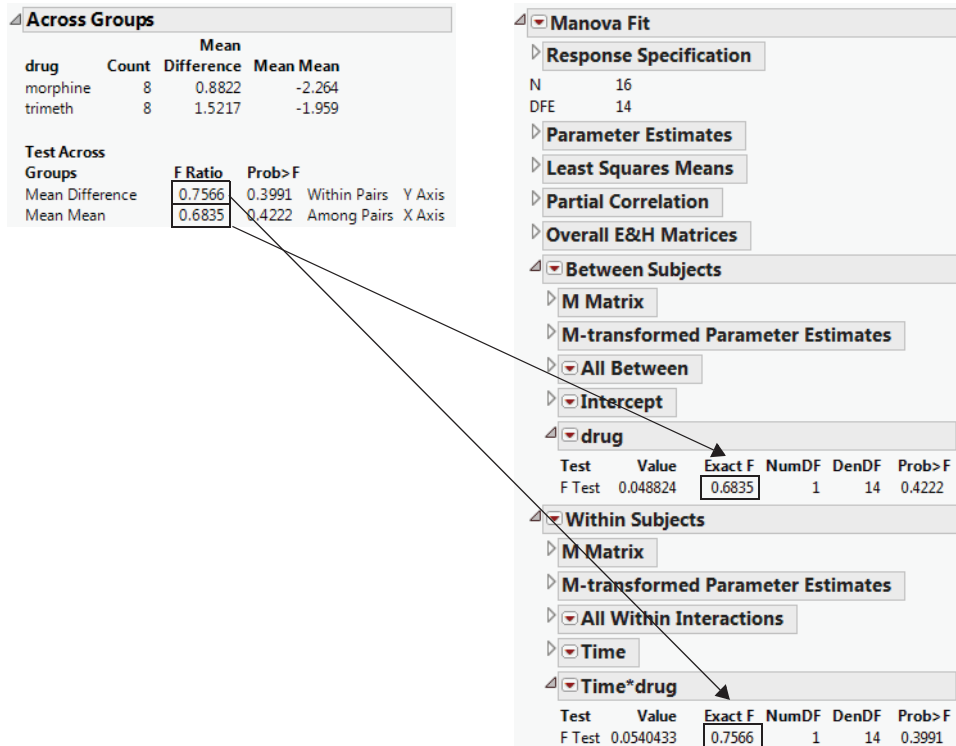
This example uses the Dogs.jmp sample data table. This example shows you how to produce both a Matched Pairs Across Groups report and the corresponding MANOVA report using Fit Model.

1. Select **Help > Sample Data Library** and open Dogs.jmp.
2. Select **Analyze > Specialized Modeling > Matched Pairs**.
3. Select LogHist0 and LogHist1 and click **Y, Paired Response**.
4. Select drug and click **X, Grouping**.
5. Click **OK**.

The report on the left in Figure 17.5 appears.

Now produce the Fit Model report using the same data table.

1. Select **Analyze > Fit Model**.
2. Select LogHist0 and LogHist1 and click **Y**.
3. Select drug and click **Add**.
4. Select the **Manova** personality.
5. Click **Run Model**.
6. In the Response Specification report, select **Repeated Measures** from the **Choose Response** menu.
7. Click **OK**.

**Figure 17.5** Examples of Matched Pairs across Groups and Fit Model MANOVA with Repeated Measures


The F Ratio for the Mean Difference in the Across Groups report corresponds to the F Ratio for Time\*drug under the Within Subjects report. The F Ratio for the Mean Mean in the Across Groups report corresponds to the F Ratio for drug under Between Subjects in the Manova Fit report.

## Statistical Details for the Matched Pairs Platform

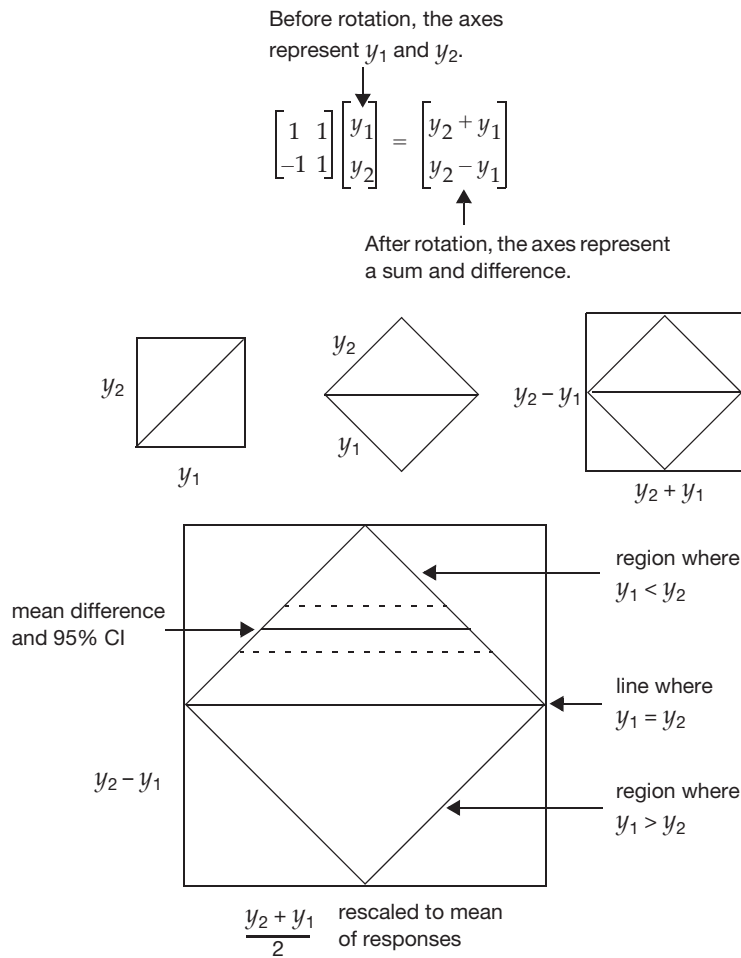
- “Graphics for Matched Pairs”
- “Correlation of Responses”

### Graphics for Matched Pairs

The primary graph in the platform is a Tukey mean-difference (Cleveland 1994, p. 130). This graph plots the difference of the two responses on the vertical axis against the mean of the two responses on the horizontal axis. This graph is the same as a scatterplot of the two original

variables, but turned 45 degrees. A 45 degree rotation and rescaling turns the original coordinates into a difference and a mean.

**Figure 17.6** Example of Transforming to Difference by Mean, Rotated by 45 Degrees



## Correlation of Responses

In most cases where the pair of measurements is taken from the same individual at different times, they are positively correlated. However, if they represent competing responses, the correlation can be negative.

Figure 17.7 shows how the positive correlation of the two responses becomes the small variance on the difference (the vertical axis). If the correlation is negative, the ellipse is oriented in the other direction and the variance of the rotated graph is large on the vertical axis.

**Figure 17.7** Examples of Positive Correlation Before and After Rotation