

Celebrate Your Independence! 8

Between-Groups Designs

Now that you have a burning question to ask in a scientific way, you have to decide how you will go about asking it. If the study you have in mind includes an independent variable (IV), that means you have at least two levels—otherwise it would not be a variable at all because nothing would vary. We will start with the simplest design you might have: one IV with two levels.

One IV, Two Levels

When people walk in the door of your lab or go to their computers to take an online survey, you have to be prepared for one of two options. First, you might ask different groups of people to complete each level of your IV. For example, if you want to know how long people will play a video game against a computer versus against another person in the room, you might ask some participants (group 1) to play a video game alone and ask completely different participants (group 2) to play the video game against another person sitting in the same room.

As a second option, you can ask each participant to play the game twice, playing against a computer *and* playing against another person. Although this second option does have the advantage of controlling for whether a participant is very good at the game (or really bad at it), you can probably already see potential problems. Participants might not want to devote a lot of time to your study, or they might get tired of playing the game after the first time and quit soon after

starting the second game. When you repeatedly test the same people, you also run the risk of participants figuring out what you are looking for in your experiment and either giving you what you want or deliberately going against your expectation, both of which would keep you from knowing the truth.

In this chapter, we will talk about the first option: You will put different people in each of your IV levels. We call this a **between-groups design**. Although a between-groups design might mean you need more people in your study, you should still be able to find an effect if one exists in the world.

Between Groups With Two Levels of an IV

When people participate in your study, in many cases, you can manipulate what happens to them. You can control the experiences they have when they are in your “lab.” This allows you to examine a potential cause-and-effect relationship between the IV and the dependent variable (DV). This also requires using a true IV, which means you do something to participants, such as asking them to play a video game with a computer or with another person. Of course, it also requires you to measure an outcome. In this example, the outcome is how long people play. Notice that you never manipulate the outcome because that would be cheating. You leave it alone and wait to see what happens.

You probably remember that an outcome is called a dependent variable (DV). Again, in the video game example, the DV is how long people play the video game.

At this point, you have one IV and one DV. One potential cause (the IV) and one effect (the DV)—one manipulated variable (the IV) and one outcome (the DV). And with a between-groups design, you have different people in the two levels of your IV. But how do you decide which people go in which group? Although the question might seem silly, it is actually important. For example, if you pick all males to play against the computer and all females to compete against another person, you will not know if differences in play time are based on the type of opponent (your IV) or the gender of the participant. Because gender completely obscures what you were truly interested in, gender is considered a **confounding variable**. A confounding variable is one that varies exactly along with the levels of your IV. In the end, a confounding variable means you have to throw your data in the trash.

As another example, suppose you asked the first 30 people who walk in the room to play against the computer and the next 30 people to play against another person. What if the first 30 people are highly motivated, early-rising, Type A people who naturally will play the game a long time? And what if the last 30 people who participate across the day are less motivated? Again, you will not be able to say whether any play-time differences are due to the experimental manipulation (computer versus in-person opponent) or differences in the type of participant who showed up early versus later on.

How do you solve this problem? The solution is simple. You **randomly assign** people to the two levels of your IV. When a participant shows up to your study (or even before the person walks in), draw one of the two IV levels from a cup. Let chance decide for you. If you are running an online experiment, randomize which level of the IV participants get when they click the link for your study. This type of random assignment is called **complete randomization**. Every participant has an equal chance of being assigned to either level of your IV.

You do not even have to worry about having the same number of participants in each IV level; chance will be on your side. Put both levels in the cup before assigning each participant to a group, and you will have a 50–50 chance of pulling each of the two conditions randomly. Random assignment also usually takes care of the many **individual differences** among all of your participants. For example, chances are slim that all the participants with video game experience will be randomly assigned to one level of your IV. Instead, video game experience is likely to be fairly equal between the two IV levels. So, voilà! These individual differences should not influence your DV. Notice that none of the individual difference variables (e.g., video game experience) vary exactly along with your IV levels. If that happened, of course we would have a confounding variable and useless data. However, variables such as video game experience *do* introduce some “noise” to the data set; variables that merely introduce some individual difference variability across conditions are called **nuisance variables** and often are part of the research process.

When using random assignment, if you want to make sure you have the same number of people in each group, you can get fancy. Put both levels in a cup, pull one level out to assign a participant, and the next participant will automatically be put in the other condition (the one still in the cup). Then return the chosen level to the cup and start over again for the third participant, and so on. This procedure is called **block randomization** because you are assigning people in blocks of IV levels before beginning with a random level again.

Regardless of whether you use complete randomization or block randomization, you will have different people in the two levels of the IV. We generally analyze such a design with a statistic called an **independent-samples *t*-test**. A ***t*-test** is used when you have one IV with two levels. It is used for simple research designs. Independent samples means you have different people in the two groups. Therefore, it makes sense that you use a statistic named *independent-samples t-test*. Using this design and statistic means you have one DV, or outcome.

