Chapter 8: A Study of Decision Making

If you understand the material in Chapters 2-6, then you understand all of the computer techniques that were involved in the studies of Birnbaum (in press-a; 1999b). If you have not done so already, load and run the decision making experiment on your CD, *Ch8_exp1.htm*. This chapter will review background in the psychology of decision making that will help you understand that study. You will also practice some tricks of data processing and analysis, and you will learn how to apply them to analyze the decision making experiment.

A. Psychology of Decision Making

Why do people do what they do? Psychology is the science of behavior, so it attempts to answer this question. As a science, it is the study of rival theories, or explanations, of behavior. One approach to understanding human behavior is to interpret what people do as the result of a decision to act. Normative decision theory prescribes how a rational person *should* decide and descriptive decision theory is the empirical study of how people *do* make decisions. As you will see, people do not always do what theoreticians think they should do.

Consider the decision of whether or not to carry an umbrella tomorrow. The contingencies are described in the matrix below:

	Rains	Does not Rain
Carry umbrella	Stay dry	Extra work
Don't carry umbrella	Get wet	Travel light

Clearly, if it is going to rain, then it would be better to carry your umbrella tomorrow, because you will stay dry. However, if it were not going to rain, then it would be easier to leave the umbrella at home. The greater the probability of rain, the stronger the argument to carry the umbrella. If the weatherman says that there is a 50% chance of rain in the afternoon, would you carry your umbrella? What you decide to do would depend on your subjective values for staying dry, getting wet, for carrying an umbrella when it does not rain, and for traveling light. What you decide to do also depends on your beliefs concerning what will likely happen when the weatherman says, "the chance of rain is 50%."

Consider the following choice, designed to create situations simpler than that of deciding to carry an umbrella. In this case, a fair coin will be tossed, and the consequences will be monetary payoffs that depend on the outcome of the coin toss. If you choose Alternative *A*, then if Heads occurs, you win $100 and if Tails occurs, you lose $10. However, if you choose *B*, then if Heads occurs, you lose $100, and if Tails occurs, you win $10. This choice seems simpler than the umbrella decision, because the probabilities of Heads and Tails are better defined than the likelihood (and strength) of rain when the weatherman says "50%." It also seems simpler because the consequences are money, rather than subjective feelings such as those of getting your hair wet. In this choice, most people would probably choose *A* over *B.*

	Heads	Tails
Alternative A	$50	–$10
Alternative B	–$100	$100

Now consider the following choice, which produces more disagreement.

	Heads	Tails
C	$40	$40
D	$100	$0

In Choice *C*, you win $40 whether Heads or Tails occurs, so it is a sure $40. For *D*, however, you might win $100 or $0. Some people prefer *C* and others will prefer *D*.

B. Expected Value and Expected Utility

The expected value (EV) of a gamble can be thought of as the average amount that you would win if the gamble were played an infinite number of times. The EV is given by the following formula,

$$EV(G) = \sum_{i=1}^{n} p_i x_i \qquad (8.1)$$

where EV(*G*) is the expected value of gamble *G*, p_i and x_i are the probability and monetary value of consequence i, summed over all *n* mutually exclusive and exhaustive outcomes of the gamble. For *D*, EV(*D*) = $50, because the two outcomes (Heads and Tails) have probabilities of .5, and the consequences are $0 and $100, so EV(*D*) = .5($0) + .5($100) = $50. The EV of *C* is $40.

In terms of expected value, gamble *D* is better than *C*; however, many people prefer *C*, because it provides a "safe and sure" $40, whereas gamble *D* seems more “risky.” When people make choices like this—i.e., they prefer a sure thing to a gamble with the same or even higher EV—their behavior is described as "risk averse."

Risk aversion is inconsistent with the theory that people choose gambles by their EV; however, Bernoulli realized that risk aversion is consistent the theory that the psychological value of money is a nonlinear function of money. This theory of Expected utility (EU) can be written as follows:

$$EU(G) = \sum_{i=1}^{n} p_i u(x_i) \quad (8.2)$$

where $u(x)$ is the utility, or psychological value, of a certain amount of money.

Bernoulli proposed Equation 8.2 as an explanation for the St. Petersburg paradox (see Chapter 5) and other violations of EV. If the utility of money is a nonlinear function of its cash value, then the cash value of the Expected utility of the St. Petersburg gamble can be finite. Bernoulli discussed the functions, $u(x) = \log x$, and $u(x) = \sqrt{x}$ as possible utility functions that would explain the St. Petersburg paradox and would also explain risk aversion, such as a preference for choice *C* over Choice *D*.

