

Chapter 13

Implementing Basic Differences Tests

Learning Objectives

- To learn how differences are used for market segmentation decisions
- To understand when t tests or z tests are appropriate and why you do not need to worry about this issue when using SPSS
- To be able to test the differences between two percentages or means for two independent groups
- To know what a paired samples difference test is and when to use it
- To comprehend ANOVA and how to interpret ANOVA output
- To learn how to perform differences tests for means using SPSS

"WHERE WE ARE"

- 1 Establish the need for marketing research.
- 2 Define the problem.
- 3 Establish research objectives.
- 4 Determine research design.
- 5 Identify information types and sources.
- 6 Determine methods of accessing data.
- 7 Design data collection forms.
- 8 Determine the sample plan and size.
- 9 Collect data.
- 10 Analyze data.
- 11 Prepare and present the final research report.

Why Differences are Important

- **Market segmentation** is based on differences between groups of consumers.
- **One commonly used basis for market segmentation is the discovery of differences that are the following:**
 - 1-Statistically significant
 - 2-Meaningful
 - 3-Stable
 - 4-Actionable differences

1-Differences must be statistically significant.

- **Statistical significance of differences** : means the differences found in the sample(s) truly exist in the population(s) from which the random samples are drawn.
- To be potentially useful to marketing researcher or manager , differences must , at minimum be statistically significant.

2- Differences must be meaningful.

- **Meaningful difference:** one that the marketing manager can potentially use as a basis for marketing decisions.
- The differences between the market segments should be of such a magnitude that the market can target them individually.

3-Differences should be **stable**.

-Stable difference is one that will be in place for the foreseeable future.

-To be potentially useful to marketing researcher or manager , differences must ,if statistically significant and meaningful , be stable.

4- Differences must be actionable.

- **Actionable difference means** the marketer can focus various marketing strategies and tactics, such as product design or advertising, on the market segments to accentuate the differences between segments.
- To be potentially useful to marketing researcher or manager , differences must ,if statistically significant ,meaningful , stable and actionable.

Small Sample Sizes: The Use of a *t* Test or *z* Test and How SPSS Eliminates the worry

- ***t* Test:** statistical inference test to be used with small sample sizes ($n \leq 30$)
- ***z* Test:** statistical inference test to be used when the sample size is 30 or greater
- Note: Most computer statistical programs report **only the *t* value** because it is identical to the *z* value with large samples.

- The great advantage to using statistical routines on a computer is that they are programmed to compute the correct statistic.

Testing for Significant Differences Between Two Groups

- Statistical tests are used when researcher wants to compare the **means** or **percentages** of two different groups or samples.

Differences Between Percentages with Two Groups (Independent Samples)

- **Independent samples** are treated as representing two potentially different populations.
- **Null hypothesis:** the hypothesis that the difference in the population parameters is equal to zero
- With a differences test, the null hypothesis states that there is **no difference** between the percentages (or means) being compared.
- alternative to the null hypothesis is that **there is a true difference** between the population parameters.

TABLE 13.1 Null Hypotheses for Group Differences Tests

Null Hypothesis	What Does It Mean if the Hypothesis Is Not Supported?
Differences between two group percents No difference exists between the percents of the two groups (populations).	A difference does exist between the percents of the two groups (populations).
Differences between two group means No difference exists between the means of the two groups (populations).	A difference does exist between the means of the two groups (populations).
Differences in means among more than two groups (Note: Only differences in means can be tested here) No difference exists between the means of all paired groups (populations).	A difference exists between the means of at least one pair of groups (populations).

Formula for Significance of the Difference Between Two Percentages

$$z = \frac{p_1 - p_2}{s_{p_1 - p_2}}$$

where

p_1 = percentage found in sample 1

p_2 = percentage found in sample 2

$s_{p_1 - p_2}$ = standard error of the difference between two percentages.