Imagine you collected the data of time (in seconds) that people play video games against either the computer or an opponent in the room. The data you collect might look like this:

Computer Opponent	Live Opponent in the Room
620	724
540	809
232	673
478	544
723	625
602	580
577	827
598	668
543	736
510	505
640	515
390	

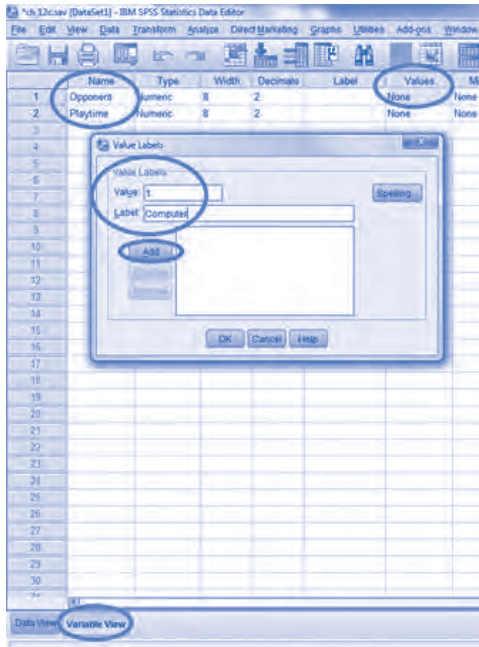
Using SPSS

But your SPSS data file will look different from the data table above (see Chapter 6 for a complete review on setting up a data file in SPSS). To analyze these data in SPSS, you will need to take the seconds of playing video games (under each IV level) and arrange them for the computer to read. In SPSS, the IV is defined in the first column using 1 for level 1 (computer opponent) and 2 for level 2 (live opponent). Please note that a second option is to label IV levels with 0 and 1; either approach is fine, and we use both in this book to give you options. After labeling IV levels, the DV numbers are typed into the second SPSS column labeled “Playtime,” making sure that all numbers for computer-opponent times are to the right of a number 1, for the first level of the IV. All live-opponent numbers are to the right of a number 2. Like this:

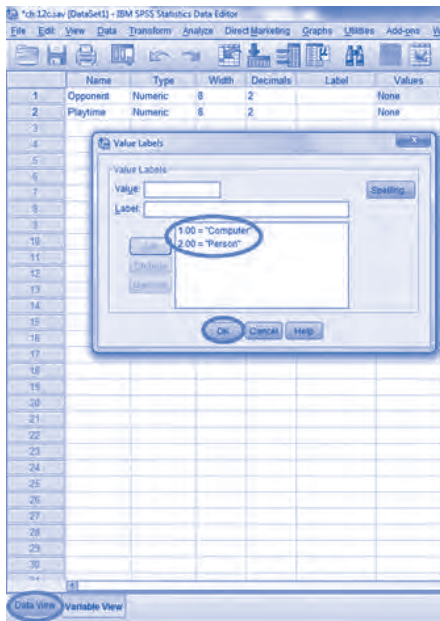
Opponent	Playtime
1	620
1	540
1	232

Opponent	Playtime
1	478
1	723
1	602
1	577
1	598
1	543
1	510
1	640
1	390
2	724
2	809
2	673
2	544
2	625
2	580
2	827
2	668
2	736
2	505
2	515

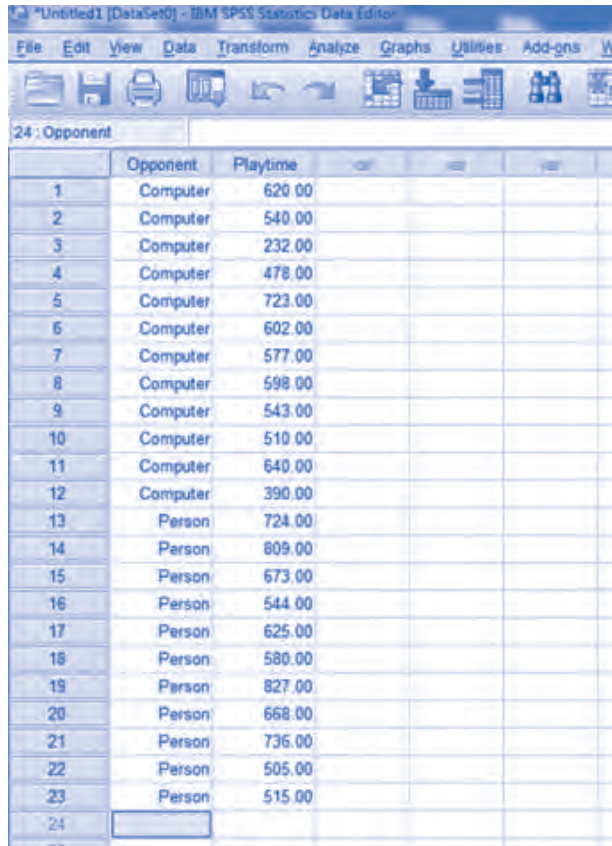
In SPSS *Variable View*, enter column headings on the far left. For the “Opponent” variable, click under *Values* (which has “None” in the box on the next page and is circled). In the box that opens, put a 1 next to *Value* and “Computer” next to *Label*. Then click *Add*.



Use the same procedure for a *Value* of 2 for “Person,” then click *Add* again (see screenshot below). Click *OK* and move to *Data View* by clicking the button at the bottom left of your screen.



Under *Data View*, when you click *View*, then *Value Labels*, you'll see "Computer" and "Person" in the first column rather than 1 and 2. Sure, the computer needs the 1 and 2 values to process data in its tiny computer brain, but your brain can process entire words. Below is what your screen should look like when you look at the *Data View*:

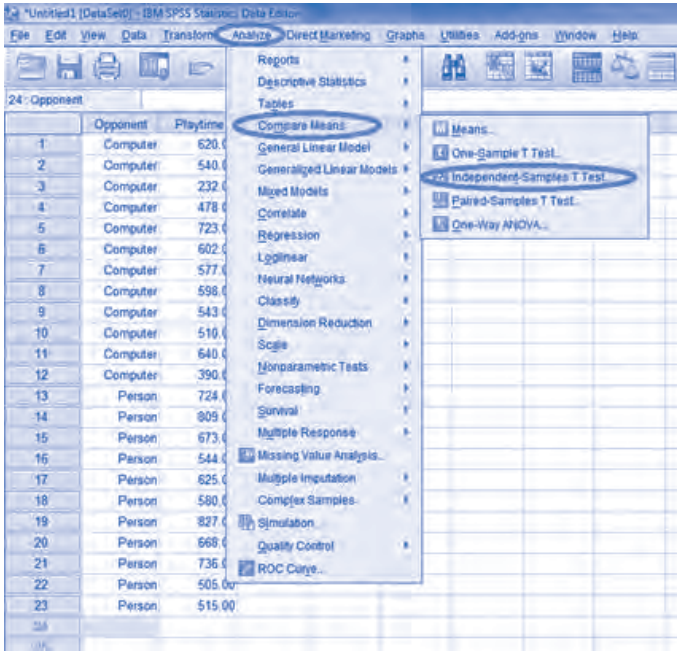


The screenshot shows the IBM SPSS Statistics Data Editor window. The menu bar includes File, Edit, View, Data, Transform, Analyze, Graphs, Utilities, Add-ons, and Windows. The toolbar contains icons for file operations and data manipulation. The active window is titled '24 : Opponent' and displays a data table with two columns: 'Opponent' and 'Playtime'. The data is organized into two groups: 'Computer' (rows 1-12) and 'Person' (rows 13-23). Row 24 is currently empty and selected.

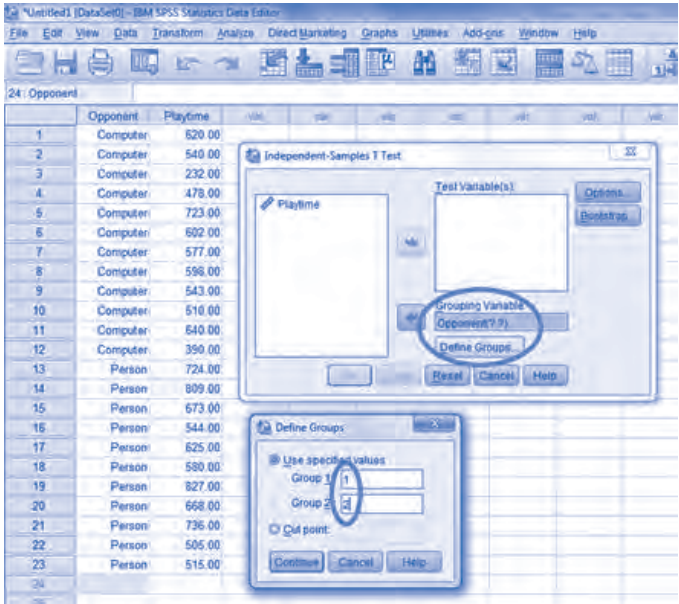
	Opponent	Playtime
1	Computer	620.00
2	Computer	540.00
3	Computer	232.00
4	Computer	478.00
5	Computer	723.00
6	Computer	602.00
7	Computer	577.00
8	Computer	598.00
9	Computer	543.00
10	Computer	510.00
11	Computer	640.00
12	Computer	390.00
13	Person	724.00
14	Person	809.00
15	Person	673.00
16	Person	544.00
17	Person	625.00
18	Person	580.00
19	Person	827.00
20	Person	668.00
21	Person	736.00
22	Person	505.00
23	Person	515.00
24		

Now that the data are entered into SPSS, you are ready to analyze the results of your experiment. This is a magical moment for most researchers. When you actually experience this moment, you will understand why we call it magical ☺. Remember, we are looking for a **significance (or *p*-value)** of .05 or less. Soon, we will click some buttons and see if we find a meaningful difference between the play times for these two groups. We will find out if people play computer games for different amounts of time when playing with a real, live person versus a computer. Here goes:

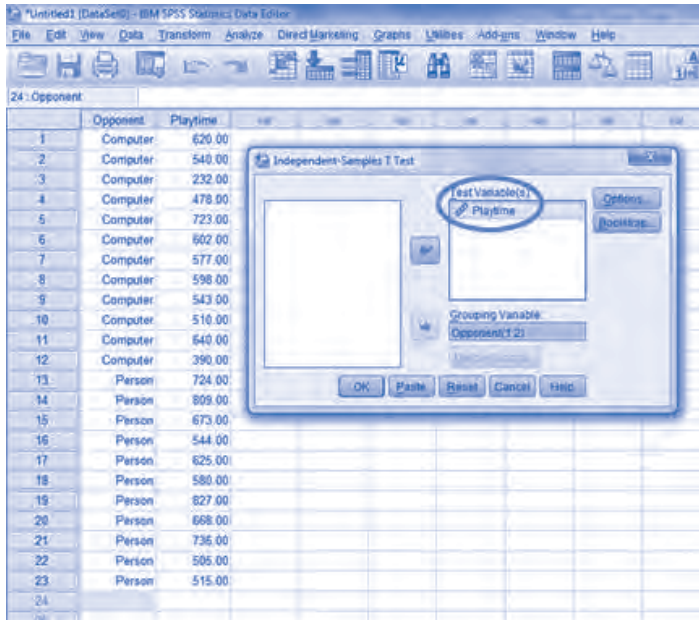
Follow the circles in the next screenshot and click *Analyze*, *Compare Means*, then *Independent-Samples T Test*. (The label should be *t*-test, with a lower-case *t*, but no big deal.)



In the box that opens, “Opponent” is in gray, so move it under *Grouping Variable* (i.e., your IV) using the arrow provided in the middle of box. Click *Define Groups*, then let the computer know that *Group 1* is indicated by a 1 (put a 1 in the box). The second box (*Group 2*) gets a 2. Click *Continue*.



