

## Chapter 12: Analysis of Impression Formation

The question posed in the last chapter is as follows: Is the impression of the whole equal to the sum (or average) of the impressions of the parts? In other words, does the effect of one adjective depend on the adjective with which it is paired? Chapter 11 showed how to use factorWiz to construct a Web-based replication of a study from Birnbaum (1974, Experiment 1).

This chapter will analyze new data from the Web version of the experiment. The chapter will show how to find means in Excel. In this chapter, you will learn how to draw a graph and examine it to see if there is an interaction between two independent variables. This chapter will also describe how to use SPSS to conduct an analysis of variance (ANOVA) to test statistical significance in a factorial design.

### A. Checking the Data

First, open the data file, *clean.xls*. Then click the pointer in Cell A1, and select from the **Data** menu, *Filter... AutoFilter*. Then click on the first column's filter arrow, and select *like5x5*, the procedure described in Chapter 6. The screen appears as in Figure 12.1.

Insert Figure 12.1 about here.

Now select the data by clicking on cell A1 and dragging to the last column (AG1), then down to the last row. Next, choose *Copy* from the **Edit** menu. Now, from the **File** menu select *New*. Open a new workbook. Then click in cell A1 and choose *Paste* from the **Edit** menu. This will paste a copy of the liking data into a new workbook. You can save this workbook as *Liking.xls*. On the CD is a copy of this workbook, which you can compare with your work.

Figure 12.1. Load the data file, *clean.xls*, and filter for *like5x5* to select the impression formation data.

Microsoft Excel

File Edit View Insert Format Tools Data Window Help

A1 = exp

clean.xls

	A	B	C	D	E	F	G	H	I	J	K
1	exp	date	time	country	age	sex	educ	v1	v2	v3	v4
	(All)	11/30/98	4:56:17 PM	18 F		12 USA		1	2	2	
	(Top 10...)	11/30/98	5:51:17 PM	18 F		12 USA		1	2	2	
	(Custom...)	11/30/98	8:48:50 PM	18 F		12 UNITED S		3	3	3	
	bayes	11/30/98	9:02:58 PM	18 F		12 Filipino		3	5	3	
	Ch5_exp3	12/1/98	8:35:21 AM	33 F		16 U.S.A.		1	4	2	
	Ch5_exp4_StPet	12/1/98	10:31:18 AM	31 F		16 USA		1	3	1	
	Ch5_exp5_StPet	12/1/98	11:23:19 AM	18 F		12 usa		1	1	3	
	Ch5_exp6_StPet	12/1/98	1:16:28 PM	24 M		12 United Sta		1	1	1	
	Ch7_exp1	12/1/98	1:42:16 PM	18 M		12 CHINESE		5	5	5	
	Ch7_exp2	12/1/98	1:48:26 PM	18 M		13 USA		2	3	1	
	Ch8_exp1	12/1/98	2:17:44 PM	18 F		12 TAIWAN		1	5	4	
	Heider	12/1/98	2:23:57 PM	22 F		15 usa		3	3	3	
	like5x5	12/1/98	2:29:33 PM	30 F		15 USA		1	3	9	
	pres_diffs	12/1/98	2:29:58 PM	19 M		12 USA		1	4	4	
	Pres_ratios	12/1/98	2:43:33 PM	19 F		13 USA		5	3	2	
	not like5x5	12/1/98	2:52:37 PM	18 F		12 Guatemala		1	1	1	
	168 like5x5	12/1/98	2:53:03 PM	18 M		12 USA		1	2	2	
	169 like5x5	12/1/98	2:54:17 PM	30 F		15 USA		1	3	2	
	191 like5x5	12/1/98	3:07:47 PM	22 F		12 us		2	3	2	
	213 like5x5	12/1/98	3:31:59 PM	31 F		16 USA		1	2	1	
	214 like5x5										
	215 like5x5										
	223 like5x5										
	229 like5x5										

CS\_3 pivot / Ch5\_exp3 / Ch5\_e4 / Ch5\_exp5 / Ch5\_exp6 / all data

Filter Mode

In the first row, you must rename the variables appropriately for this experiment. The first variables are *exp* (experiment name), *date*, *time*, *age*, *sex*, *education*, and *nationality*, then cells (1,1), (1, 2) ... up to (5, 5), which have been named  $v(1, 1)$  to  $v(5,5)$ . (If you collect additional data with the liking experiment, *like.htm*, remote address will also appear as a variable; it has been removed here.)

Next, click the cursor on the cracks between column headings above the sheet and adjust the width of the columns. The screen now appears as in Figure 12.2.

Insert Figure 12.2 about here.

It is a good idea to examine data for values that are "out of bounds". The instructions specified ratings from 1 to 9. Thus, if someone responded with a number like, say, 3333333, it must be some error. If you find such a number, you should set that subject's data aside for separate analysis, because one strange number in the data can have a dramatic effect on the means. You can put that person's data in a separate file. If the experiment used a row of radio buttons instead of a text input box, no one could have entered out of range numbers even if they wanted to, and this check would be unnecessary.

Procedures used to clean data should be planned in advance of the analysis and should be independent of the hypothesis of the study. You should keep a record of any changes and report them in the method section of your paper. Otherwise, there is a danger that an experimenter may try to "help" the hypothesis along by deleting data of people who don't conform to the experimenter's theory. The purpose of checking is to ensure that a single strange number does not produce a wrong conclusion, and checking in this study should be strictly to see if there are numbers that violate the instructions.

To easily spot numbers that are out of range, you can use Excel's *Conditional Formatting*. First, select the judgments (columns H to AF), then from the **Format** menu, select *Conditional Formatting*. Figure 12.3 shows the dialog box that appears.

Insert Figure 12.3 about here.

Figure 12.2. Data have been filtered, copied to a new workbook, *liking.xls*, and variable names have been typed in Row 1. Row 1 has also been formatted to bold and a larger font.

	A	B	C	D	E	F	G	H	I	J	K	L
	exp	date	time	age	sex	educ	nation	v(1,1)	v(1,2)	v(1,3)	v(1,4)	v(1,5)
2	like5x5	11/30/98	4:56:17 PM	18	F	12	USA	1	2	2	2	5
3	like5x5	11/30/98	5:51:17 PM	18	F	12	USA	1	2	2	3	6
4	like5x5	11/30/98	8:48:50 PM	18	F	12	UNITED S	3	3	3	4	5
5	like5x5	11/30/98	9:02:58 PM	18	F	12	Filipino	3	5	3	3	5
6	like5x5	12/1/98	8:35:21 AM	33	F	16	U.S.A.	1	4	2	2	2
7	like5x5	12/1/98	10:31:18 AM	31	F	16	USA	1	3	1	2	5
8	like5x5	12/1/98	11:23:19 AM	18	F	12	usa	1	1	3	1	6
9	like5x5	12/1/98	1:16:28 PM	24	M	12	United Sta	1	1	1	9	1
10	like5x5	12/1/98	1:42:16 PM	18	M	12	CHINESE	5	5	5	5	5
11	like5x5	12/1/98	1:48:26 PM	18	M	13	USA	2	3	1	1	4
12	like5x5	12/1/98	2:17:44 PM	18	F	12	TAIWAN	1	5	4	4	7
13	like5x5	12/1/98	2:23:57 PM	22	F	15	usa	3	3	3	3	3
14	like5x5	12/1/98	2:29:33 PM	30	F	15	USA	1	3	9	3	3
15	like5x5	12/1/98	2:29:58 PM	19	M	12	USA	1	4	4	6	6
16	like5x5	12/1/98	2:43:33 PM	19	F	13	USA	5	3	2	2	5
17	like5x5	12/1/98	2:52:37 PM	18	F	12	Guatemala	1	1	1	1	1
18	like5x5	12/1/98	2:53:03 PM	18	M	12	USA	1	2	2	4	6
19	like5x5	12/1/98	2:54:17 PM	30	F	15	USA	1	3	2	3	3
20	like5x5	12/1/98	3:07:47 PM	22	F	12	us	2	3	2	2	4

Figure 12.3. Dialog box for Conditional formatting. In this case, cells will have a special format if the cell value is not between 1 and 9. Clicking the *Format...* button allows one to set the format for such cases, which would be inconsistent with the instructions.

**Conditional Formatting**

Condition 1

Cell Value Is   and

Preview of format to use when condition is true: AaBbCcYyZz

By using the little drop down menus, you should make a conditional format for cells whose value is *not* between 1 and 9. You can format such numbers in red font with a yellow background, so that a quick look through the data will spot them.

Whenever you have a question about data processing, you can analyze the data with the questionable data excluded and included, to see if it makes a difference. In this case, the results would not be affected.

Another potential problem to check is multiple submission of data by the same person. In Rows 36 and 39 are records that came in at 10:15 and 10:32 of the same day from a male, 19 year old from Taiwan. Other identifiers (which have been removed) indicated that the same person gave both records. Apparently, he finished his judgments, then re-thought the instructions, and repeated the experiment, giving different answers. The first time, he gave mostly neutral judgments (judgments near 5); however, the second time, he gave judgments indicating that he expected to dislike most people, except for those with the most favorable traits.

One should follow a consistent rule for how to handle multiple submissions. For example, one might delete the first record on the supposition that the person corrected his answers. On the other hand, some studies may be focused on first reactions, so subsequent data should be removed. Completely blank records, which happens when someone scrolls to the end of the form without doing anything and clicks the submit button, should be deleted. To delete an entire line, click on the row number to select the entire line, then from the **Edit** menu, select *Delete*. The whole line will vanish.

One student put “ba” for education. That student was probably trying to say she had a BA degree, which should be recorded as “16” years of education according to the

original instructions so change “ba” to 16. You should make any such corrections on the copy, keeping the original data for possible re-analysis and a record of all changes.