Go to p357-358 for example

- If Z is greater than 1.96 the difference between the two percentages is significant.
- With a differences test, you test the null hypothesis that no differences exist between the two group means (or percentages).
- If the null hypothesis is true, we would expect there to be no differences between the two percentages.
- Yet we know that, in any given study, differences may be expected due to sampling error.

- If the null hypothesis were true, we would expect 95% of the z scores computed from 100 samples to fall between $+1.96$ and -1.96 standard errors.
- If the computed z value is greater than $+1.96$ or -1.96 , it is not likely that the null hypothesis of no difference is true. Rather, it is likely that there is a real statistical difference between the two percentages.

Using SPSS for Differences Between Percentages of Two Groups

- SPSS does not perform tests of significance of the difference between the percentages of two groups, but you can use SPSS to generate the relevant information and perform a hand calculation.
- Use the SPSS command `FREQUENCIES` to produce the percentages you need.

Testing the Difference Between Means

- We have three testing difference between means;
 - 1-Differences between **two means from independent samples**
 - 2-Differences between **three or more means from independent samples**
 - 3-Differences between **paired means**

First; Differences Between Means with Two Groups (Independent Samples)

- The procedure for testing the significance of difference between two means from two different groups is identical to the procedure for testing two percentages.

Formula for significance of the difference between two means

$$z = \frac{\bar{x}_1 - \bar{x}_2}{s_{\bar{x}_1 - \bar{x}_2}}$$

Where

\bar{x}_1 = mean found in sample 1

\bar{x}_2 = mean found in sample 2

$s_{\bar{x}_1 - \bar{x}_2}$ = standard error of the difference between two means

Formula for the standard error of the difference between two means

$$s_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

Where

s_1 = standard deviation in sample 1

s_2 = standard deviation in sample 2

n_1 = size of sample 1

n_2 = size of sample 2

An Example: Testing the Difference Between Two Means

- Do male teens and female teens drink different amounts of sports drinks?

Computation of the significance of the difference between two means

$$\begin{aligned} z &= \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} & \bar{x}_1 &= 9.0 \\ & & \bar{x}_2 &= 7.5 \\ &= \frac{9.0 - 7.5}{\sqrt{\frac{2^2}{100} + \frac{1.2^2}{100}}} & s_1 &= 2.0 \\ & & s_2 &= 1.2 \\ &= \frac{1.5}{\sqrt{.04 + .0144}} & n_1 &= 100 \\ & & n_2 &= 100 \\ &= \frac{1.5}{0.233} \\ &= 6.43 \end{aligned}$$

The difference between males (9 bottles) and females (7.5 bottles) is significant; $z = 6.43$.

FIGURE 13.1 A Significant Difference Exists Between the Two Means Because z Is Calculated to Be Greater Than 1.96 (95% Level of Confidence)