Next, click “Playtime” to highlight it, and move it over to *Test Variable(s)* (i.e., your DV), again using the arrow in the middle. Before you click *OK*, make sure your setup looks like the screenshot below.



After you click *OK*, you will see your results in the form of an output file. Below is what the SPSS output file looks like. The first part of the output file to find is the significance level. Did we get the magic number of .05 or less? Can we say that our two groups differed in a meaningful way?

The screenshot shows the SPSS Statistics Viewer window displaying the output of an Independent-Samples T Test. The syntax window shows the following commands:

```
T-TEST GROUPS=Opponent(1 2)
/MISSING=ANALYSIS
/VARIABLES=Playtime
/CRITERIA=CI(.95).
```

The output is organized into sections:

- T-Test**
 - [DataSet0]
- Group Statistics**
- Independent-Samples Test**

The **Group Statistics** table is as follows:

	Opponent	N	Mean	Std. Deviation	Std. Error Mean
Playtime	Computer	12	537.7500	128.19587	36.95098
	Person	11	655.0909	113.27685	33.85274

The **Independent-Samples Test** table is as follows:

	Levene's Test for Equality of Variances		t-Test for Equality of Means							
	f	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Playtime	Equal variances assumed	.004	.951	-2.327	21	.030	-117.34891	50.43608	-223.28951	-12.45331
	Equal variances not assumed			-2.380	20.965	.029	-117.34891	50.13683	-221.61452	-13.08728

The significance level (Sig. (2-tailed)) is highlighted with a red circle in the original image.

We hope you answered, “Yes!” The significance value circled (i.e., **Sig. [2-tailed]**) was .03 across from the row labeled *Equal variance assumed* (the top row of the table), which says the difference between the two groups was meaningful rather than just random variability in play time (DV) numbers. So, the IV, or type of interaction they experienced (person versus computer), significantly changed the DV, the number of seconds they played the game.

Before we go any further, it is always a good idea to save both of your files. You have a data file, where you entered the data, and you now have an output file, where the results of your analysis are found. Save these two files separately using whatever names will help you remember what the study is about. The default file names provided by SPSS are not very helpful when it comes to finding the file again. So, for this example, you might save the data file as “video game.sav” and the output as “video game.spv.” (FYI: Those file extensions are SPSS defaults.) Later you will be able to easily find the files, open them, and either review your results or conduct additional analyses.

Now you get to share our results with the world, or at the very least you will share with your instructor who assigned this task. We will help you do that using the highly organized APA style. Your job will be to pull relevant information from your SPSS output and write an APA-style results section. Our job is to show you how.

From the independent-samples *t*-test output, you will need

- the *t*-value,
- **degrees of freedom (*df*)**,
- the significance value,
- the two group means,
- the number of participants in each group (*N* values, although they really should be symbolized by *n* values), and
- the variability or spread of numbers between the two groups (standard deviation is fine).

Below, we have circled relevant information from the SPSS output. Notice in the bottom table that you have a *t*-value, degrees of freedom, and a significance value on the row marked *Equal variances assumed*. This row is the correct one to use when you report data. You also have group means, standard deviations, and the number of participants per group (*n*) in the top table.

Group Statistics

Observed	N	Mean	Std. Deviation	Std. Error Mean
PlayTime - Computer	12	537.7500	126.10000	36.50000
PlayTime - Person	11	655.0000	142.20000	33.60714

Independent Samples Test

	Levene's Test for Equality of Variances		t-Test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	95% Error Difference	95% Confidence Interval of the Difference
PlayTime								
Equal variances assumed	.304	.581	-2.327	21	.030	-117.34891	50.43609	[-222.22651, -12.45131]
Equal variances not assumed			-2.348	20.685	.028	-117.34891	60.13682	[-221.81492, -13.08029]

Before we look at an APA-style results section, you need to know one final piece of information. If you have a significant effect, as you do here, you will need to calculate the size of the effect. Unfortunately, SPSS does not calculate **Cohen's d** , which is the effect-size statistic, for us. However, SPSS output does give us all the numbers we need for the calculation. Here is the basic equation for calculating Cohen's d :

$$d = \frac{M_{group1} - M_{group2}}{SD_{pooled}}$$

M represents a mean. M_{group1} is the mean for group 1 (playing against the computer), and M_{group2} is the mean for group 2 (playing against another person in the room). As a shortcut if you do not want to subtract means, SPSS gives us the numerator for the equation; it is labeled "Mean Difference" in the output table, and the value is -117.34091 . The denominator of Cohen's d is the standard deviation (a measure of variability) across the two groups, called *standard deviation (SD) pooled*. The formula for standard deviation pooled is

$$SD_{pooled} = \frac{SE_{pooled}}{\sqrt{\frac{1}{N_{group1}} + \frac{1}{N_{group2}}}}$$

You will use values from the output to calculate SD_{pooled} . Look for the *std error difference* in the table to find 50.43609 for this example. This is what you will use for the numerator. You likely have guessed that the two values for N refer to the number of observations in each of the two groups, in this case 12 and 11. See the items circled below.

SPSS Statistics Viewer

SPSS Statistics

T-TEST GROUPS=Playtime(1,2)
/MISSING=SYSMIS
/VARIABLES=Playtime
/CRITERIA=(1,.95).

