Generating Independent Sample T-statistics and How Weighting Affects Results: mTAB vs. SPSS

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When to Use the T Test for Independent Samples

When analyzing data, analysts typically want to compare ratings/scores among independent groups of respondents. For example, is there a difference in overall vehicle satisfaction ratings when comparing Brand A vehicle owners to Brand B vehicle owners? Or, is there a difference in the overall satisfaction rating for a school program when comparing students with parents? The T Test for Independent Samples is appropriate in both instances. mTAB allows analysts to easily generate T-statistics and use them to determine if mean rating differences from the independent samples are significant.

Comparing mTAB and SPSS T-test results

The following examples will show that mTAB and SPSS yield identical T-statistic results when unweighted datasets are used. When weighted datasets are used, the examples will show that mTAB and SPSS will yield different T-statistic results because SPSS uses weighted bases and mTAB uses unweighted bases when calculating T-statistics. Finally, the comparison of weighted T-tests will show why using weighted bases can sometimes yield false conclusions of significant mean differences.

Some Considerations before Running a T Test for Independent Samples

Equal or Unequal Variances?

There are two T-statistic values that can be generated for independent samples: T-statistic for equal variances and T-statistic for unequal variances. Actually, the two tests tend to be fairly close with most distributions. If you are unsure about the difference between the two tests, use the T test for unequal variances as a conservative approach.

If you are more familiar with data distributions and variances, you can run some preliminary summary statistics to examine the variances of your dependent variable ahead of time to help decide which T test to use. However, the best way to determine if the data has equal or unequal variances is to perform Levene's Test for Equality of Variances (F test).

When using Levene’s Test, the test fails if F is large and the p value (usually denoted as sig) is less than .05, meaning that the variances are not equal and the T test for unequal variances should be used.

Dependent Variable (Rating) Scale
Survey data is often collected using rating scales. It is important to be familiar with the scale of the survey question you are using. In many instances, data has to be rescaled for any number of reasons: to match the scale in a previous wave, to allow for the mean rating to be calculated correctly, or to transform to a numbered scale. Examining the scale of key variables is particularly important if you have used mTAB’s “Slice” feature, which allows users to extract raw data from mTAB for proprietary studies. When “Slice” is used, the extracted data sometimes has to be rescaled because only the raw data is exported. mTAB often uses rescaling for the reasons mentioned above. The rescaling is an independent process and not part of the raw data. When comparing results to published/mTAB results from the same dataset, the analyst may have to transform or recode the question scale to get the correct/matching results.

Examples are:

Please rate your overall satisfaction using the 5 point scale where 1 is “completely satisfied,” 2 is “somewhat satisfied,” 3 is “neither satisfied nor dissatisfied,” 4 is “somewhat dissatisfied” and 5 is “completely dissatisfied.”

Please rate your overall satisfaction using the 5 point scale where 1 is “completely satisfied” and 5 is “completely dissatisfied”

Please rate your overall satisfaction using the 5 point scale where 5 is “completely satisfied” and 1 is “completely dissatisfied”

Please rate your overall satisfaction using the 10 point scale where 1 is “completely satisfied” and 10 is “completely dissatisfied”

Data Weighting

Data results are frequently balanced or weighted to simulate a population or market. The following is an example from the auto industry: Make/model ownership survey data is often weighted using actual registration or sales figures so that the survey results reflect the correct make/model ownership mix in the current market.

Statistical test results, like those generated from the T Test for Independent Samples are altered when weighted datasets are used. Weighting data distorts the distribution of the data which alters statistic results such as mean and standard deviation. Many times these alterations are slight (by one tenth, one hundredth, or one thousandth). Many of the test statistic formulas, such as the T-statistic, include mean and standard deviation in the formula. These summary statistic changes usually have a small effect on the test statistic (T-statistic) result. However, the bigger influence on the test statistic when using weighted datasets is the group sample size or base size. Since the base sizes can be greatly altered by weighting and base sizes are used in the test statistic (T-statistic) formula, the base size is the biggest influence on the weighted test statistic (T-statistic) result.

For this reason, some researchers argue that test statistics, including tests of significance, should only be performed on unweighted datasets. Others argue that weighted test statistic results are fine to use because, in most cases, the conclusion drawn will be the same whether weighted or unweighted data is used. Finally, since base size is the greatest influence on the test statistic result of a weighted dataset, others simply recommend replacing the weighted base sizes with the unweighted base sizes in the test statistic formula, while still using the weighted summary statistics such as mean and standard deviation. When the data is weighted, mTAB uses the unweighted base sizes, but weighted summary statistics in test statistic calculations.
mTAB T-statistic Formulas for equal and unequal variances where:

SDx = standard deviation

Mx = Mean

US = unweighted sample

T-Statistic Equal Variances

\[ \frac{(Mo - Mr)}{\sqrt{SDo^2 \times (USo-1) + SDr^2 \times (USR-1)}} \times \left( \frac{1}{USo} + \frac{1}{USR} \right) \]