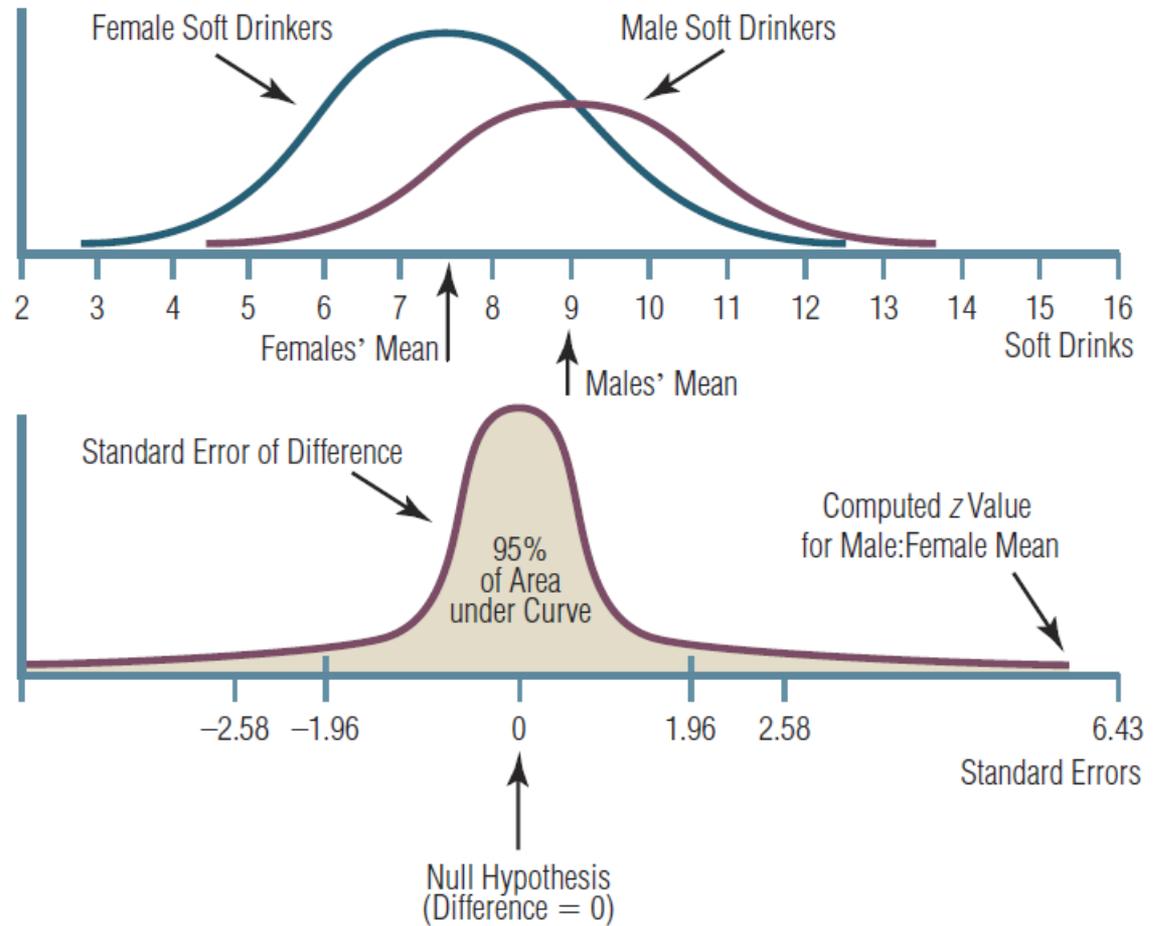


FIGURE 13.2 The SPSS Clickstream to Obtain an Independent Samples t Test

Source: Reprint courtesy of International Business Machines Corporation, © SPSS, Inc., an IBM Company

The image shows a screenshot of the SPSS software interface. The 'Analyze' menu is open, and the path 'Analyze > Compare Means > Independent-Samples T Test...' is highlighted. Callout 1 points to this menu path. Below the menu, the 'Independent-Samples T Test' dialog box is open. The 'Test Variable(s)' field contains 'Desirability Standard Si...'. The 'Grouping Variable' field contains 'gender (2, 2)'. Callout 2 points to the 'Define Groups...' button. The 'Define Groups' dialog box is also open, showing 'Use specified values' selected, with 'Group 1' set to 0 and 'Group 2' set to 1. Callout 3 points to the 'Continue' button. Callout 4 points to the 'OK' button in the 'Independent-Samples T Test' dialog box.