T-Test

[DataSet0]

Group Statistics

Playtime	Computer	Person
N	12	11
Mean	37.7500	65.0000
Std. Deviation	128.10587	112.27695
Std. Error Mean	36.89099	33.85274

Independent Samples Test

		Levene's Test for Equality of Variances		t-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
#Playtime	Equal variances assumed	.004	.991	-1.327	21	.030	-117.34091	50.43609	Lower	Upper
	Equal variances not assumed			-2.246	20.965	.029	-117.34091	50.17587	-218.1442	-18.08729

Now put all the pieces together in the formula.

$$SD_{pooled} = \frac{50.43609}{\sqrt{\frac{1}{12} + \frac{1}{11}}} = 120.94985$$

You are ready to calculate Cohen's d .

$$d = \frac{-117.34091}{120.94985} = -.970162$$

The sign of Cohen's d does not matter; think of it in terms of absolute value. In the APA-style results section below, we can remove the negative sign and simply discuss the absolute size of the effect, included as d below.

Writing an APA-Style Results Section

Results

We analyzed these data using an independent-samples t -test. Type of opponent affected how long people played a video game, $t(21) = -2.33$, $p = .03$, $d = .97$. Participants who played against a person in the same room played longer ($M = 655.09$ sec, $SD = 112.27$, $n = 11$) than those who competed against the computer ($M = 537.75$ sec, $SD = 128.11$, $n = 12$).

Independent-Samples t -Test With a Pseudo-IV

Remember that we have been discussing one IV with two levels. A true IV is a variable that you manipulate. In the study we have been discussing, we manipulated participants by asking them either to play a video game against a computer or a real person in the room. Sometimes we have a study design that looks like it has an IV and can even be analyzed using the independent-samples t -test. But it is not really a *manipulated* variable, so we are not technically allowed to call it an IV. During design and analysis, we have to call this non-manipulated variable a pseudo-IV, a fake IV, or any other name that reminds you that the variable was *not* manipulated. (Please note that when you decide to submit a manuscript for publication, you do not say you had a fake IV! If you clearly define your variables and method, the fact that you did not manipulate a variable should be clear.)

Why is an understanding of pseudo-IVs important? Because manipulation of a true IV (a real experiment) means you can learn cause and effect. Without manipulation, we cannot know cause and effect; we will only know that the two variables—the pseudo-IV and DV—are related. Look at the APA-style results

section for the computer game study above. Because we had a true IV, we were allowed to tell the world that we found cause and effect. Even the APA wording reflects that. We cannot use cause–effect wording without manipulation (remember this discussion from Chapter 2).

As a completely new example, suppose we wanted to examine how long males versus females play a video game. So, in this example, we are not comparing two types of opponents (computer versus person). Instead, we are comparing males and females, which is what differentiates the two groups. The non-manipulated IV is gender, and the DV is still playing time. If we ran the study, imagine the data looked like this:

Males	Females
780	540
689	320
756	780
644	655
530	486
833	592
715	400
730	771
877	690
579	622
	561

Using SPSS

We would still lay out the data in SPSS using “Gender” in the first column, with 1 representing males and 2 representing females. And the DV numbers (Play time) will still be in the second SPSS column. To analyze these data just as the prior example, click *Analyze*, *Compare Means*, then *Independent-Samples T Test*. Set up your variables in the boxes that open, including labeling values of “Gender” as 1 = “Males” and 2 = “Females.” After clicking *OK* and obtaining the SPSS output, pull relevant numbers (see numbers circled in the next screenshot) to write your APA-style results section. You will notice that we have reached the magical significance number of $p < .05$ again, so we know males and females truly differ in the amount of time they play computer games.

T-TEST GROUPS=gender(1,2)
/MISSING=SYSMIS
/VARIABLES=Playtime
/CRITERIA=CI(.95).

T-Test

[DataSet0]

Group Statistics

Gender	N	Mean	Std. Deviation	Std. Error Mean
Playtime Males	10	713.3068	107.98210	34.18098
Playtime Females	11	583.3636	143.89073	43.25756

Independent Samples Test

	Levene's Test for Equality of Variances		T-Test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	t	df	sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Playtime: Equal variances assumed	.751	.391	3.323	19	.003	129.93836	55.94507	12.84199	247.03073
Playtime: Equal variances not assumed			2.395	18.394	.030	129.93836	55.16612	14.20995	245.66278

Here is the one *big* difference: When you write your APA results, do not say gender *caused* playtime to vary. Only say gender *related* to length of time people played video games. After pulling relevant SPSS output, and calculating Cohen's *d* using the formula discussed earlier, below is what the results section looks like for the pseudo-IV.

Writing an APA-Style Results Section

Results

We analyzed these data using an independent-samples *t*-test. Gender of participant related to how long people played a video game, $t(19) = 2.32, p = .03, d = 1.01$. Male participants played longer ($M = 713.30$ sec, $SD = 107.86, n = 10$) than female participants ($M = 583.36$ sec, $SD = 143.80, n = 11$).

Between Groups With More Than Two Levels of an IV

A *t*-test is reserved for a simple research design with one IV (or pseudo-IV) having two levels. But often, you will want to conduct a study with more than two levels of the IV. For example, you might want to examine three types of videogame opponents: the computer, a person in the room playing, and a person

playing from a remote location. With three IV levels, you cannot analyze data using a *t*-test; you must use an analysis called ANOVA (or analysis of variance). Keep in mind that a between-groups design always involves different people in the IV levels. And if you are manipulating people (have a true IV), you will still want to randomly assign people to IV levels.