## B. Finding Means

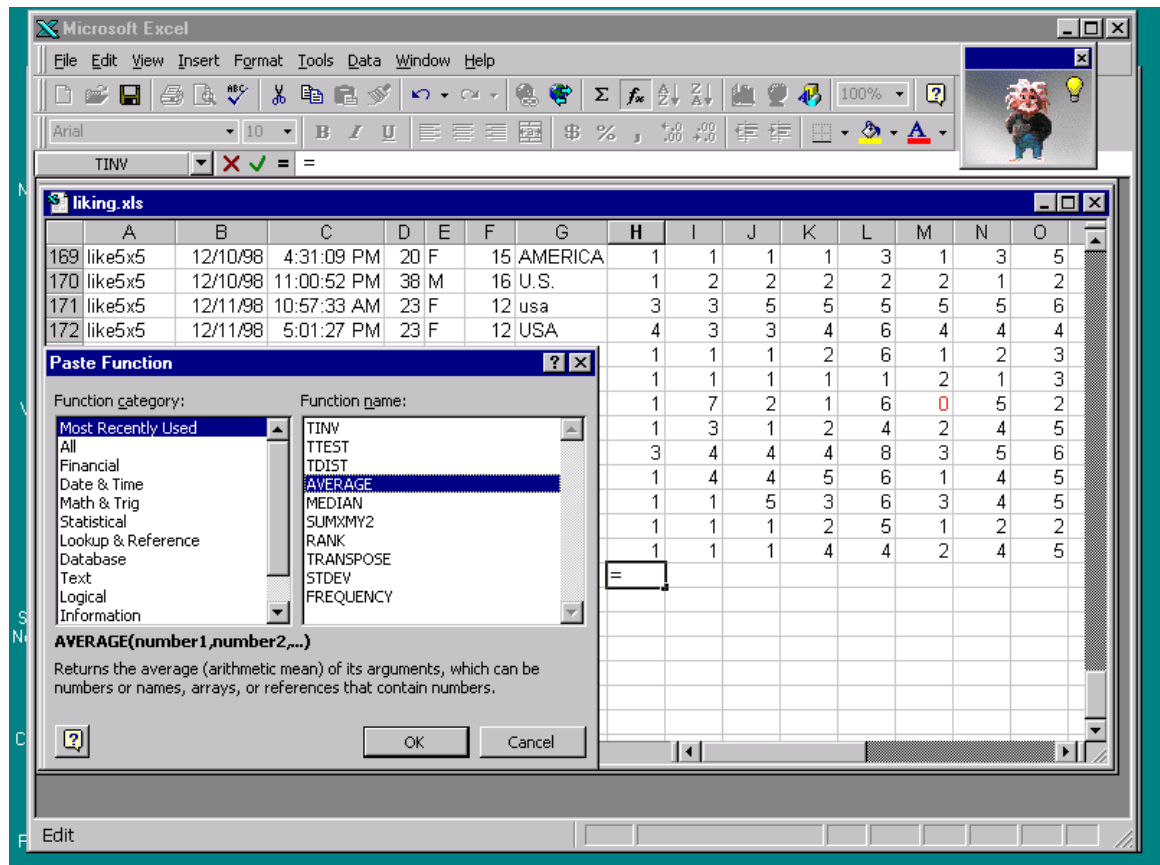
Now that you have examined and cleaned the data, the next steps are to find the means and plot the data. Click the cursor in the row after the last row of data (i.e., in cell H182). Then, select *Function* from the **Insert** menu (you can also click the function icon,  $f_x$ , on the toolbar). The dialog box in Figure 12.4 appears.

[Insert Figure 12.4 about here.]

Select *AVERAGE* and click *OK*. That brings up the dialog box shown in Figure 12.5. The program will try to guess what you want averaged. When there is a missing value in the column, Excel may guess wrong. In this case, it correctly guessed. That range is H2:H181. In general, you will type in the range of cells that should be averaged. One can also select this range by first clicking in the box for *Number1*, then clicking and dragging in the workbook to select what should be averaged. Note that the dialog box also shows the tentative result (1.90556). If everything is ok, click *OK* and the value will be entered in the cell that was originally selected. Now, fill in all of the means with *Autofill*. To do this, click in the cell and position the cursor in the lower right of the cell (until you see +); next, drag to the right to spread the same idea (find column means) to all of the columns. Whenever you use the *Autofill* feature, you should check to make sure that Excel properly generalizes the idea you want applied to fill in the cells.

[Insert Figure 12.5 about here.]

Figure 12.4. Click in a cell, then choose *Function* from the **Insert** menu. This dialog box appears. Select from the list, *AVERAGE*, and click *OK*.







Next, highlight these cells in yellow. To make the cells stand out, select them then click on the drop down arrow next to the paint can on the formatting toolbar to make their backgrounds yellow. You can also change formats and background colors by selecting the cells and then choose *Format cells* from the **Format** menu. That brings up the dialog box in Figure 12.7.

Insert Figure 12.7 about here.

Note that there are several tabs, for *Number*, *Alignment*, *Font*, etc. The *Patterns* tab has been clicked, which brings the *Cell shadings* to the front. Click on one of the yellow cells to give the cells the appearance of yellow highlighting. Click *OK*, and when you click outside the selected cells, you will see that the background is now yellow.

### C. Arrange the Matrix of Cell Means

The next step is to copy the means to another worksheet. First, select the means (be sure to get the entire row of 25 means), then choose *Copy* from the **Edit** menu, then click on *Sheet 2* tab on the bottom of the worksheet. Now click in cell B2, and from the **Edit** menu, select *Paste Special*. The dialog box in Figure 12.8 appears.

Insert Fig 12.8 about here.

Figure 12.7. Dialog box of *Format Cells*. Note the different tabs.

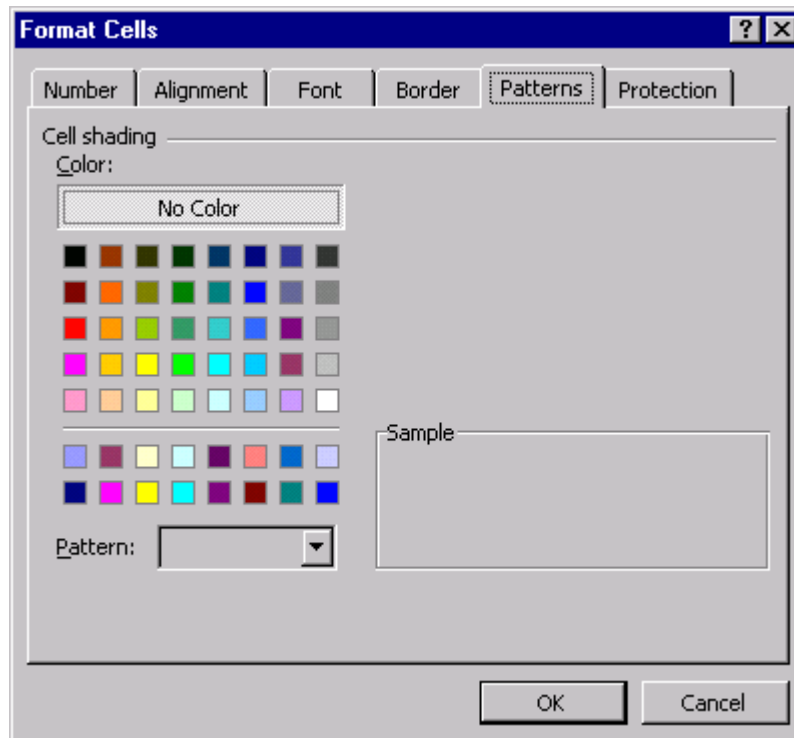
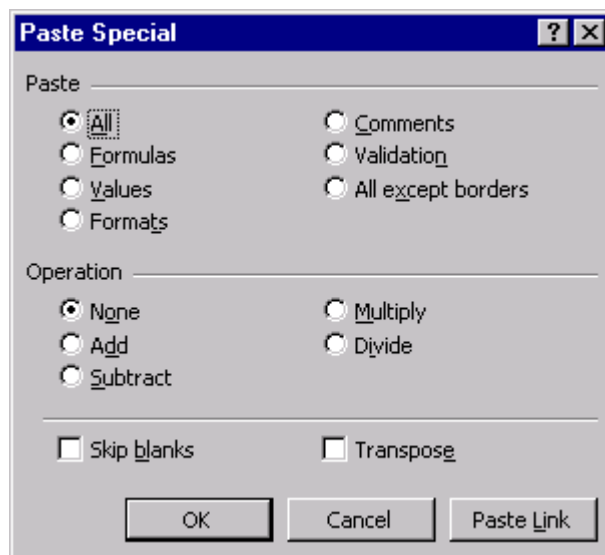


Figure 12.8. Paste special dialog box. In this case, select *All* for *Paste*, and click the *Paste link* button.



Click the *Paste Link* button in the lower right of this dialog. You might have copied just the values (by clicking the Values button and then *OK*); however, if you later make a change in the data page, you would have to redo your work. With *Paste Link*, any change in the data will automatically be corrected in the matrix that you will construct. Pasting a link means that the data on this page are linked to the means on the previous page. If you changed the data, it would change the means, and because of the link, it would change the means on this page as well.

The next task is to arrange the data into a matrix of rows and columns. Click in cell G2 and drag until all of the 20 cells to the right are selected. Then choose *Cut* from the **Edit** menu (or click the *Cut* icon from the toolbar—the little scissors), then click in cell B3 and choose *Paste* (or click the *Paste* icon in the toolbar). That moved 20 cells. Then do the same thing to *Cut* and *Copy* the next 15 cells into Row 4 (select from Cell G3 to the right, cut, click in cell B4 and paste. Row 4 of the Excel worksheet holds the third row of the data matrix). Then *Cut* the next 10 cells to construct Row 5; finally *Cut* and *Copy* the last 5 cells into Row 6 (the fifth row of data). When done, the matrix will appear as in Figure 12.9. Insert Figure 12.9 about here.