Suppose $u(x) = \sqrt{x}$. For gamble *D*, the EU is $.5\sqrt{0} + .5\sqrt{100}$ = 5. For gamble *C*, EU(*C*) = $.5\sqrt{40} + .5\sqrt{40}$ = 6.32 > EU(*D*) = 5; therefore, this theory predicts that a person would prefer *C* to *D*. In EU theory, *C* is better than *D* because the psychological value of $40 is better than half the psychological value of $100. In other words, this theory says that the subjective difference from $0 to $40 exceeds the subjective difference from $40 to $100.

C. The Principle of Dominance

Some choices are relatively easy, and there is little disagreement, as in the choice between *E* and *F*:

	Heads	Tails
E	$100	$50
F	$65	$50

Notice that gamble *E* is strictly better than gamble *F*, because for either Heads or Tails, the consequence of choosing *E* is always better than or equal to the consequence of *F*--For Tails, the consequences are the same, but for Heads, *E* gives $100 and *F* gives only $65. When one gamble is strictly better than another in this way, we say that *E* *dominates F*. If *G* and *H* are two distinct gambles such that $P(x > t \mid G) \geq P(x > t \mid H)$, then gamble *G* is said to *stochastically dominate* gamble *H*. This concept is also known as “first stochastic dominance.”

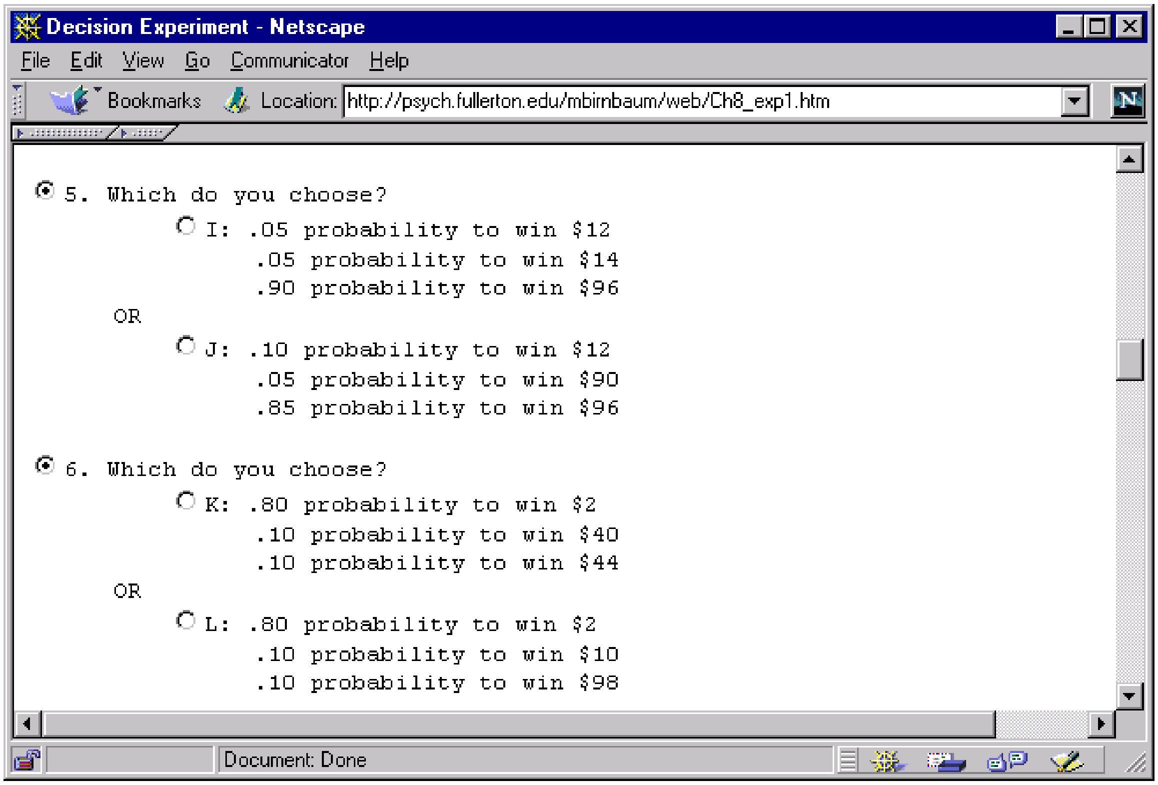
Many descriptive (psychological) theories of decision-making, including Expected Utility theory, imply that people should obey stochastic dominance. These theories predict that people will choose the dominant gamble. The study described in this chapter tested conditions under which people satisfy and violate dominance. This study also tested other properties of choice (Birnbaum, 1999b).