After running the study, your data might look like this on paper:

Computer Opponent	In-Person Opponent	Remote-Location Opponent
620	724	655
540	809	792
232	673	765
478	544	879
723	625	634
602	580	778
577	827	671
598	668	804
543	736	732
510	505	420
640	515	510
390		814
		788

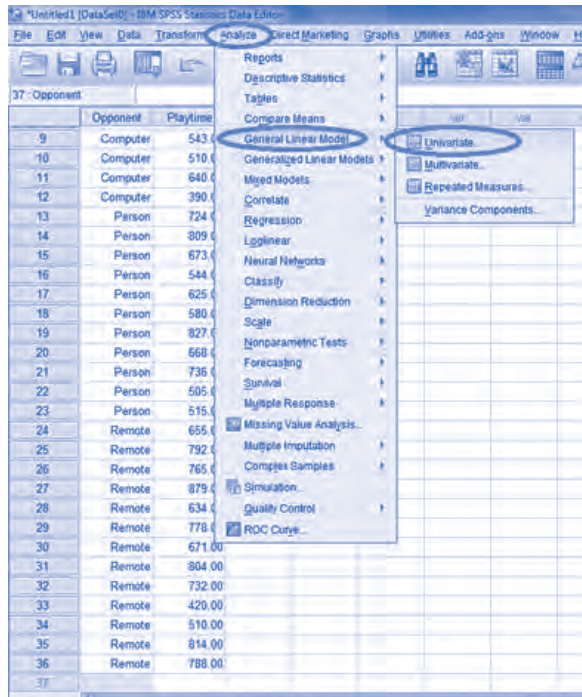
Using SPSS

Data layout in SPSS would be very similar to the independent-samples *t*-test, but instead of 1 and 2 representing levels, you will need 1, 2, and 3 to represent all three levels in the first column. Of course you will identify the labels as “Computer,” “Person,” and “Remote” rather than view mere numbers in the first column.

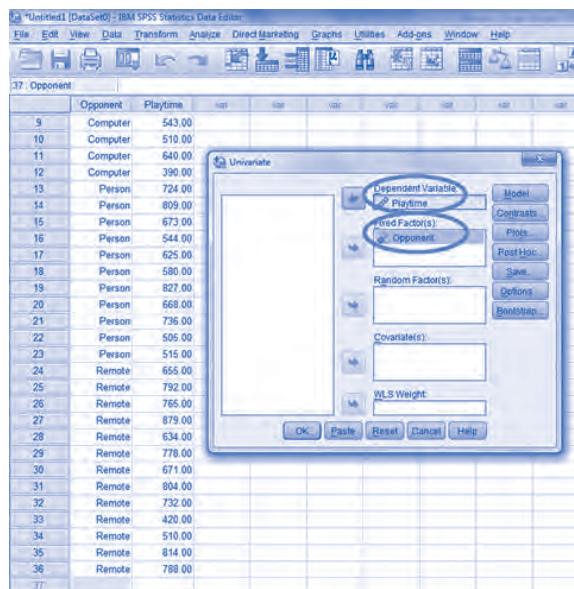
The screenshot shows the IBM SPSS Statistics Data Editor window. The title bar reads '*Untitled1 [DataSet0] - IBM SPSS Statistics Data Editor'. The menu bar includes File, Edit, View, Data, Transform, Analyze, and Graph. Below the menu bar is a toolbar with icons for file operations and analysis. The main window displays a data table with the following columns: 'Opponent' and 'Playtime'. The table contains 29 rows of data, with the 'Opponent' column categorized into 'Computer', 'Person', and 'Remote'. The 'Playtime' column contains numerical values ranging from 232.00 to 827.00. At the bottom of the window, there are two tabs: 'Data View' (which is selected) and 'Variable View'.

	Opponent	Playtime
1	Computer	620.00
2	Computer	540.00
3	Computer	232.00
4	Computer	478.00
5	Computer	723.00
6	Computer	602.00
7	Computer	577.00
8	Computer	598.00
9	Computer	543.00
10	Computer	510.00
11	Computer	640.00
12	Computer	390.00
13	Person	724.00
14	Person	809.00
15	Person	673.00
16	Person	544.00
17	Person	625.00
18	Person	580.00
19	Person	827.00
20	Person	668.00
21	Person	736.00
22	Person	505.00
23	Person	515.00
24	Remote	655.00
25	Remote	792.00
26	Remote	765.00
27	Remote	679.00
28	Remote	634.00
29	Remote	778.00

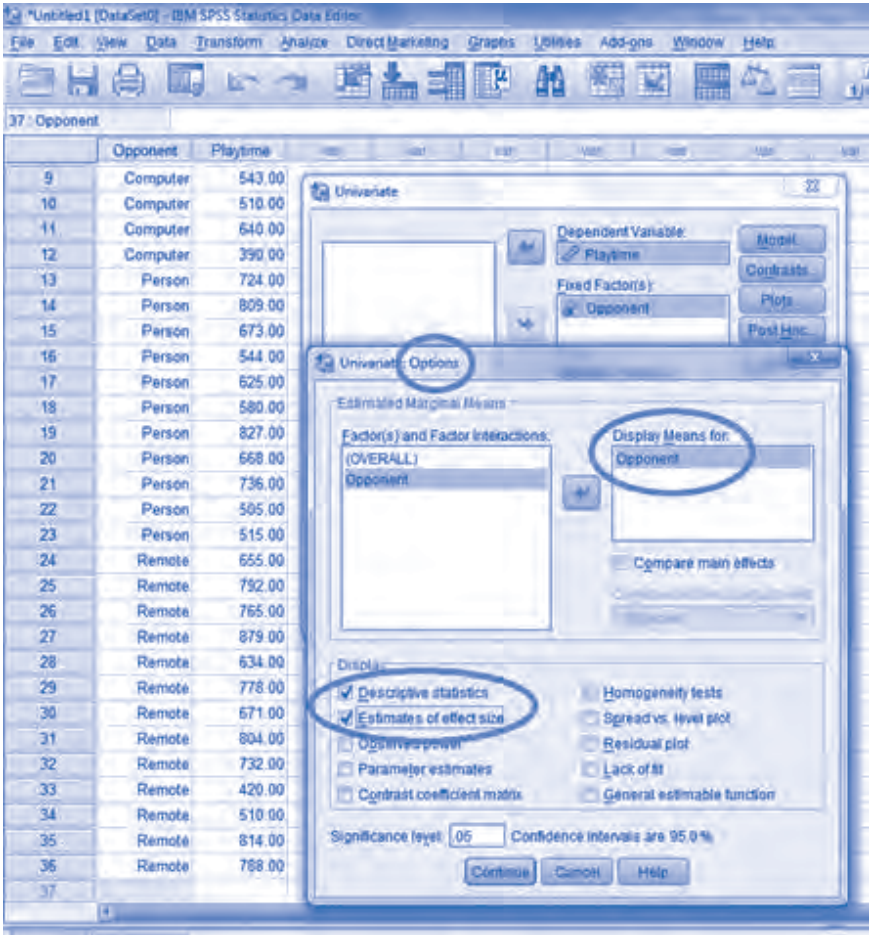
To analyze the data and look for that important significance value, the next screenshot points out what to choose to analyze your data. Simply click *Analyze*, *General Linear Model*, and *Univariate*.