T-statistic Unequal Variances

\[ \frac{(Mo - Mr)}{\sqrt{SDo^2 \times USo + SDr^2 \times USR}} \]

Test Case Examples: Comparing mTAB and SPSS T-statistic Results for Independent Samples: Dataset Information and Background

Example Data Information

The following examples use a data set containing

A weighting variable (V1)

two brands (Brand A=1, Brand E=5)

overall satisfaction 5 point rating scaled as the following:

- 9.5 = completely satisfied
- 7.5 = very satisfied
- 5.5 = fairly satisfied
- 3.5 = somewhat dissatisfied
- 1.5 = very dissatisfied

How to Obtain T-statistics in mTAB (Format Styles: Custom)

Start by dragging “Overall Opinion of Item” over to the ROW tab twice. Highlight both “Overall Opinion” variables in the ROW tab and use the AVAILABLE FORMATS STYLES drop down menu and select MEAN. Then, highlight the first “Overall Opinion” variable in the ROW tab and Right Click and choose FORMAT STYLES to bring up the full FORMAT STYLES menu.
First step:
Create a new mTAB “Format Style” that you will name T Stat for equal Variances.

Once in the FORMAT STYLES menu, choose NEW.

In the NEW FORMATS STYLE menu, type in a new name for the format in the FORMAT STYLE NAME box. Maximize the STATISTICS option in the AVAILABLE FORMAT OPTIONS box and Double Click the T-STATISTIC (EQUAL VARIANCES) option so that it appears in the FORMAT DISPLAY ORDERING box. In this example, the same steps were taken to also include the WEIGHTED TOTAL SAMPLE COUNT from the TOTALS option in the AVAILABLE FORMAT OPTIONS box. Click OK when completed. Then choose APPLY.

The steps in the paragraph directly above are repeated for the second “Overall Opinion” variable in the ROW tab, but this time choosing T-STATISTIC (UNEQUAL VARIANCES) and then titling the format style appropriately.
Setting up the Tab in mTAB

“Overall Opinion” variables (same variable twice) should already be in the ROW tab from the “How to Obtain T-Statistics in mTAB” above. The first ROW variable is formatted as T-Stat Equal Variances and the second is formatted as T-Stat Unequal Variances, again from the previous section.

In this case, our independent variable is “Brand of Item Purchased” and is moved over to the COLUMN tab. Once in the COLUMN tab, highlight the COLUMN variable and Right Click, choosing SUBSET.

In the SUBSET editor, choose the groups you want to compare. In this case, Brand A and Brand E are selected. Click OK.
Test Case Examples: Comparing mTAB and SPSS T-statistic Results for Independent Samples: Unweighted Example

This example illustrates the comparison between mTAB results and SPSS results when the same dataset is used in both packages. The weights are ignored in mTAB and the SPSS test is performed on unweighted data.

Ignoring the Weights in mTAB

By default, mTAB applies any weights assigned to a dataset when running all tabs. For unweighted results, the weights must be “turned off” or “ignored.” Since this is an unweighted example, the weights are ignored by:

Select the VIEW ribbon and click on the STUDY WEIGHTS icon.
Select the USE SELECTED WEIGHT radio button on the STUDY WEIGHT CONFIGURATION menu
Use the STUDY WEIGHTS drop down menu to select NO WEIGHT or UNWEIGHTED and click OK

Obtaining the Unweighted Results in mTAB
Now that the weights are “turned off,” run the tab.

Run the tab by selecting the RUN, RUN TAB on the QUESTION ribbon.

mTAB Unweighted Results

Once the results run, highlight the Brand A column and choose the BASE COLUMN icon. Choose SET BASE Column to set the base comparison column to Brand A.

NOTE: This example uses only two groups (Brand A and E). mTAB supports group comparisons of more than two. Simply select more Brands (groups) in the COLUMN SUBSET menu for more group comparisons. Because mTAB supports more than two groups for comparison, it is important to set the base comparison column as pictured below.

The final results appear below. Custom highlighting was added to aid with the SPSS comparison results that follow. Note: these are two-tailed test results at the 95% confidence level.

Obtaining Unweighted Results in SPSS

Within the ANALYZE MENU under COMPARE MEANS, select INDEPENDENT - SAMPLES T TEST. Place the “Overall Opinion” variable in the TEST VARIABLE BOX.
and place the “Brand” variable in the GROUPING VARIABLE box. Make sure to define the groups by choose “1” for Brand A and “5” for Brand E. SPSS only supports a two group comparison within the INDEPENDENT –SAMPLE T TEST function.

Note: The weighting function within SPSS is not used in this example and the “Overall Opinion” variable was scaled (recoded) to match mTAB scaling.

Note: Levene’s Test for Equality of Variances fails as F is large and the significance value is less than .05.

Comparing Unweighted Results: mTAB vs. SPSS

The sample output above (SPSS and mTAB) yields the same results. T-statistics means and unweighted sample counts are identical. The SPSS and mTAB results show there is a significant difference between mean ratings for Brand A and Brand E.