D. Decision Making Experiment

If you examine *Ch8_exp1.htm* in a text editor, you will find that the experiment makes use of hidden variables, text boxes, and radio buttons. There is no new computer technique here, just variations of things you have learned in previous chapters. Note that each choice between two gambles is constructed from a set of three radio buttons. By using three radio buttons, it is possible to distinguish preference for the first gamble (-1), preference for the second gamble (+1), or a failure to respond (0). Note that the button for non-response is in the left margin, making it easy for the subject to see if she or he has completed all of the questions. A portion of the experiment is shown in Figure 8.1.

Insert Figure 8.1 about here.

Figure 8.1. Appearance of two trials in the decision-making experiment, *Ch8_exp1.htm*.



When this experiment was actually run, some lucky participants were given a chance to play one of their chosen gambles for real. For the first 1900 people tested, there were 19 winners, including 11 who won over $90. The version on your CD does not offer prizes, but you can get an idea of what it was like to be a participant in the study.

One of the questions addressed in this study is as follows: Would people, motivated by money, choose the dominant gamble? It is not only the rational thing to do, but it is also predicted to be what people would do if they satisfied Expected Utility theory or one of several modern utility theories (Luce & Fishburn, 1991; 1995; Tversky & Kahneman, 1992). However, configural weight models of Birnbaum (1997) imply that people will violate stochastic dominance in certain specially constructed choices.

E. Rank-Dependent Expected Utility Theory

The theories of Luce and Fishburn (1991; 1995) and of Tversky and Kahneman (1992) have the same representation as Rank-Dependent Expected Utility theory (Quiggin, 1993) when the gambles have strictly positive consequences. These theories represent the utility of such gambles as follows:

$$RDU(G) = \sum_{i=1}^{n} u(x_i)[W(P_i) - W(P_{i-1})] \qquad (8.3)$$

where *RDU(G)* is the rank-dependent expected utility of gamble *G*; *u*(*x*) is the utility of consequence *x*; *W(P)* is a strictly monotonic weighting function that assigns decumulative weight to decumulative probability, with *W*(0) = 0 and *W*(1) = 1; P_i is the (decumulative) probability of winning x_i or more and P_{i-1} is the probability of winning strictly more than x_i. If *W(P) = P*, then this theory reduces to EU theory. This theory can account for the

Allais paradoxes, phenomena that violate EU theory (Quiggin, 1993). This theory also implies that if *G* stochastically dominates *H*, then the *RDU(G)* > *RDU(H)*, so people should choose *G* over *H*.

F. Comparing Rival Theories

Use Netscape to load the decision calculator, *taxcalculator.htm*, from the CD. This calculator uses JavaScript (presented in Chapters 17-19) to calculate predictions for three models of decision-making. This calculator is also available at URL [http://psych.fullerton.edu/mbirnbaum/taxcalculator.htm].

One model is the TAX model of Birnbaum and Navarrete (1998), the second is the Cumulative Prospect Theory (CPT) model of Tversky and Kahneman (1992), and the third is EV. The CPT model is a special case of Equation 8.3. Calculate the value of gambles *I* and *J* in Choice 5 of Figure 8.1.

To use the calculator, first press the *Set Values* button. This action sets the parameters of the models to values published in the literature. Next, type *3* for the *number of outcomes*. Type the outcomes (the prizes) in order from the lowest outcome on the left to the highest. Leave spaces to the right blank. Enter the corresponding probabilities in the spaces provided. Press the *Compute* button and read off the values according to the CWT (configural weight, TAX model), CPT, and Expected Value. Help and instructions are available in the file.

You will see that different theories make different predictions for this choice. Which gamble has the higher EV? (Answer: *I* is higher in EV than *J*, $87.7 to $87.3). Which gamble has the higher CPT value? (Answer: *I* is higher than *J*, $72.27 to $71.73). Which gamble has the higher TAX value? (Answer: *J* is higher than *I*, $63.10 to $45.77).

Which gamble did you pick? If you are like most undergraduates who served in this experiment, you probably chose *J*, as predicted by the TAX model. In the next sections, you will analyze the data to find out which gamble most people preferred to see whether the CWT TAX model or CPT is more accurate.