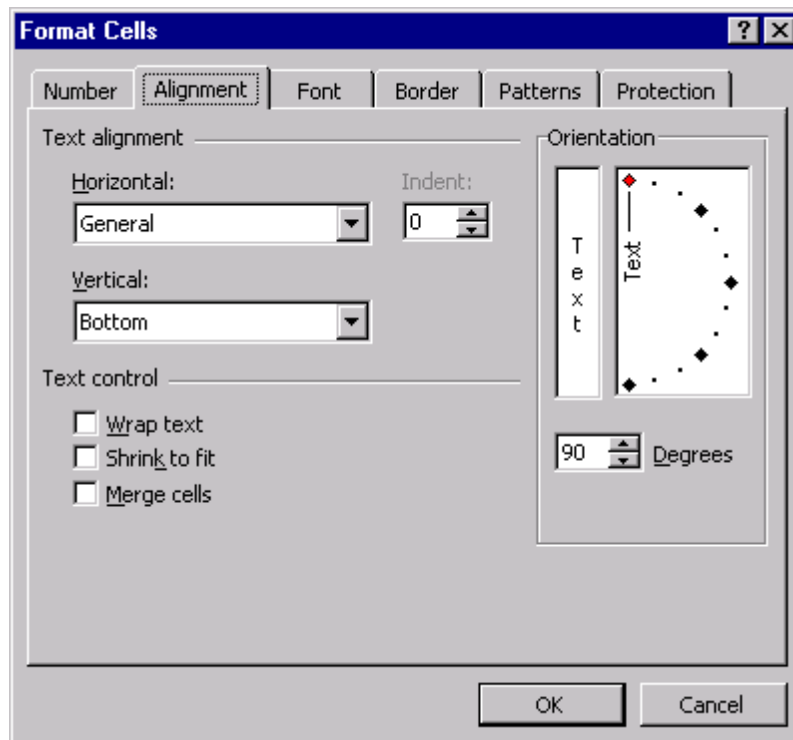
Next, type in the adjectives, to clearly label each entry. Recall, from the last chapter, the adjectives for Rows were *phony*, *squeamish*, *blunt*, *informal*, and *sincere*; for Columns, they were *mean*, *listless*, *solemn*, *lighthearted*, and *trustworthy*. Type these in the labels for row and column. Next, select the adjectives in Row 1, and then from the **Format** menu, select *Cells...* The dialog in Figure 12.10 appears.

Insert Figure 12.10 about here.



Figure 12.10. Format cells, *Alignment* tab is used to make text align to vertical.

Use the mouse to click and drag the colored diamond from horizontal to the desired angle.



Click on the *Alignment* tab, and then in the box on the right, click and drag the red diamond from horizontal to vertical, showing 90 degrees of rotation of the text. Click on the *Font* tab, and make the font bold and size 12. Also make the Row adjectives bold and size 12, but leave them horizontal. Then select the numbers in the matrix, choose **Format Cells...**, and from the *Number* tab, select *Number*, then select 2 for *Decimal places*, as shown in Figure 12.11. Insert Figure 12.11 about here.

The formatted matrix should now appear as in Figure 12.12. Next, double click on the tab at the bottom of the page labeled *Sheet2* and rename it “matrix.”

Insert Figure 12.12 about here.

Figure 12.11. Use *Format Cells* to change the number of decimal places in the display. First select the cells, then from the **Format** menu, select *Cells*, then click the *Number* tab. In the select list click *Number*, then change *Decimal places* to 2.

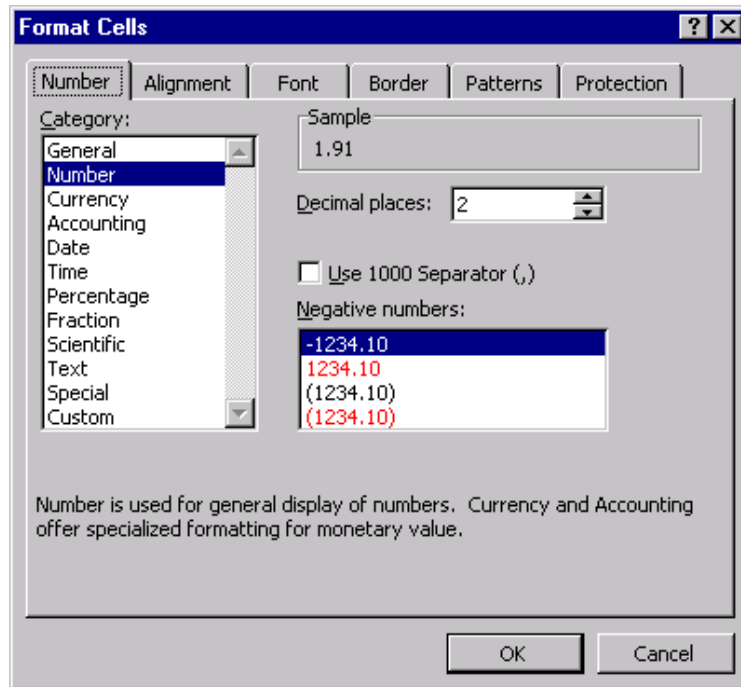
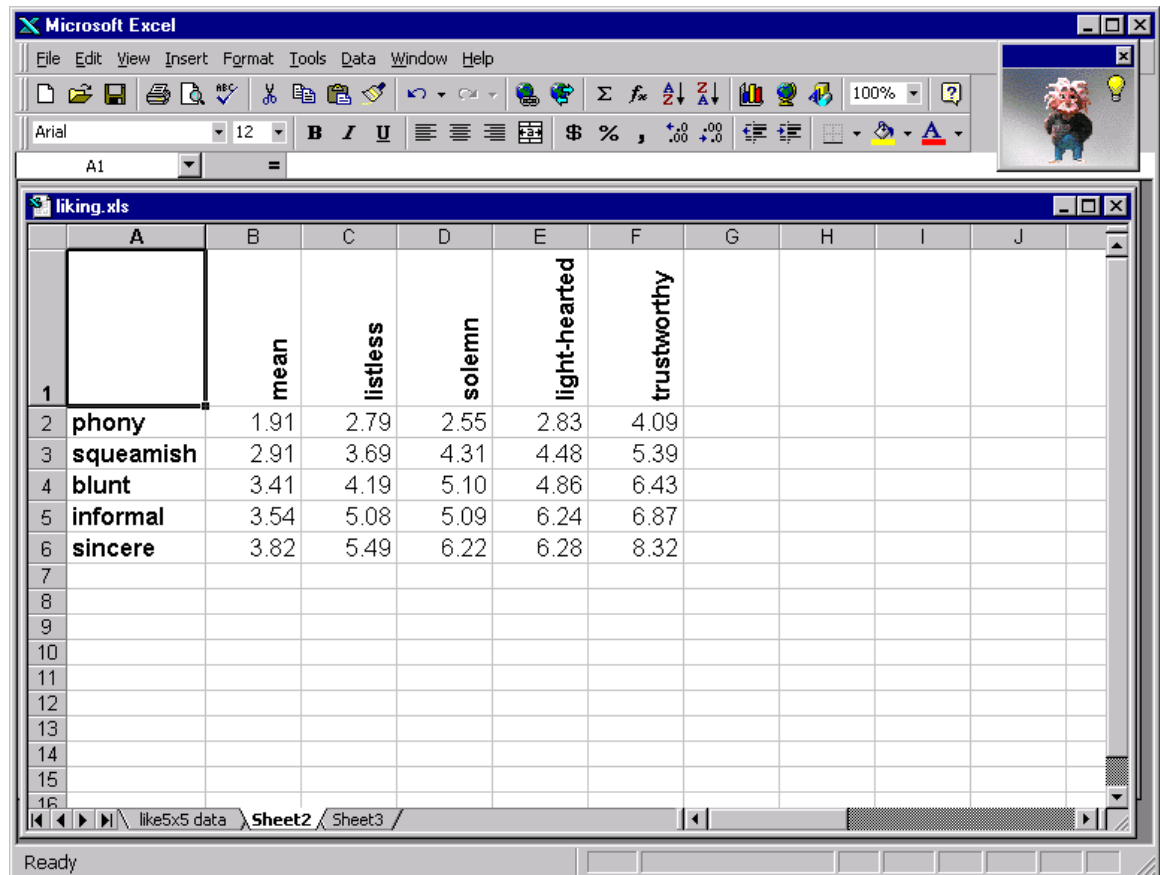




Figure 12.12. Matrix of formatted mean judgments of likeableness.



Microsoft Excel

File Edit View Insert Format Tools Data Window Help

File Edit View Insert Format Tools Data Window Help

A1

liking.xls

	A	B	C	D	E	F	G	H	I	J
1		mean	listless	solemn	light-hearted	trustworthy				
2	phony	1.91	2.79	2.55	2.83	4.09				
3	squeamish	2.91	3.69	4.31	4.48	5.39				
4	blunt	3.41	4.19	5.10	4.86	6.43				
5	informal	3.54	5.08	5.09	6.24	6.87				
6	sincere	3.82	5.49	6.22	6.28	8.32				
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										

like5x5 data Sheet2 Sheet3

Ready

### D. Making a Graph of the Data

The next task is to draw a graph of the data, to examine the interaction. But first, look at the data and think about them for a few moments. A person who is described by one source as *phony* and by another source as *mean* gets a mean rating of 1.91, which on the 1 to 9 scale is close to 2 = *dislike very much*. A person described as *sincere and trustworthy* is rated 8.32 (close to 8 = *like very much*). Half-way between 2 and 8 would be 5 = *neutral*. However, notice that if a person is described by one source as *phony* and by another as *trustworthy*, then the mean rating is 4.09 (close to 4 = "dislike slightly"). Similarly, a person described as *sincere & mean* is rated 3.82 on the average. Thus, when there is disagreement, the "benefit of the doubt" goes to the lower trait—not really a benefit! You will be able to see this interaction visually in the graph that will be drawn next.