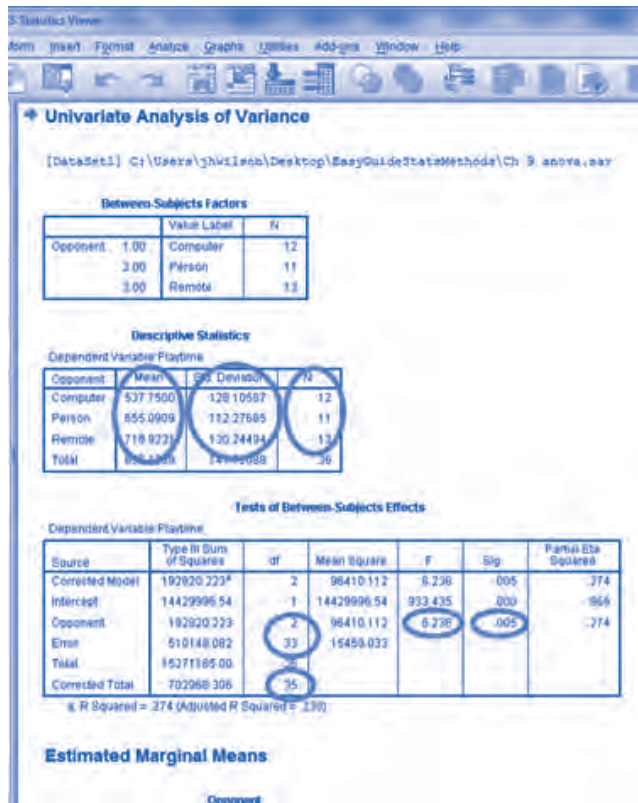
When the box opens, your two variables will be on the left. Move “Opponent” to *Fixed Factor(s)* on the right as shown below. Click “Playtime” to highlight the variable, and move it over to *Dependent Variable*.



Click *Options*, highlight “Opponent,” and move it from the left to under *Display Means for* on the right as shown below. On the lower half of the box, click *Descriptive Statistics* and *Estimates of effect size*.



Click *Continue*. Finally, click *OK* to view output. Although you will not have these nice circles to point out particular information on your output, it should generally look like this:



The significance value (*Sig.*) found on the *Tests of Between-Subjects Effects table* is less than .05 (in fact, it is less than .01).

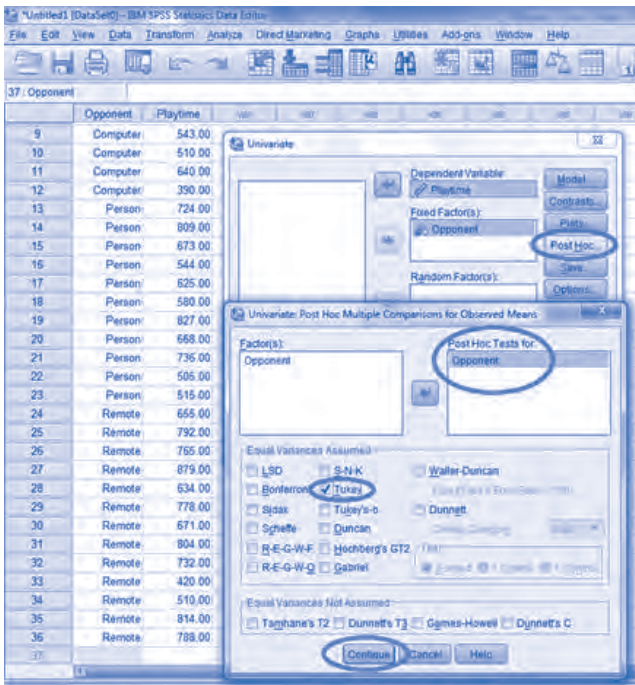
Notice we circled the relevant information for you. You need

- the *F*-value (similar to a *t*-value),
- *df* (two numbers in this analysis),
- the significance value,
- three group means,
- the number of participants in each group (*N* values), and
- three group standard deviations.