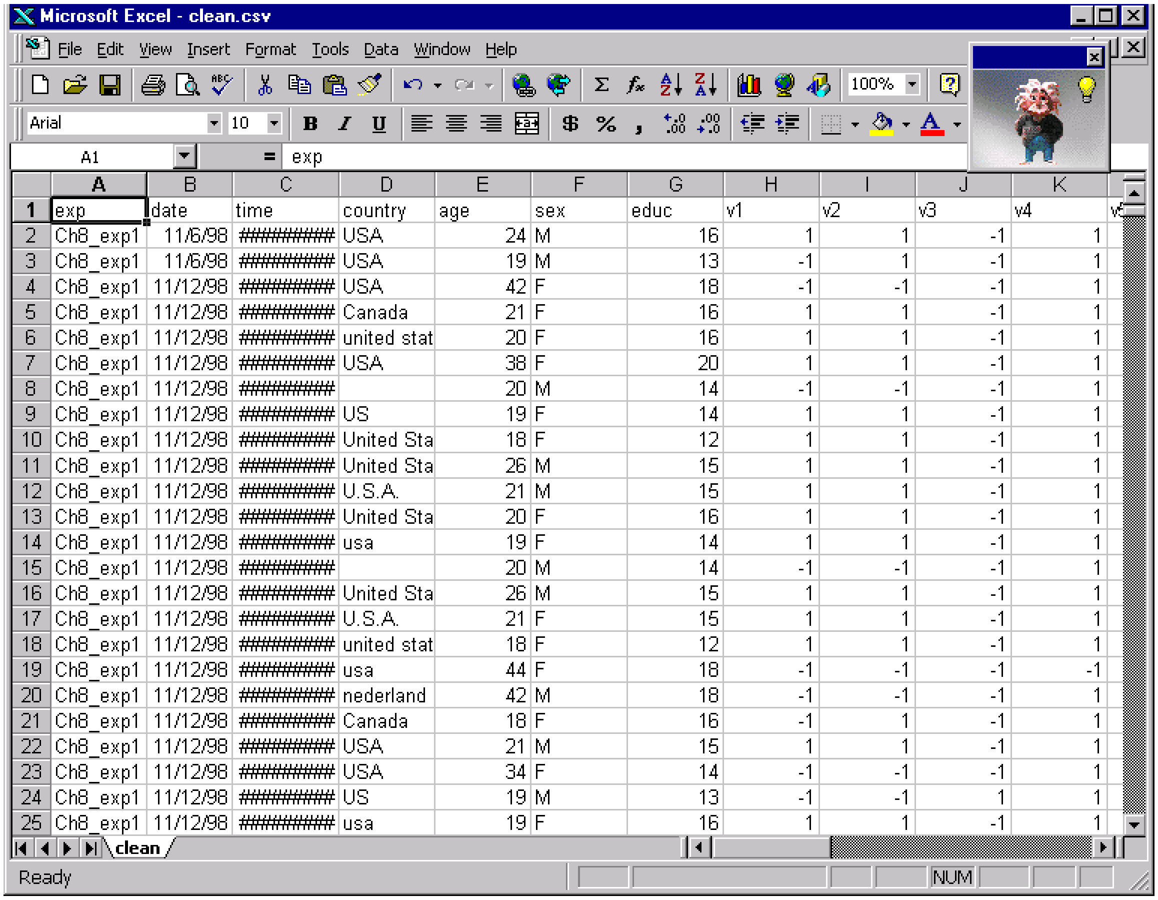
G. Data Analysis of Decision Experiment

In the next sections, you will import the data file into Excel to analyze the data. You could also use SPSS, as in Chapter 6.

Your CD includes files named *clean.csv* and *clean.xls* that contain the data analyzed in this chapter. These files have been cleaned of identifying information such as email addresses that were used to notify winners. To follow along in this analysis, open the file *clean.xls* in Excel—either the one you created in Chapter 6, or the one provided on the CD.

Insert Figure 8.2 about here.

Figure 8.2. Appearance of *clean.csv* when opened by Excel.