To draw a graph of the data, select the whole table, adjectives and all (A1:F6). Then select *Chart* from the **Insert** menu (or click the *Chart* icon on the standard toolbar). The *Chart Wizard* appears, as shown in Figure 12.13.

Insert Figure 12.13 about here.

Select *XY (Scatter)* as the chart type, then click the icon showing points connected by straight lines, as shown in Figure 12.13. At this point, you can press on the bar marked "Press and hold to view sample," which shows a preview of the graph. Then click *Next*, bringing up Step 2, shown in Figure 12.14.

Insert Figure 12.14 about here.

Figure 12.13. Step 1 of the *Chart Wizard*. Click *XY (Scatter)* for *Chart type* and choose *Scatter with data points connected by lines* as the *Chart sub-type*, as shown.

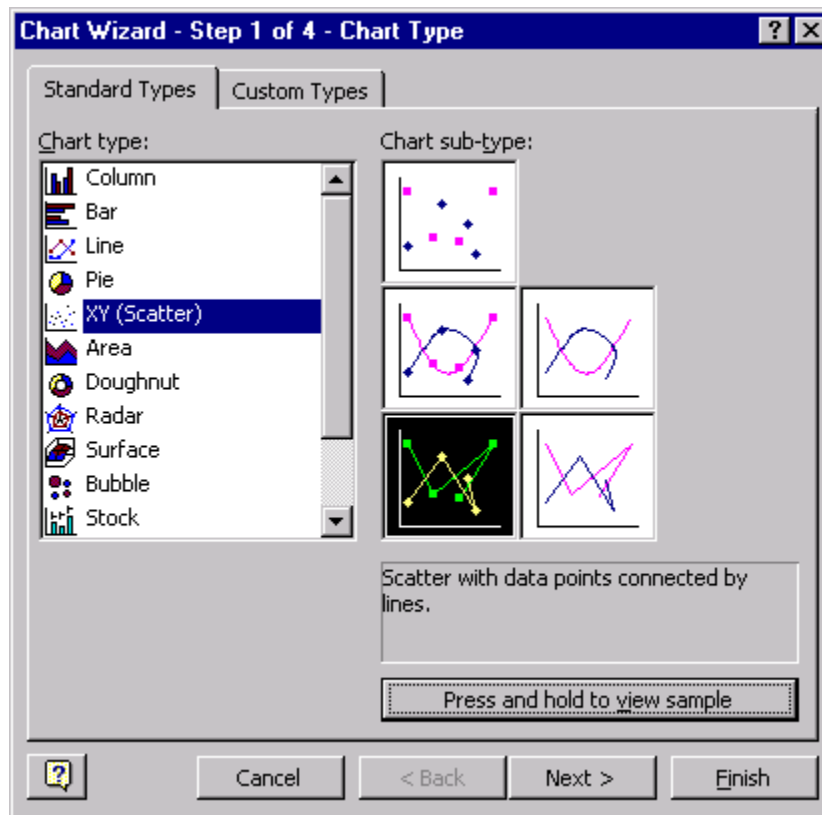
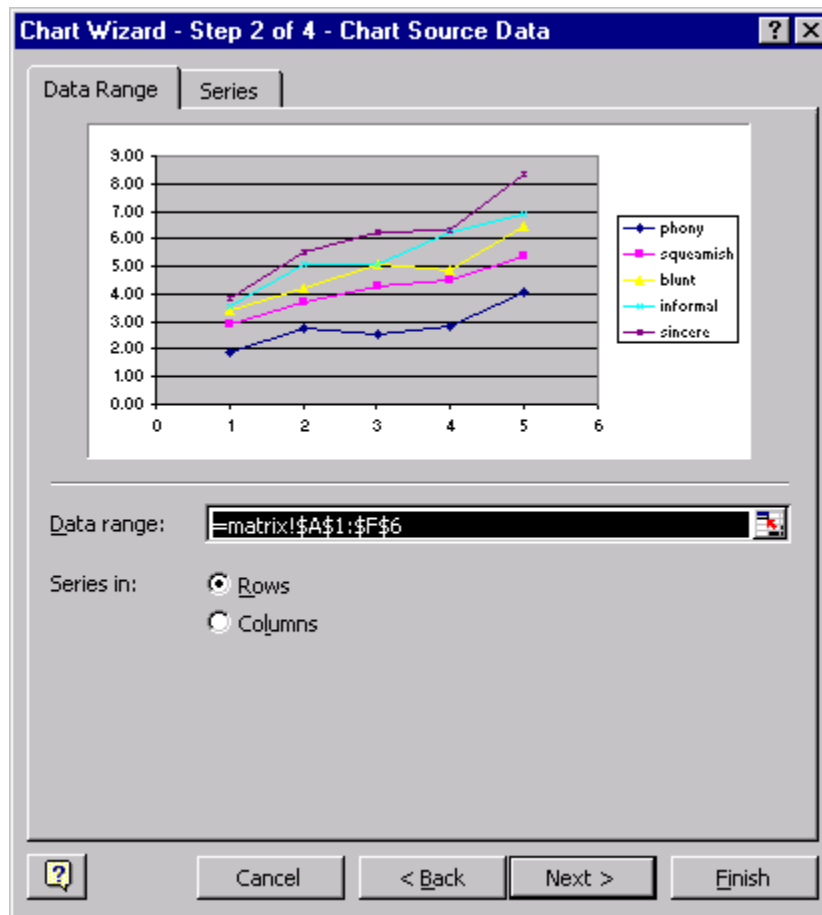


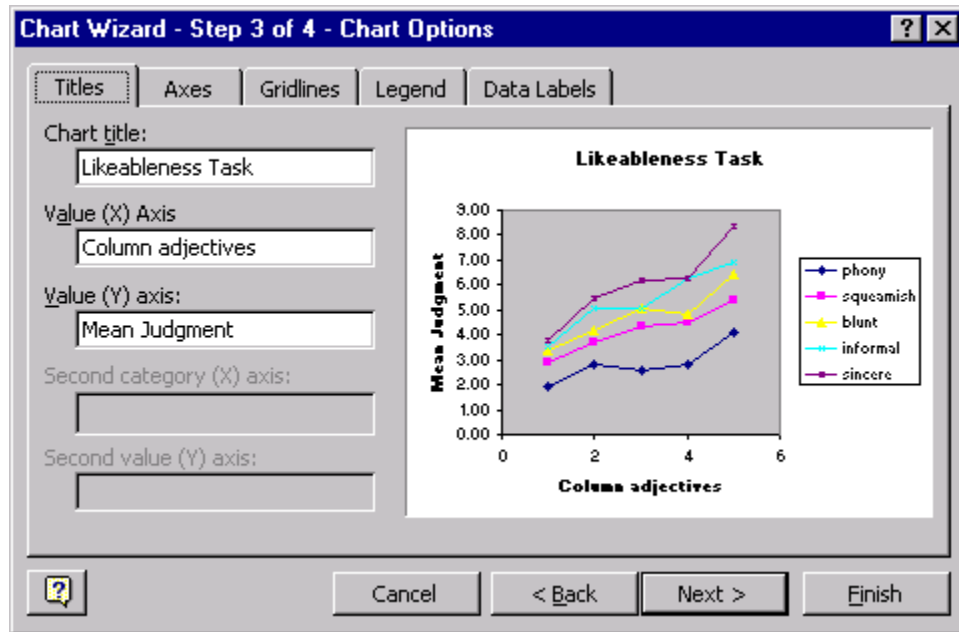
Figure 12.14. In Step 2, try viewing the series in *Columns*, but click *Rows* again before you press *Next*.



Try clicking on the “Columns” button. If you look closely at the graph, You will see that it plots each column of data as a curve instead of plotting each row of data as a curve. By plotting the same data in different ways, it gives the eyeball a chance to see them from another viewpoint. After studying the data in the other format, click back on *Rows*, and then click *Next*, which brings up Figure 12.15.

Insert Figure 12.15 about here.

Figure 12.15. Step 3 of the *Chart Wizard*. Give the chart a title and labels for the X and Y axes. Note the tabs for *Axes*, *Gridlines*, *Legend*, and *Data Labels*. Click the tab for *Gridlines*, and remove gridlines.



In the dialog in Figure 12.15, there are several tabs. On the *Titles* page, enter a title for the graph. Then label the X-axis (abscissa) as “Column adjectives” (remember, 1 is *mean*, 2 is *listless*, etc. Next, label the Y-axis (ordinate) as “Mean judgment.” After a few seconds, these labels appear in the little figure. Click the tab for *Gridlines*, and click to remove the check, getting rid of the horizontal lines. You can experiment with adding horizontal and vertical gridlines, but when you are done trying these features, get rid of them. Explore the other tabs (for example, look at the effect of adding values or adding labels—adding labels puts the adjectives on the graph; adding values puts the data means on the graph). When you are done exploring those options, click *Next*, which brings up the box shown in Figure 12.16.

Insert Figure 12.16 about here.

Click the button next to *As new sheet*; otherwise, it would put the graph on the same worksheet as the data matrix. Then click *Finish* (you are not yet finished, but you are done with the wizard). The graph appears as in Figure 12.17.