1 Use Compare Means - Independent-Samples T Test

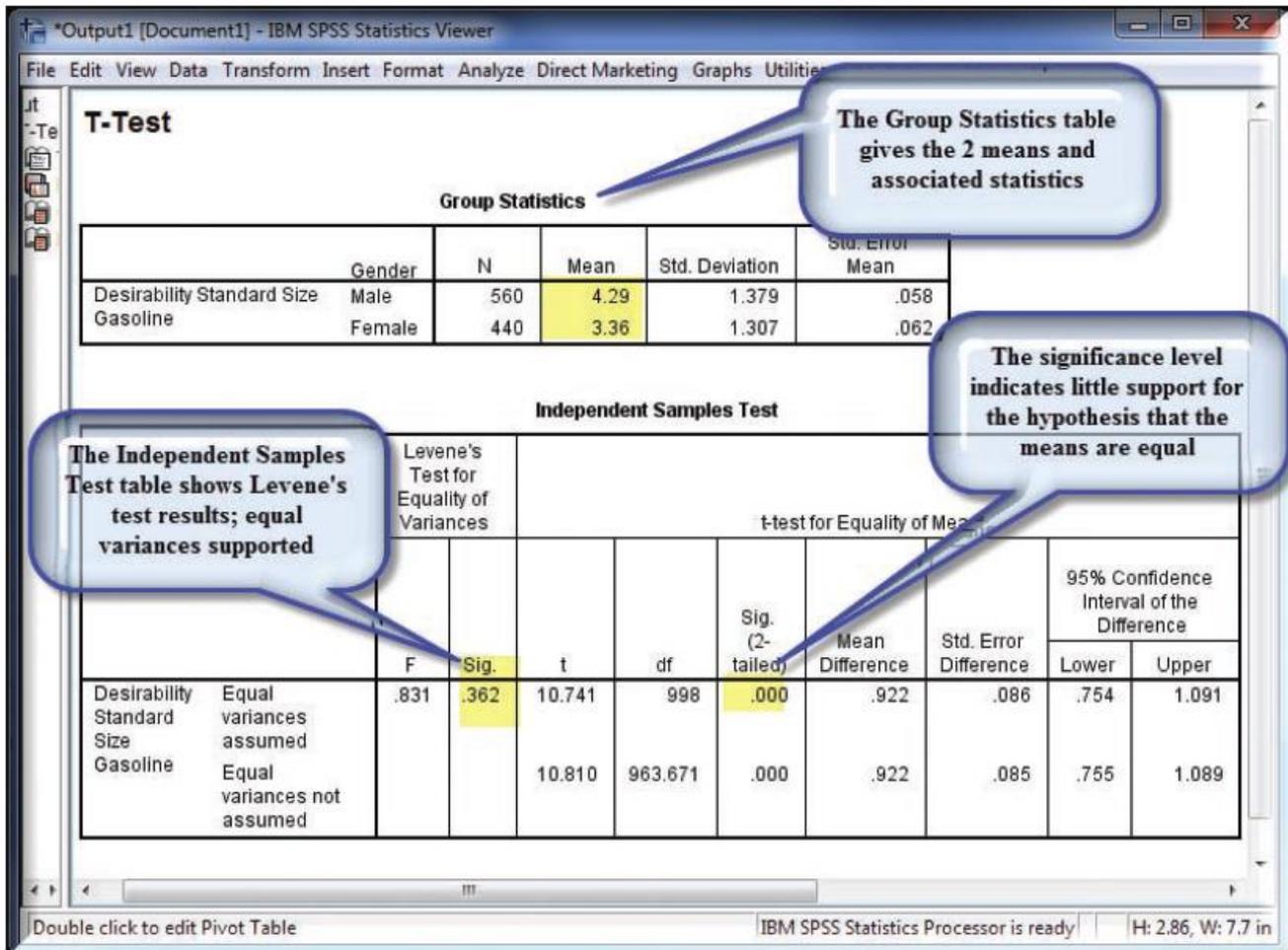
2 Select Test Variable(s) and Grouping Variable; Click on Define Groups...

3 Enter the value codes for each of the 2 groups to be used in the analysis; click Continue

4 After selecting Variables and Defining groups, click OK to perform analysis

FIGURE 13.3
SPSS Output for an Independent Samples t Test

Source: Reprint courtesy of International Business Machines Corporation, © SPSS, Inc., an IBM Company



Second; Testing for significant differences in means Among than two Group; Analysis of Variance

- **Analysis of variance (ANOVA):** used when comparing the means of three or more groups
- ‘ANOVA is an investigation of the differences between the group means to ascertain whether sampling errors or true population differences explain their failure to be equal.