**Test Case Examples: Comparing mTAB and SPSS T-statistic Results for Independent Samples: Weighted Example**

**Obtaining the Weighted Results in mTAB**

Using study weights is the default in mTAB. If study weights have not been manually “turned off”, Run the same tab from the “Unweighted” example. If the study weights have manually been set to “No Weight” or “Unweighted”:

1) Select the VIEW ribbon and click on the STUDY WEIGHTS icon.
2) Select the USE ASSIGNED WEIGHTS radio button and click OK

Run the tab by selecting the RUN, RUN TAB

**mTAB Weighted Results**

Once the results run, highlight the Brand A column and choose the BASE COLUMN icon. Choose SET BASE Column to set the base comparison column to Brand A.
mTAB performs the test using weighted summary statistics, but uses unweighted base counts to remove the test distortion driven by weighting the data.

The final results appear below. Custom highlighting was added to aid with the SPSS comparison results that follow. As a reminder, mTAB performs the test using weighted summary statistics, but uses unweighted base counts (6,148 and 1,286, respectively) to combat the test distortion driven by weighting the data.

Obtaining Weighted Results in SPSS

When importing a dataset into SPSS or SAS, weight parameters must be defined if data weighting is desired. If weighting parameters are not defined and applied, any results will be unweighted, by default. Before any weighted tests are performed or weighted summary statistics are calculated in SPSS, the weight function must be defined and applied. A weight can be applied by

1) Go to DATA menu in SPSS and choose WEIGHT CASES

2) Select the WEIGHT CASES BY radio button

3) Drag the weight variable (V1 in this example) over to the FREQUENCY VARIABLE box and click OK
Unlike mTAB, SPSS uses weighted summary statistics and weighted bases to calculate weighted T-statistics.

Again, within the ANALYZE MENU under COMPARE MEANS, select INDEPENDENT - SAMPLES T TEST. Place the “Overall Opinion” variable in the TEST VARIABLE BOX and place the “Brand” variable in the GROUPING VARIABLE box. Make sure to define the groups by choosing “1” for Brand A and “5” for Brand E.

Notes:
SPSS only supports a two group comparison within the INDEPENDENT –SAMPLE T TEST function

The weighting function within SPSS is used in this example and the “Overall Opinion” variable was scaled (recode) to match mTAB scaling

Levene’s Test for Equality of Variances fails as F is large and the p-value (sig) is less than .05

SPSS uses weighted summary statistics and weighted bases to calculate weighted T-statistics

The weighted T-statistic value in mTAB (using unweighted bases) better approximates the true unweighted T-statistic value.

Comparing Weighted Results: mTAB vs. SPSS

The sample output above (SPSS and mTAB) yield different results. While means and weighted sample counts are identical, the T-statistics are very different. Using the “Unequal Variances” T-statistic as an example, mTAB calculates T as 4.020 while SPSS calculates T as 19.810. This difference is due to the use of weighted bases in the SPSS calculation vs. the unweighted bases used in the mTAB calculation. The weighted mTAB T-statistic is much closer to the true unweighted T-statistic of 3.249 from the unweighted example. However, both SPSS and mTAB weighted test results show there is a significant difference.
between mean ratings for Brand A and Brand E as the significance value for T (.000-SPSS, .000-mTAB) is less than .05.

While the values of the weighted T-statistics are different (SPSS vs. mTAB), the same overall conclusion is drawn in this example (the mean ratings are significantly different). However, using weighted bases in the weighted T-statistic calculation/test can sometimes lead to a false conclusion that the means are significantly different. Larger base sizes have more of a tendency to yield significant results, simply due to the T-statistic formula. Weighted bases are larger than unweighted bases; hence, using weighted bases has more risk of a false positive conclusion (the mean ratings are significantly different, when they're not).

Conclusions

If unweighted datasets are used, SPSS and mTAB yield the same T-statistic values and conclusive results. If weighted datasets are used, mTAB and SPSS yield different T-statistic value results. This difference is solely influenced by mTAB using unweighted bases and SPSS using weighted bases in the T-statistic calculation. Using weighted bases when performing a T-test can sometimes lead to false conclusions of significant mean differences. Furthermore, the weighted T-statistic value in mTAB (using unweighted bases) better approximates the true unweighted T-statistic value.
About the Author

Renee M. Love, Research Director of Productive Access, Inc., has over 18 years of market research industry experience, including project design, data processing, statistical analysis and “finding the story” within a research project.

Renee has a in depth knowledge of SPSS as well as Productive Access’s mTAB survey analysis tool, having trained Fortune 500 Consumer Marketing Analysts and Marketing Researchers in the operation of both analysis tools.

mTAB enables companies to maximize the value from past and present marketing research by providing a data prep service and software, making large non-uniform data sets easy to analyze, insightful and immediately accessible for everyone.

To learn more about how mTAB can extend the value of your existing marketing research projects, please visit our website at http://www.mtabsurveyanalysis.com.