Insert Figure 12.17 about here.

Figure 12.16. In Step 4, select *As new sheet*. Otherwise, the figure will appear on the same page as the data.

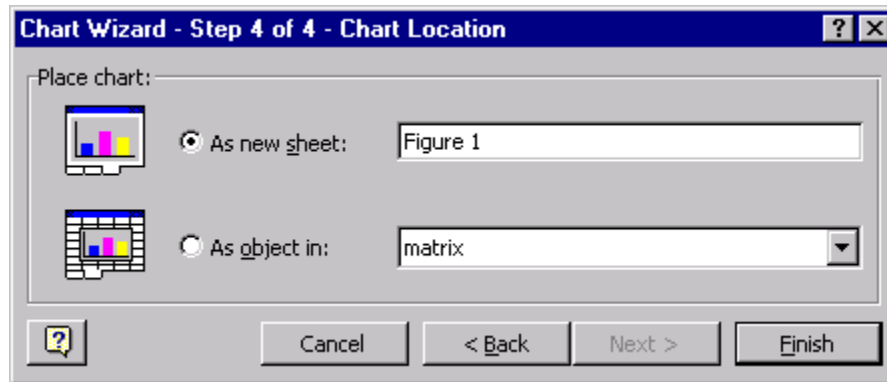
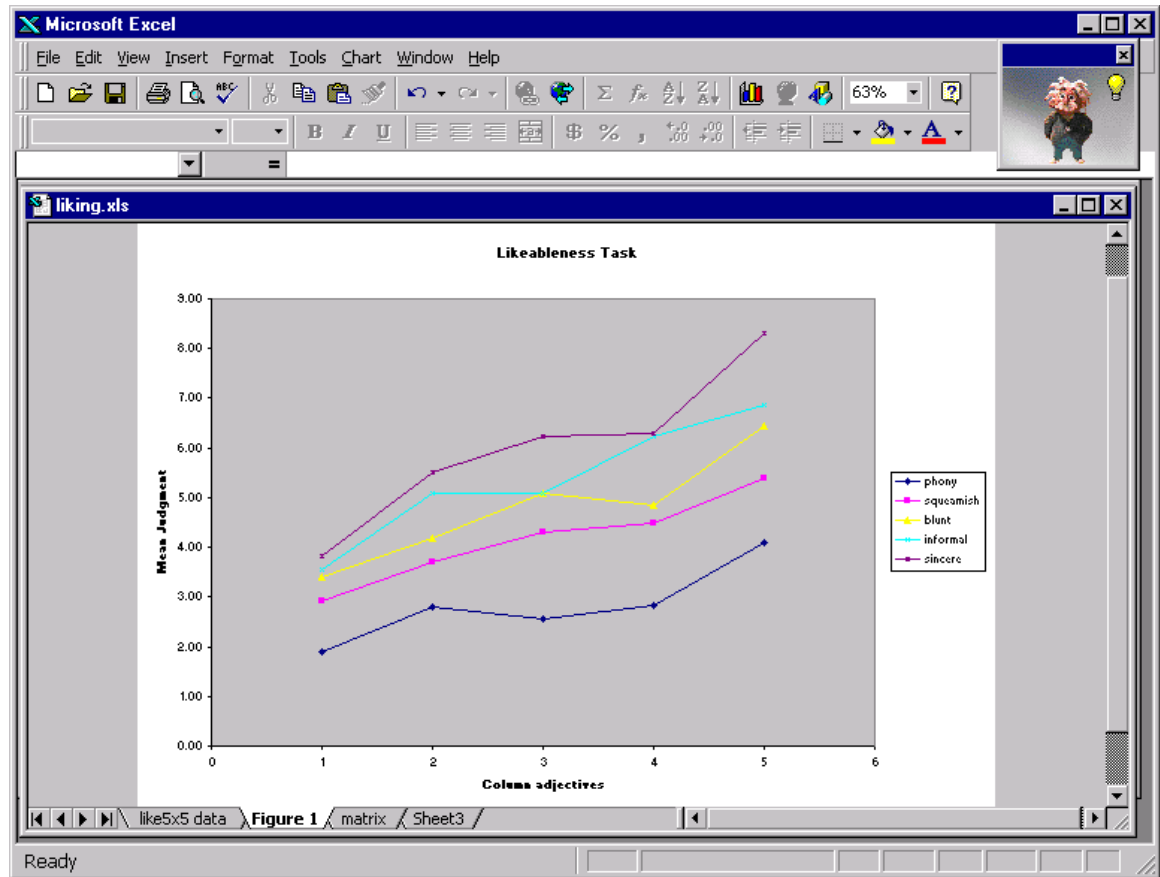


Figure 12.17. Appearance of the graph on its new sheet. The fonts and data symbols are small.

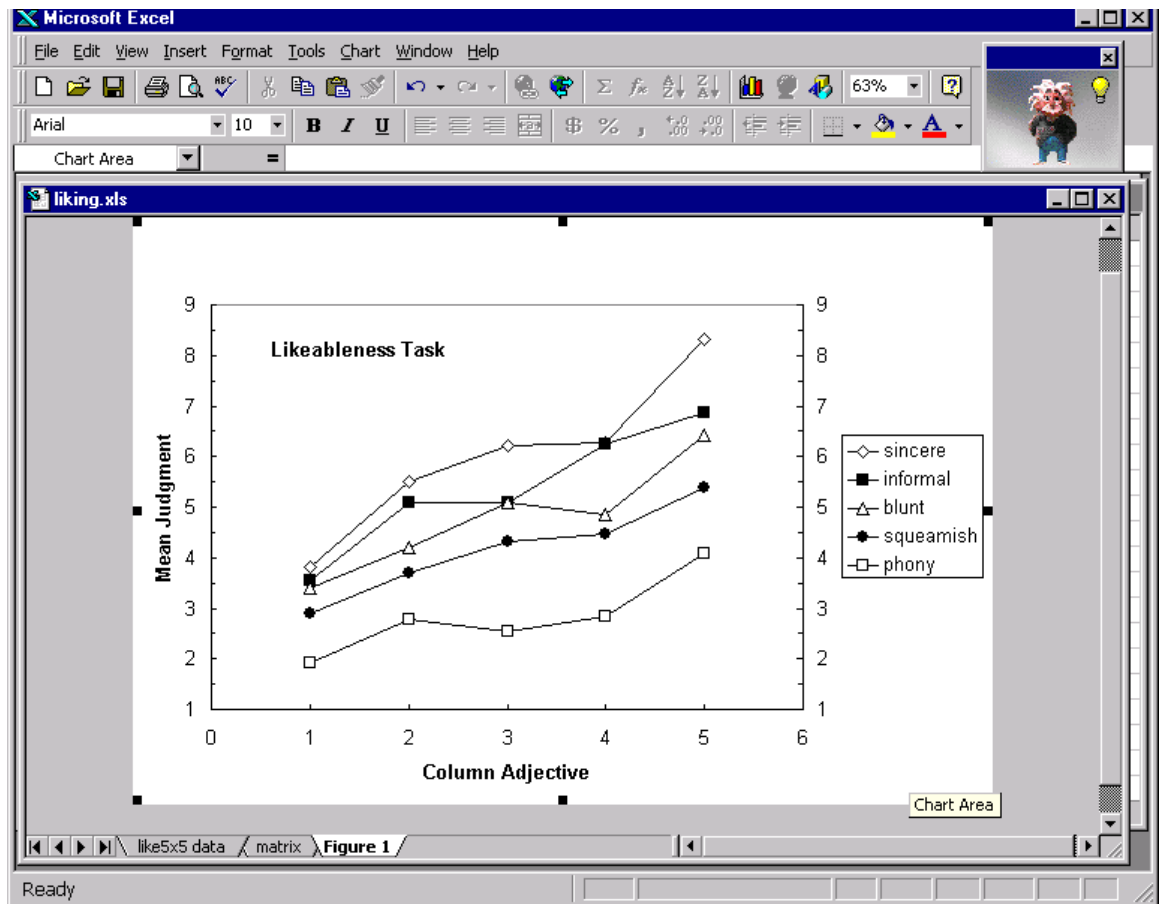




To edit elements in the chart, point and double click on them; then make adjustments in the dialog boxes. For example, to increase the fonts of the axis labels, double click on the axis labels, then change the font size to 16. Make all of the fonts size 16. To change data symbols or lines, point to the right-most symbol for a given line, and double-click. Then make the changes in the symbol type, the color of the foreground and background, etc. Make all of the symbols 9 or 10 in size, and make all colors black or white. After adjustments to increase fonts, make the background white, and other modifications, the graph appears as in Figure 12.18. In addition to double-clicking on a graph element, you can right-click (PC) or CTRL-click (Mac) on a graph element and a drop down menu of choices will appear.

Insert Figure 12.18 about here.

Figure 12.18. Appearance of the graph after adjustments to font sizes, symbol markers, lines, and background color.



If there were no interaction, the curves would be parallel. Instead, the slope of each line increases as the row adjective improves: The curves diverge to the right. The slope for the lowest curve (*phony*) is the smallest. If a person is *phony*, then the increase in liking produced by changing the column adjective from *mean* to *trustworthy* is only about 2 points on the scale. However, if the row adjective is *sincere*, it makes more than 4 points difference to be *trustworthy* instead of *mean*. Similarly, the vertical gaps between curves represent differences between the rows. The difference between being *phony* and *sincere* (the vertical gap) depends on whether the person was also *mean* or *trustworthy*. If the person was *mean*, it makes little difference; if the person was *trustworthy*, it makes twice the difference.

If these curves had been parallel (no interaction) then the slopes of each segment would be the same for all rows, and the vertical gaps between any two rows would be the same for all columns.