- ANOVA will “flag” when at least one pair of means has a statistically significant difference, but it does not tell which pair.

TABLE 13.2 Results of 5 Independent Samples *t* Tests of How Likely Customers Are to Return to Make Their Next Major Purchase

Groups compared	Group means*		Significance
Electronics: Home and Garden	5.1: 5.3	.873	Significant difference between the two compared groups
Electronics: Sporting Goods	5.1: 5.6	.469	
Electronics: Automotive	5.1: 2.2	.000	
Home and Garden: Sporting Goods	5.3: 5.6	.656	
Home and Garden: Automotive	5.3: 2.2	.000	
Sporting Goods: Automotive	5.6: 2.2	.000	

*Based on a scale where 1 = very unlikely and 7 = very likely.

TABLE 13.3 Results of ANOVA of How Likely Customers Are to Return to Make Their Next Major Purchase

F	Sig.	
226.991	.000	

There is a significant difference between at least two groups

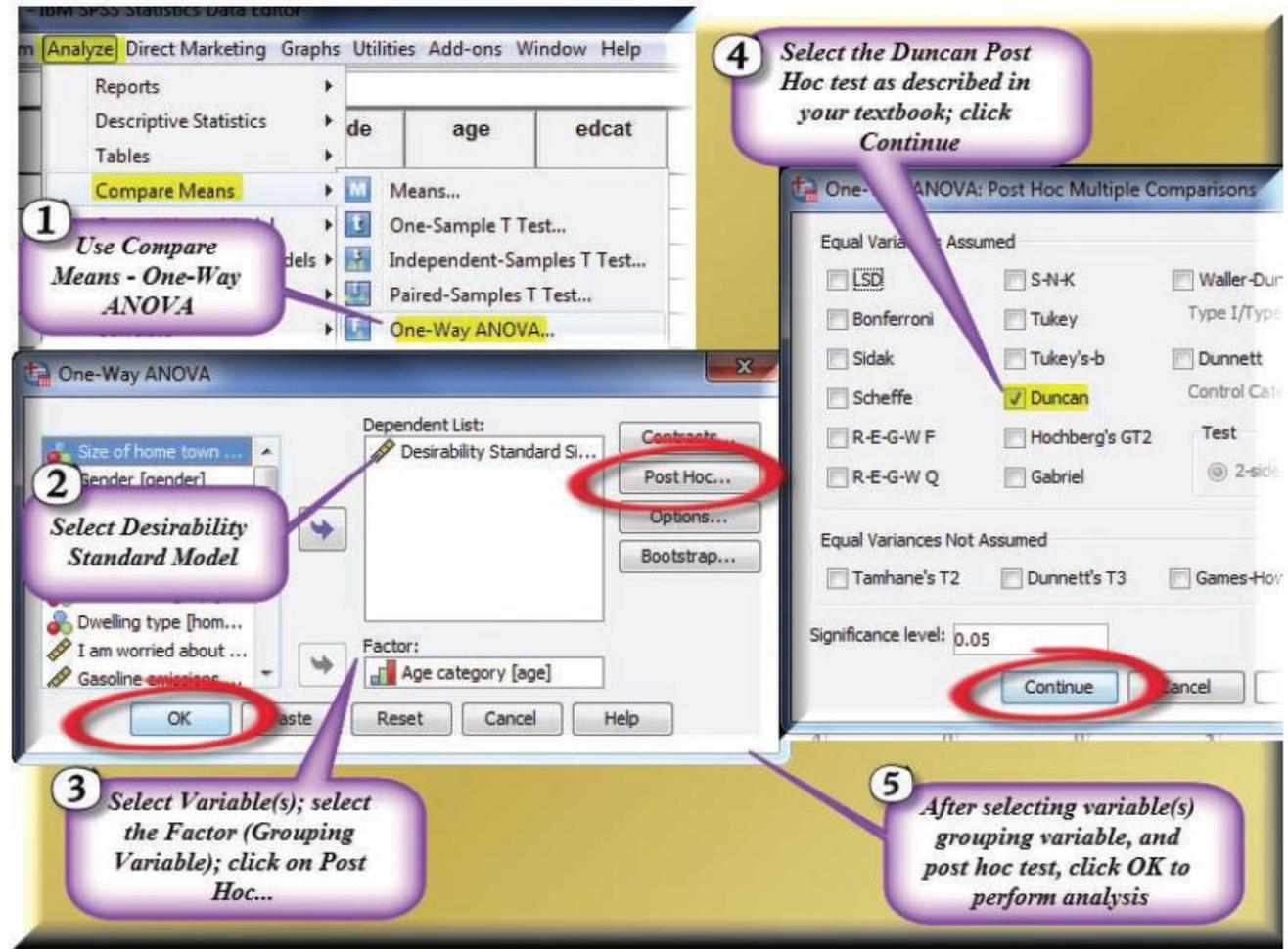
Department	Subsets*	
	1	2
Automotive	2.2	
Electronics		5.1
Home and Garden		5.3
Sporting Goods		5.6