A significant effect means that your groups differ. When you had only two groups (with the *t*-test), you certainly knew which two differed. But in the current study, you have three groups. At this point, you only know that at least two of them differ from each other. However, you do not know *which* group means

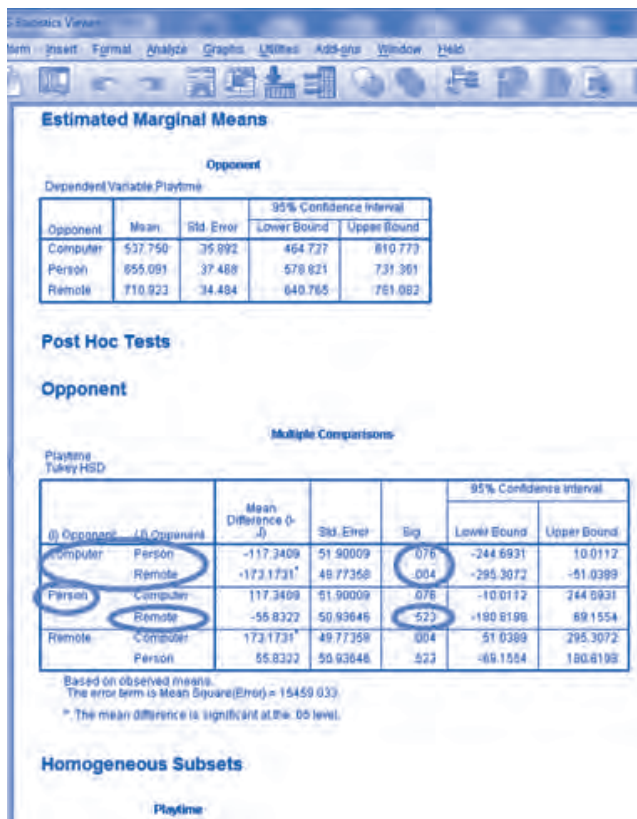
differ from each other. No problem, since SPSS can conduct another test to use only when you have a significant ANOVA outcome; you know that at least two groups are different when compared to each other. SPSS offers *post hoc tests* to see where specific effects are.

After you have a significant ANOVA, conduct *post hoc* tests by again opening your main box (*Analyze, General Linear Model, Univariate*), then click *Post Hoc* at the right of the box. Move “Opponent” to the right, under *Post Hoc Tests for*, then click *Tukey* in the bottom half of the box for a conservative test to see which group means differ from each other in a meaningful way. When your *post hoc analysis* is set up like the one below, click *Continue*.



We should tell you that it is OK to set up both the ANOVA and *post hoc* analyses in SPSS when you are ready to analyze a data set. You do not have to first run the ANOVA, examine the output, then go back and run *post hoc* tests if the ANOVA value is significant. But be careful! If you want to go ahead and run the *post hoc* tests, do not even look at them if your ANOVA is not significant! An ANOVA that fails to find significance means *no* groups differ from each other; it makes no logical sense to then conduct *post hoc* tests to see *which* means differ from each other.

Your *post hoc* output should look like this:



Because the ANOVA was already set up, the output will start with the overall ANOVA again, followed by *post hoc* comparisons of group means (*Multiple Comparisons*). On the first row, "Computer" and "Person" have been compared. Look at the top *Sig.* value that is circled and has a value greater than .05. We now know that "Computer" and "Person" groups failed to differ in a meaningful way. Next, look at the second *Sig.* value that compares the "Computer" and "Remote" groups; a *Sig.* value (*p*-value) of .004 indicates a meaningful difference between those two groups. Now notice that the third row compares "Person" and "Computer," but we already looked at that comparison on the first row. Skip it and move on to the fourth row—a comparison of "Person" and "Remote." This is the third and final unique comparison among the three group means. With a significance value of .523, the two groups did not differ from each other.

The only remaining task is to write your results in APA style. You will need the circled items from the ANOVA and from follow-up *post hoc* analyses. Because you had a true IV (you manipulated people), you can use cause-effect language in your results section. Finally, you will need to report the effect size

using **partial eta squared (η^2)**. Partial η^2 also has a longer name, *proportion of variance accounted for*. It essentially tells you how much of the variance in your data set “is associated with” or “can be explained by” the different levels of your between groups factor. If eta squared is .5 then we could explain 50% of the variance in the DV by knowing about the between groups factor. Look at your original ANOVA output table to locate effect size to the right of *Sig*.

Writing an APA-Style Results Section

Results

We used a one-way, between-groups ANOVA to analyze these data. Tukey's *post hoc* comparisons examined differences between groups ($p < .05$). Type of opponent affected how long participants played a video game, $F(2, 33) = 6.24, p < .01, \eta^2 = .27$. Participants who played against another person from a remote location played longer ($M = 710.92, SD = 130.24, n = 13$) than participants who played against the computer ($M = 537.75, SD = 128.11, n = 12$). No other group means differed ($p > .05$).

In this example, we included a true IV; we manipulated people to either play against the computer or another person who is present or absent (three IV levels). But, remember that you cannot use cause–effect language if you decide to use a pseudo-IV, one that you would not manipulate. A true experiment and IV require manipulation. Imagine measuring time people play video games based on year in college: first year, sophomore, junior, or senior. You would not manipulate year in college, but the data could be analyzed using the between-groups ANOVA described above. Data entry, analysis, and SPSS output would be the same. The only difference would be in writing an APA-style results section. You would have to be careful to avoid cause–effect language and say year in college related to time spent playing video games.

Summary

In this chapter, we covered between-groups designs, defined by different people in the groups or levels. Between-groups designs include the independent-samples *t*-test and the one-way, between-groups ANOVA. In either type of analysis, you can choose to manipulate a variable (IV) or leave it free to vary (pseudo-IV), and then measure an outcome (DV). If you manipulate a variable, you should randomly assign participants to the IV conditions. If a *t*-test provides a significant outcome, you know which two groups differ because you only compare two groups in a *t*-test. However, a significant ANOVA requires *post hoc* tests because you will not know which pairs of means differ from each other across three or more conditions. When you know details of your *t*-test or ANOVA result, APA-style writing allows you to share your work with others.