The nonparallelism of the curves (the divergence, or spreading out of the curves), shows an interaction, or nonadditivity. Ratings are not just the sum or average of the separate impressions of the adjectives. Something else is happening. The divergent interaction suggests that the worst trait gets more weight than the best trait in a person. Some people may forgive another person their faults, but the average person puts the most weight on another's worst trait. These results are similar to those observed by Birnbaum (1974, Experiment 1).

### **E. Examining Individual Data**

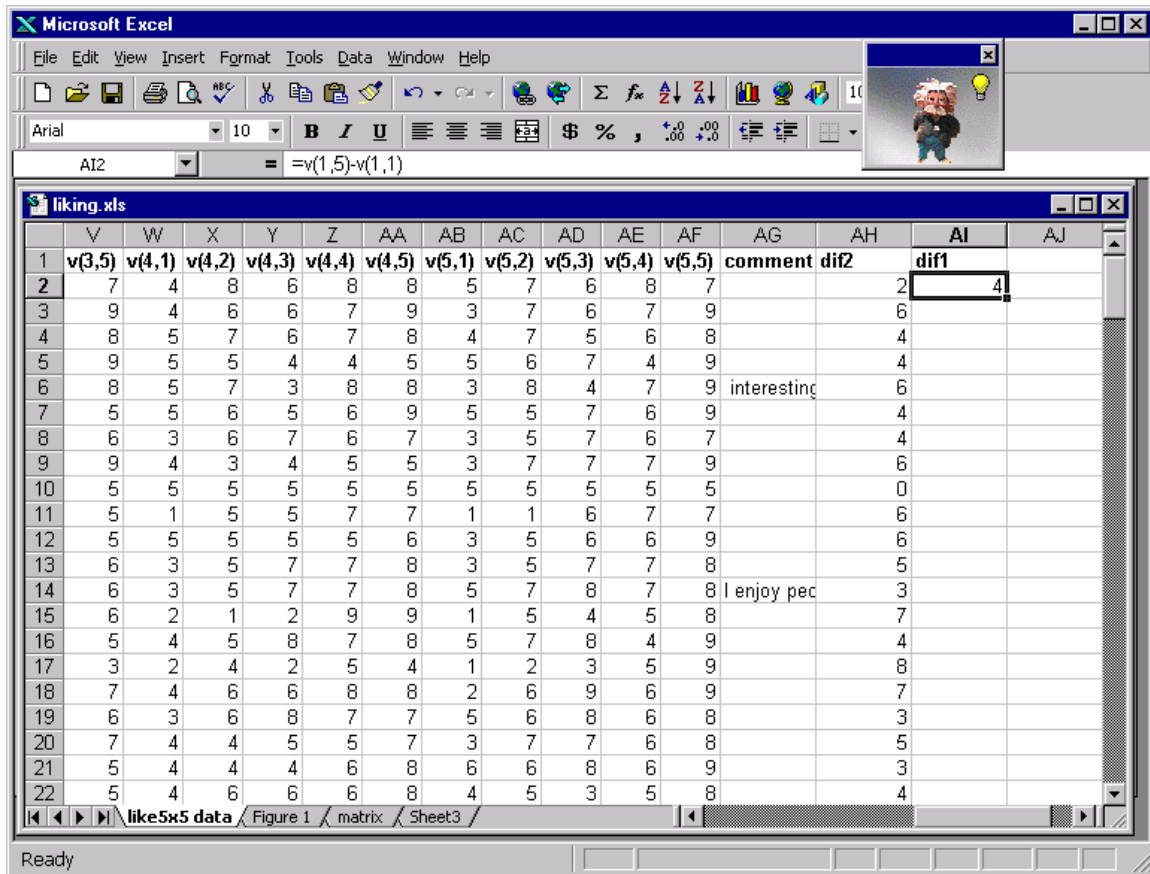
To investigate individual differences, you could draw a graph like Figure 12.18 for each person. You can also calculate, for each participant, the difference between

*sincere & trustworthy* and *sincere & mean* and compare it to the difference between *phony & trustworthy* and *phony & mean*. If the first difference is greater than the second difference, then this person has the same type of divergent interaction as the mean judgments shown in the graph of Figure 12.18. If the second difference is greater than the first, then this individual has the opposite type of interaction, convergent instead of divergent.

To do this analysis in Excel, return to the worksheet showing the data (click on the tab for *like5x5 data*). Now, click the cursor in cell AH2. Then click the equal sign on the formula line (above the worksheet and below the icons). To take the difference between cell  $v(5,5)$  and cell  $v(5,1)$ , type  $v(5,5)-v(5,1)$  then hit return. A number will appear in the cell, and you should verify that it is correct. Then click your cursor in the lower-right corner of the cell (the + appears), and use *AutoFill* to drag down the column to fill in the whole column of differences. Drag all the way down, including the column means. Name this variable *dif2*. Then, click in cell AI2, and click the equal sign on the formula line. Type here  $v(1,5)-v(1,1)$ , as shown in Figure 12.19.

Insert Figure 12.19 about here.
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Figure 12.19. Excel can be used to calculate an interaction for each participant. Click in cell A12, press =, and type the expression. In this case,  $dif1$  is  $v(1, 5) - v(1, 1)$ .



Now, use *Autofill* to drag down this column. Name the second column *dif1*. For each subject, if  $dif2 > dif1$ , then that person has a divergent interaction, like the means. Note in the last row, that the mean  $dif2 = 4.51$ , which is more than twice the the mean of *dif1*, which is 2.19.

You could look at  $dif2 - dif1$  for each participant and count by hand how many people show positive differences. However, you can use Excel to do the counting. Use the logical function *IF*. Click in cell AJ2, and then click the equal sign in the formula line (or choose *Function* from the **Insert** menu).

The *paste function* dialog comes up, as shown in Figure 12.20. Paste the logical function, *IF*, which brings up the display in Figure 12.21. Enter the logical expression shown in Figure 12.21.

Insert Figures 12.20 and 12.21 about here.
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Figure 12.20. Paste the logical function, *IF*. Then click *ok*. That brings up Figure 12.21.

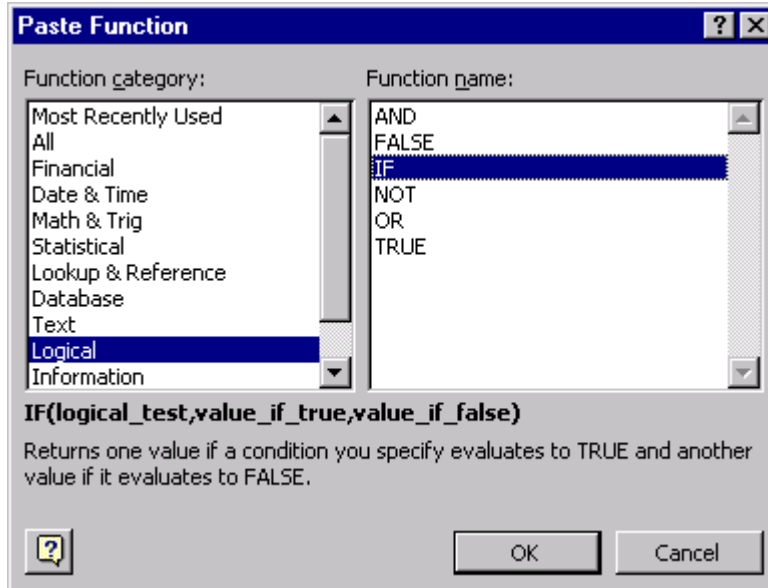
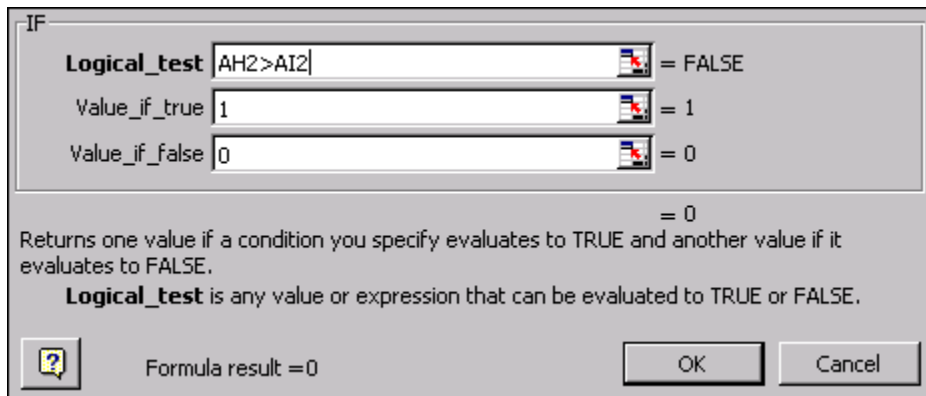


Figure 12.21. Type in AH2>AI2 for the logical\_test, 1 for the value if true, 0 if false.



Then type in the logical test,  $AH2 > AI2$  (or click in those boxes to supply their locations). Type in 1 as the *value\_if\_true*, and 0 for the *value\_if\_false*, then click *OK*. Then click in the lower right-hand corner (of AJ2) to get the *Autofill* handle, and drag down to the last subject, but do not include here the line of means. Now, in the next line (the line of the means), click in the cell and then click the *AutoSum* button (cap sigma  $\Sigma$  on the standard toolbar). Hit return, and the sum will appear (You can also select “*Sum*” from the list of functions from **Insert Function**). Use the same procedures to find out how many did the opposite.