We have a problem with the Automotive Department!

*Means in the same column are not significantly different; means in different columns are significantly different.

FIGURE 13.4 SPSS Clickstream to Perform Analysis of Variance (ANOVA)

Source: Reprint courtesy of International Business Machines Corporation, © SPSS, Inc., an IBM Company



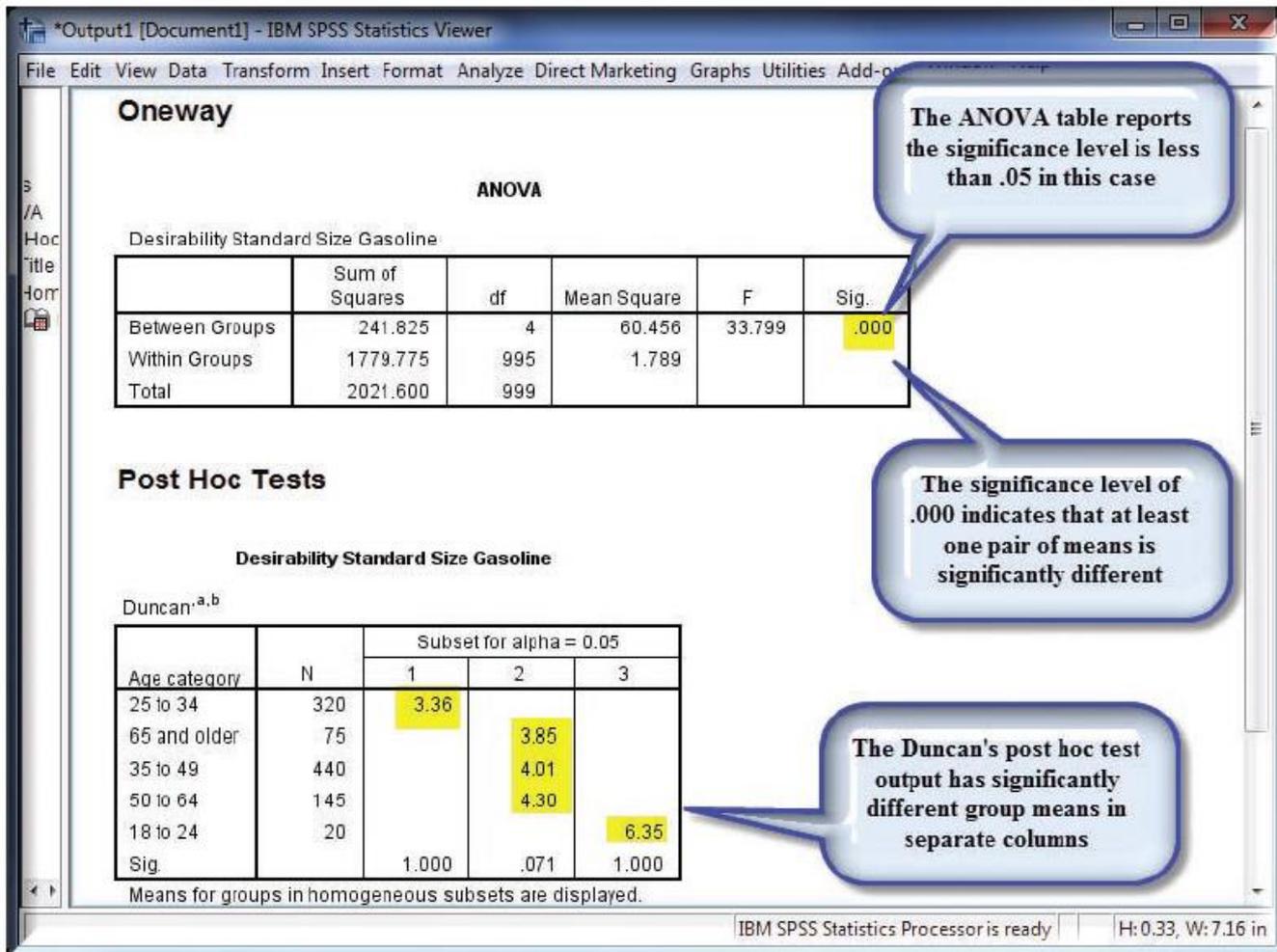


FIGURE 13.5 SPSS Output for Analysis of Variance (ANOVA)

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ANOVA Advantages;

- **ANOVA has two distinct advantages over performing multiple t tests of the significance of the difference between means.**
 - 1-Immediately notifies researcher if there is any significant difference
 - 2-Arranges the means so the significant differences can be located and interpreted easily

Post Hoc Tests: Detect Statistically Significant Differences Among Group Means

- **Post hoc tests:** options that are available to determine where the pair(s) of statistically significant differences between the means exist(s)
 - **Duncan's multiple range test:** provides output that is mostly a “picture” of what means are significantly different
 - The Duncan multiple range test's output is much less statistical than most other post hoc tests and is easy to interpret.