Results show that of 180 subjects, 135 (75%) show the same trend as the means, 22 (12%) show the opposite, and 23 had both differences equal. The binomial sign test (Chapter 8) can be used to test if the difference is significant. There were 157 who showed some difference, so the null hypothesis has a mean of 78.5 ( $157/2$ ) and a standard deviation of 6.26. Therefore,  $z = (135 - 78.5)/6.26 = 9.02$ , which is significant (recall that  $z > 1.96$  is significant at the  $\alpha = .05$  level). This result shows that significantly more subjects showed a divergent interaction than showed a convergent interaction.

These results show that impressions of personality are not just the sum or a simple average of the likeablenesses of the separate traits. Instead, these results replicate previous findings suggesting that impression formation follows a configural process in which people place more weight on the lower valued of two traits (Birnbau, 1974; Birnbau & Jou, 1990).

## F. ANOVA with SPSS

Another approach to testing the significance of interactions is by Analysis of Variance, also known as ANOVA. SPSS is fairly easy to use to compute ANOVA. To



import the CSV data into SPSS, select *Read Text Data* from the **File** menu. Indicate *All files* for *Files of Type*, and open *liking.csv*. The Wizard appears. In Step 1, indicate that the data are not in predefined format. In Step 2, indicate that the data are *Delimited*, and check *Yes* to indicate that the variable names are at the top of the file. In Step 3 indicate that the first case is on line 2, that each line represents a case, and to import *all cases*. In Step 4, check that the *delimiter* is a comma. Remove any other checks here. For example, *Space* may be checked. Uncheck it if it is checked. You do not want to declare "United States" to be two different variables, just because there is a space in the middle. In Step 5, click on each of the variables to make sure that SPSS has correctly identified all of the v11 to v55 variables as numeric. Click *Finish* in Step 6, and you will see some warnings that long comments and long nationalities have been truncated.

To do an analysis of variance, from the **Analyze** menu, select *General Linear Model*, then *Repeated Measures*, as shown in Figure 12.22. (When each participant receives all of the treatment combinations in a within-subjects design, the design may also be given the term, *repeated measures*.) The dialog box of Figure 12.23 appears. In this box, name the row factor *adj1* (Adjective 1), with 5 levels, and name the column factor *adj2*, also with 5 levels. Click *Add* to add each variable. Then click *Define*, which brings up the box in Figure 12.24.

Insert Figures 12.22, 12.23, and 12.24 about here.
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Figure 12.22. To do ANOVA, from the **Analyze** menu, select *General Linear Model*, then *Repeated Measures*.

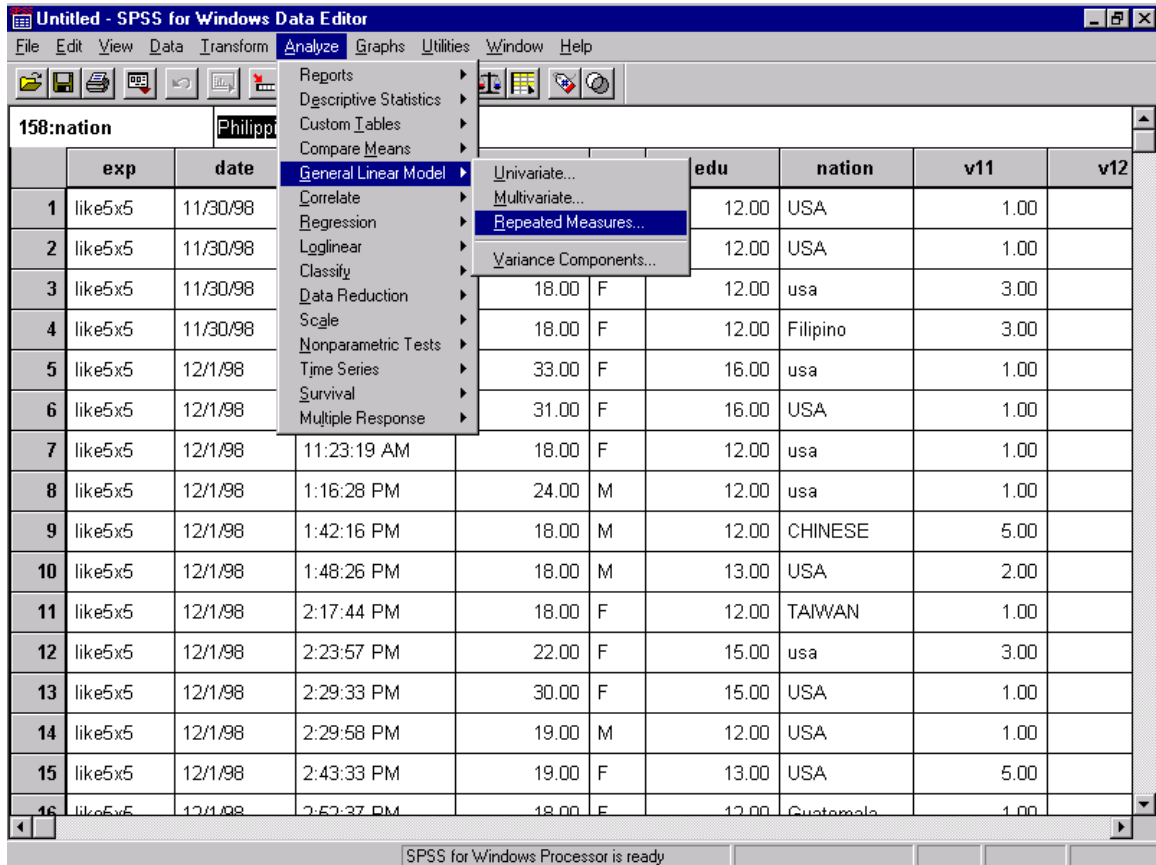


Figure 12.23. Define the Row factor (Adjective 1) as *adj1* with 5 levels; then define the Column Factor, *adj2*, with 5 levels. Press *Add* to add each factor. When both factors have been added, press *Define*.

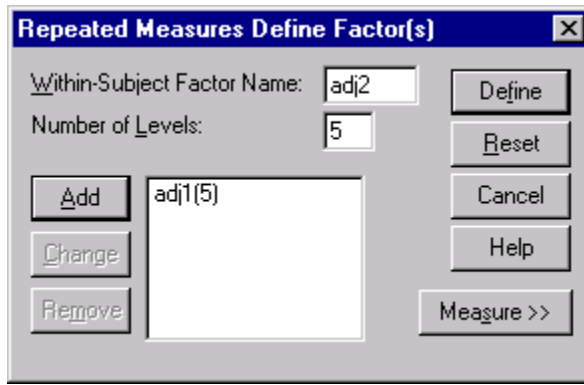
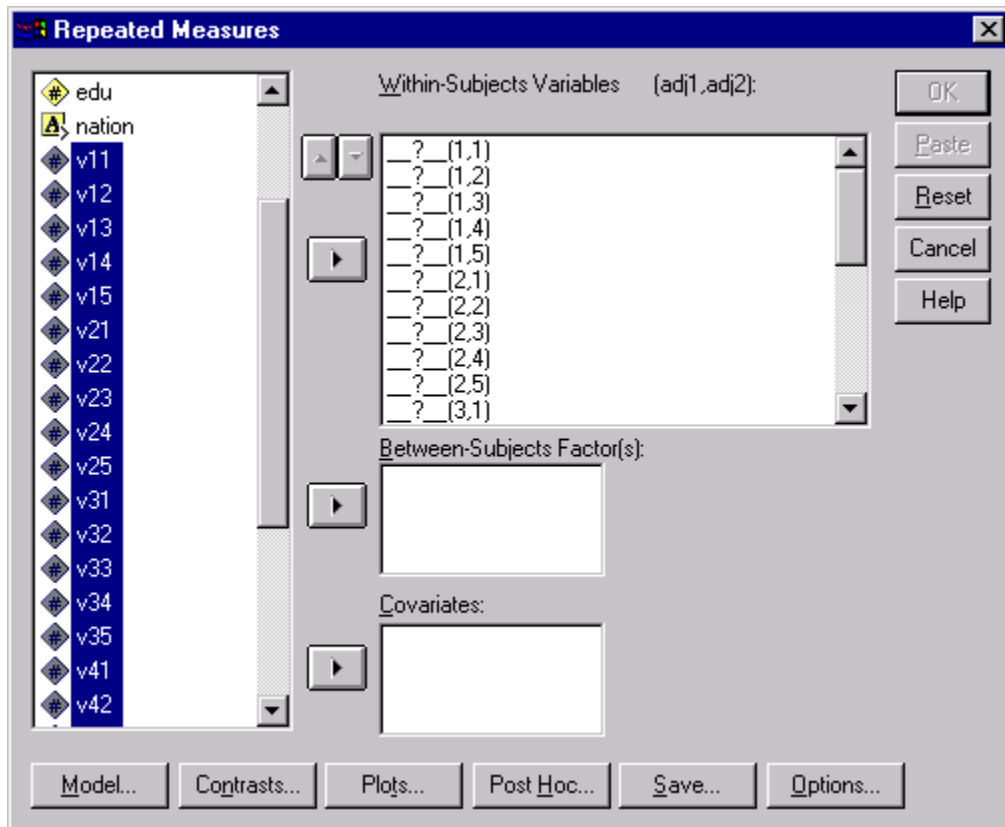


Figure 12.24. Select all of the variables, v11 to v55, and click the right-facing arrow, which will send them to the box for *Within-Subjects Variables*. Because the data are organized in factorial order, this step can be done with one click of the arrow.



Select all of the within-subjects variables,  $v11$ ,  $v12$ , ...,  $v55$ . Then click the right-facing arrow to send these variables to the box. Click *Model* at the bottom-left of this dialog box, and click the button for *Full factorial*. Click *Continue*, then click the button for *Plots*. Insert *adj1* in *Horizontal axis*, and *adj2* for *separate lines*. Then click *Add*, to add the graph. You can request another graph, with *adj1* for separate lines, and *adj2* on the *Horizontal axis*. Press *Continue*.

Explore the *Post Hoc* and *Save* dialogs, but do not make any changes. Now, click *Options*, and make the selections shown in Figure 12.25. The descriptive statistics option will print cell means and standard deviations. Click *Continue*. Then click *OK* on the *Repeated Measures* screen of Figure 12.24. After a few moments, the output will be available for viewing. Standard errors of means can be found by dividing standard deviations by the square root of  $n$ . In this case,  $n = 180$ . Thus, the standard error for a standard deviation of 1.5 would be .11. Thus, an observed mean can be considered an estimate of the population means with a 95% confidence interval of .22. In other words, the confidence interval for a sample mean of 2.00 would be 1.78 to 2.22. One could add error bars to Figure 12.18 to show these standard errors.

The ANOVA table from the output is shown (in part) in Figure 12.26. The main purpose of the analysis was to test the significance of the interaction. The ANOVA has been done by several methods. The interaction is statistically significant,  $F(16, 2864) = 22.37$ . SPSS provides additional results for more conservative procedures; in this case, the result is significant by all procedures. Examine the rest of the output from SPSS, including the graphs, which you can compare with Figure 12.18.

Figure 12.25. Options dialog. Here, select the main effects and interactions shown, and click the right-facing arrow to send them to the *Display Means* box. Also check the box for *descriptive statistics* and the other options shown. Click *Continue*.

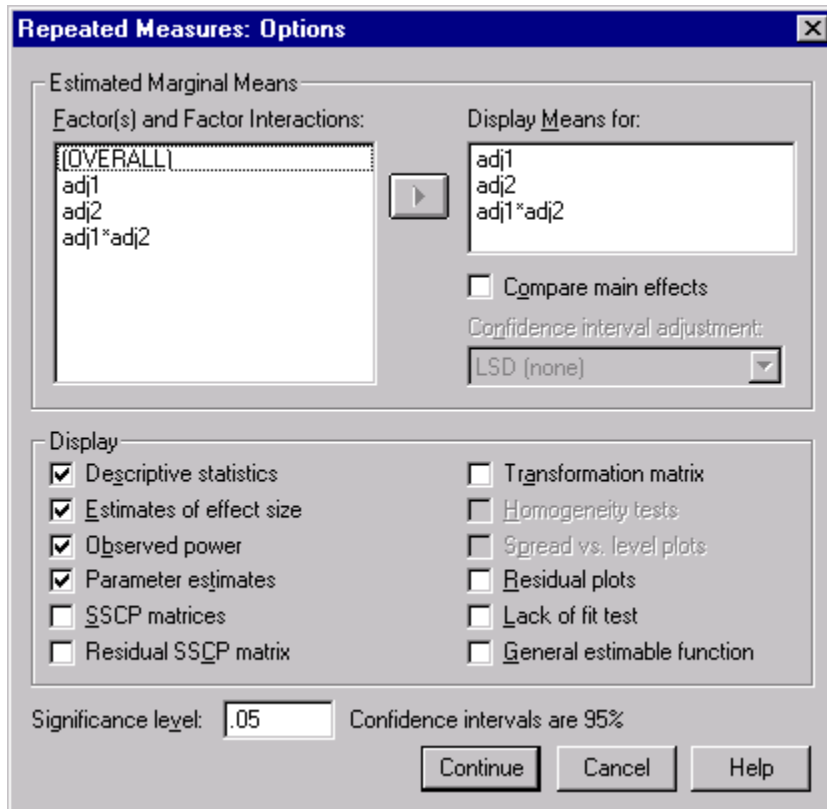


Figure 12.26. Analysis of Variance table for impression formation experiment. The F-ratio for adj1\*adj2 interaction is  $F(16, 2854) = 22.37$ , shown in bold type. Both main effects are also significant. Different rows within each source are tests that take into account correlations among the repeated measures. Even by the most conservative procedure, the interaction is significant,  $F(1, 179) = 22.37$ ,  $p < .001$ .

Output1 - SPSS for Windows Viewer

File Edit View Insert Pivot Format Analyze Graphs Utilities Window Help

Output  
Log  
General List  
Title  
Notes  
Within-Subjects  
Descriptive Statistics  
Multivariate Tests  
Mauchly's W  
Tests  
Tests  
Tests  
Parameter Estimates  
Estimates  
1.  
2.  
3.  
Profile  
Title  
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Source		Type I Sum of Squares	df	Mean Square	F	Sig.
ADJ1	Sphericity Assumed	5377.030	4	1344.258	471.491	.000
	Greenhouse-Geisser	5377.030	3.024	1777.995	471.491	.000
	Huynh-Feldt	5377.030	3.082	1744.655	471.491	.000
	Lower-bound	5377.030	1.000	5377.030	471.491	.000
Error(ADJ1)	Sphericity Assumed	2041.370	716	2.851		
	Greenhouse-Geisser	2041.370	541.334	3.771		
	Huynh-Feldt	2041.370	551.678	3.700		
	Lower-bound	2041.370	179.000	11.404		
ADJ2	Sphericity Assumed	4565.379	4	1141.345	380.338	.000
	Greenhouse-Geisser	4565.379	3.476	1313.352	380.338	.000
	Huynh-Feldt	4565.379	3.553	1284.799	380.338	.000
	Lower-bound	4565.379	1.000	4565.379	380.338	.000
Error(ADJ2)	Sphericity Assumed	2148.621	716	3.001		
	Greenhouse-Geisser	2148.621	622.227	3.453		
	Huynh-Feldt	2148.621	636.055	3.378		
	Lower-bound	2148.621	179.000	12.003		
ADJ1 * ADJ2	Sphericity Assumed	494.636	16	30.915	<b>22.369</b>	.000
	Greenhouse-Geisser	494.636	12.678	39.015	22.369	.000
	Huynh-Feldt	494.636	13.709	36.082	22.369	.000
	Lower-bound	494.636	1.000	494.636	22.369	.000
Error(ADJ1*ADJ2)	Sphericity Assumed	3958.164	2864	1.382		
	Greenhouse-Geisser	3958.164	2269.394	1.744		
	Huynh-Feldt	3958.164	2453.874	1.613		
	Lower-bound	3958.164	179.000	22.113		

a. Computed using alpha = .05

SPSS for Windows Processor is ready

H: 416 , w: 653 pt

Therefore, we can reject the hypothesis that the deviations from parallelism are due to chance in favor of a theory in which the true means are not parallel.

### **G. Summary**

In this chapter, you learned how to analyze data from a within-subjects factorial design. You learned how to use conditional formatting in Excel to find values that violate the instructions. You also learned how to Format cells to make the Excel spreadsheet easier to read. You used Excel to find means, and you learned how to use *Autofill* to easily find all of the cell means. These means were copied using *Paste Special* (*Paste Link*) to a new sheet and arranged in a matrix. You learned to make a graph of the data in which the curves for each row would be parallel if there had been no interaction. You learned how to compute the interaction for each person to see if the pattern of means is also representative of the majority of individuals. Finally, you learned how to conduct an analysis of variance for a repeated measures factorial design by means of SPSS. This program will find means, standard deviations, and compute *F*-tests of significance of the rows, columns, and interaction. The data showed a significant interaction, which means that impressions of personality are not just the sum of the impressions of the parts.

The techniques covered in this chapter are reviewed in Table 12.1.

Insert Table 12.1 about here.
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Table 12.1. Review of techniques for analysis of data.

Concept	Technique
data filtering	Autofilters in Excel (from <b>Data</b> menu)
data checking	Conditional Formatting in Excel
means	Insert Function in Excel (AVERAGE)
repeating operation	AutoFill in Excel
arrange matrix	Copy and Paste Special in Excel (Paste Link)
graph	Insert Chart in Excel
interaction	deviations from parallelism in graph
statistical tests in factorial design	ANOVA by SPSS (General Linear Model)

## H. Exercises

1. In the data file, delete the data for those participants who gave numbers out of range.

Reanalyze the data (or examine the results in Excel, which should update automatically). Does it make a difference?

2. Separate the data by Excel into Males and Females. Analyze the data for males only or females only, replicating the analyses of this chapter. Try to do the reanalysis without looking at the book. Are the conclusions different when the data are analyzed in this way?



3. Separate the data by age (subdivide the data into those who are below the median in age and those above the median in age). Do all of the analyses of this chapter separately on those who are younger or older than the average. Do the results and conclusions depend on age?
4. Suppose the matrix of means in Figure 12.12 were as shown below. (a) Is there an interaction in these data? (Draw a graph as in Figure 12.18 to decide). (b) What would you conclude about impression formation if the data consistently yielded the above pattern of results?

	<i>mean</i>	<i>listless</i>	<i>solemn</i>	<i>light-hearted</i>	<i>trustworthy</i>
<i>phony</i>	1.00	2.00	3.00	4.00	5.00
<i>squeamish</i>	2.00	3.00	4.00	5.00	6.00
<i>blunt</i>	3.00	4.00	5.00	6.00	7.00
<i>informal</i>	4.00	5.00	6.00	7.00	8.00
<i>sincere</i>	5.00	6.00	7.00	8.00	9.00

5. If people gave the benefit of the doubt to higher-valued traits (instead of to lower-valued ones), how would the data of Figures 12.12 and 12.18 appear? Draw a graph to show your answer.
6. Project idea: Use factorWiz to set up an experiment that applies a scale-free test of the interaction. Use the following six combinations as levels of both Row and Column: *phony and mean*, *phony and solemn*, *phony and trustworthy*, *sincere and mean*, *sincere and solemn*, and *sincere and trustworthy*. The task is to judge differences in likeableness between each person, each described by a pair of adjectives. See Birnbaum (1974, Experiment 4).