FIGURE 13.6 The Clickstream to Obtain a Paired Samples t-Test

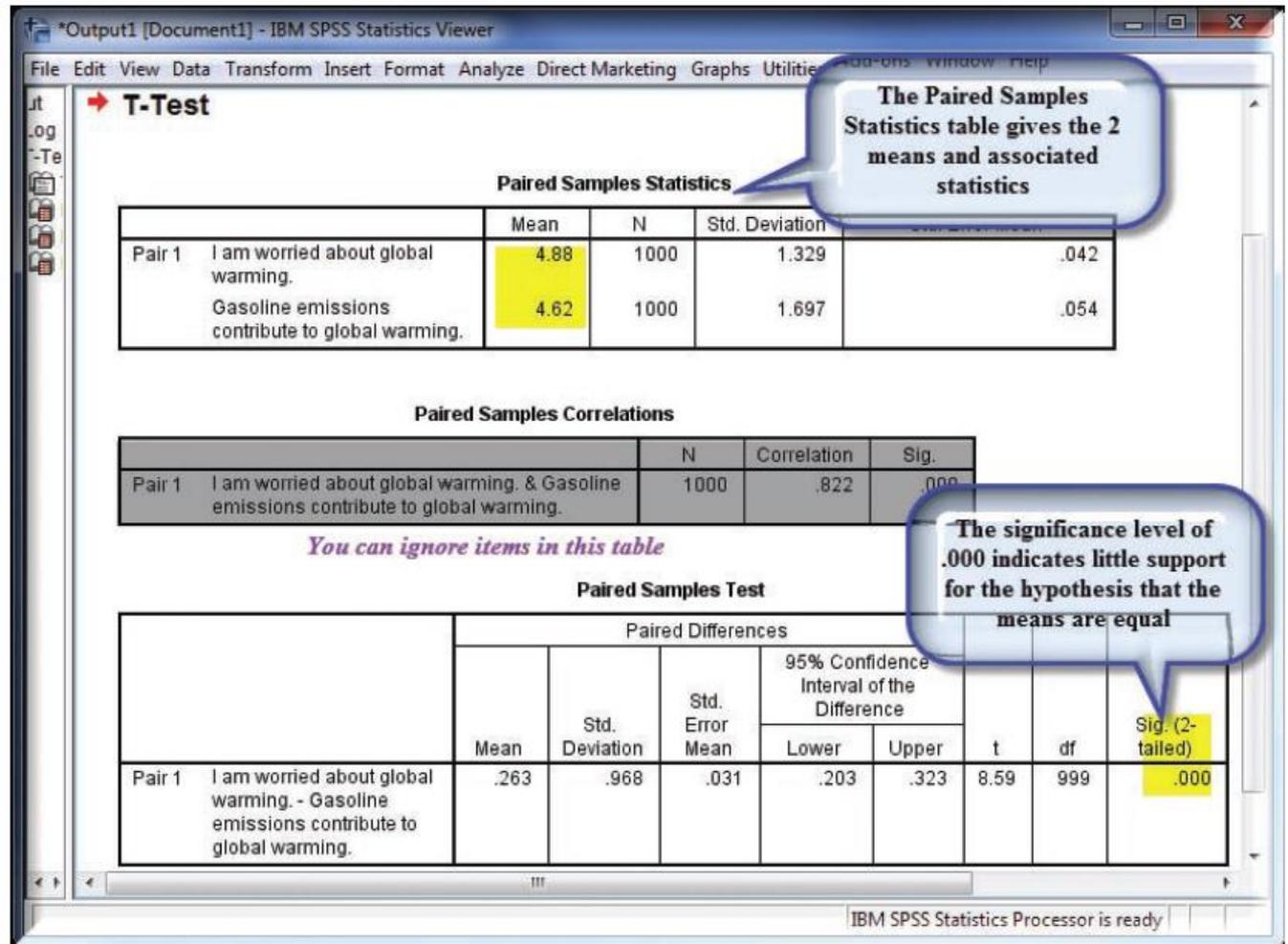
Source: Reprint courtesy of International Business Machines Corporation, © SPSS, Inc., an IBM Company

The screenshot shows the IBM SPSS Statistics Data Editor interface. The 'Analyze' menu is open, and the path 'Analyze > Compare Means > Paired-Samples T Test...' is highlighted. A callout bubble labeled '1' points to the 'Paired-Samples T Test...' option with the text 'Use Compare Means - Paired-Samples T Test'. Below the menu, the 'Paired-Samples T Test' dialog box is open. The 'Paired Variables' table contains two rows: Row 1 has 'I am wo...' in Variable1 and 'Gasolin...' in Variable2; Row 2 is empty. A callout bubble labeled '2' points to the 'I am wo...' variable in the list on the left and the 'Paired Variables' table with the text 'Select the variable pairs from the list; click OK to perform analysis'. The 'OK' button at the bottom of the dialog box is circled in red.

Pair	Variable1	Variable2
1	I am wo...	Gasolin...
2		

FIGURE 13.7 SPSS Output for a Paired Samples t-Test

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Reporting Group Differences Tests to Clients

- Finding significant differences is exciting to marketing researcher because it means they will have something that is potentially useful to report to clients.
- The reporting of finding has a significant ethical burden for marketing researcher as they cannot choose to report only “good news” to client .

Third ; Differences Between Two Means Within the Same Sample (Paired Sample)

- You can test the significance of the difference between two means for two different questions answered by the same respondents using the same scale.
- **Paired samples** test for the differences between two means: a test to determine if two means of two different questions using the same scale format and answered by the same respondents in the sample are significantly different.