	A	B	C	D	E	F	G	H	I	J	K
1	exp	date	time	country	age	sex	educ	v1	v2	v3	v4
2	Ch8_exp1	11/6/98	##########	USA	24	M	16	1	1	-1	1
3	Ch8_exp1	11/6/98	##########	USA	19	M	13	-1	1	-1	1
4	Ch8_exp1	11/12/98	##########	USA	42	F	18	-1	-1	-1	1
5	Ch8_exp1	11/12/98	##########	Canada	21	F	16	1	1	-1	1
6	Ch8_exp1	11/12/98	##########	united stat	20	F	16	1	1	-1	1
7	Ch8_exp1	11/12/98	##########	USA	38	F	20	1	1	-1	1
8	Ch8_exp1	11/12/98	##########		20	M	14	-1	-1	-1	1
9	Ch8_exp1	11/12/98	##########	US	19	F	14	1	1	-1	1
10	Ch8_exp1	11/12/98	##########	United Sta	18	F	12	1	1	-1	1
11	Ch8_exp1	11/12/98	##########	United Sta	26	M	15	1	1	-1	1
12	Ch8_exp1	11/12/98	##########	U.S.A.	21	M	15	1	1	-1	1
13	Ch8_exp1	11/12/98	##########	United Sta	20	F	16	1	1	-1	1
14	Ch8_exp1	11/12/98	##########	usa	19	F	14	1	1	-1	1
15	Ch8_exp1	11/12/98	##########		20	M	14	-1	-1	-1	1
16	Ch8_exp1	11/12/98	##########	United Sta	26	M	15	1	1	-1	1
17	Ch8_exp1	11/12/98	##########	U.S.A.	21	F	15	1	1	-1	1
18	Ch8_exp1	11/12/98	##########	united stat	18	F	12	1	1	-1	1
19	Ch8_exp1	11/12/98	##########	usa	44	F	18	-1	-1	-1	-1
20	Ch8_exp1	11/12/98	##########	nederland	42	M	18	-1	-1	-1	1
21	Ch8_exp1	11/12/98	##########	Canada	18	F	16	-1	1	-1	1
22	Ch8_exp1	11/12/98	##########	USA	21	M	15	1	1	-1	1
23	Ch8_exp1	11/12/98	##########	USA	34	F	14	-1	-1	-1	1
24	Ch8_exp1	11/12/98	##########	US	19	M	13	-1	-1	1	1
25	Ch8_exp1	11/12/98	##########	usa	19	F	16	1	1	-1	1

The variable names have been entered already in *clean.csv*. If you examine the experimental form, *Ch8_exp1.htm*, you will see that the *date* and *time* are inserted as hidden variables. Note that the time variable shows up as ######## in Figure 8.2. The times are too big to fit in the default display.

You can adjust the spacing of the columns in Excel by placing your arrow pointer on the cracks between column labels at the top of the sheet, clicking and dragging. Place the mouse pointer on the crack between C and D, at the top of the column. When the two-headed arrow appears, drag the crack to the right to make column C bigger. You can also double-click on the crack to automatically adjust its width to the data. Now the *times* can be read. Next, respace the columns for the choices (–1 and 1), to make them thinner so that you can see more of the data on one screen.

Before you go on, save the file as an Excel workbook, but so as not to erase the work of Chapters 6 and 7, save it this time on your hard drive as *clean2.xls*.

Check the variable names in the first row. These names have been entered for you, but in a new study, you would fill them in according to what is in the new experiment. The first variable identifies the experiment, "**exp**," the next two variables are **date** and **time**, followed by **country** (nationality), **age**, **sex** (gender), and **edu** (education). After that, the next 20 variables (**v1** to **v20**) are the choices in the 20 decision problems, in the order that they appeared in *Ch8_exp1.htm*. The next item is a question that asked if the participant has read a scientific paper or book on the theory of decision making, which is called **Read DM** (read on decision making). The last value is a field for **Comments**. There had also been a box for the email address, which has been removed. Some of the subjects were students who were tested in the department's computer lab, and others were volunteers who took the experiment via the Internet. Select the first row, and click **B** icon on the formatting toolbar to make the variable names bold.

H. Filtering the Data

Filter the data so that all records have *"Ch8_exp1"* in the first column. As in Chapter 6, select *Filter: AutoFilters* from the **Data** menu. A number of little pull down arrows will appear on the variable names. In the first column, select *Ch8_exp1*. The file will then appear as in Figure 8.3.

Insert Fig. 8.3 about here

Selecting one value causes all other lines of data to be hidden from view. Now select all of the data showing—do this by clicking in cell A1 and dragging the mouse to the right to column AC and down the page until everything visible is selected (to row 1288). Next, choose *Copy* from the **Edit** menu and then select from the **Insert** Menu, *Insert a new Worksheet*. Paste the selected data into the new worksheet, and you have filtered the data needed. This time, you were instructed to copy the first row because the variable names are correct for this study. It is a good idea to save the file again. The file now appears as in Figure 8.4. (Your CD also contains the file, *DMaking.xls,* with which you can compare your results, and *DMaking.csv*; which you can load into SPSS without the filtering step.)

Insert Figure 8.4 about here.

Figure 8.3. From the **Data** menu, select *Filter*, then *Autofilters*. Drop down filter arrows appear. The arrow in the first column has been clicked, showing a list of possible values in the first column. Select *Ch8_exp1*.

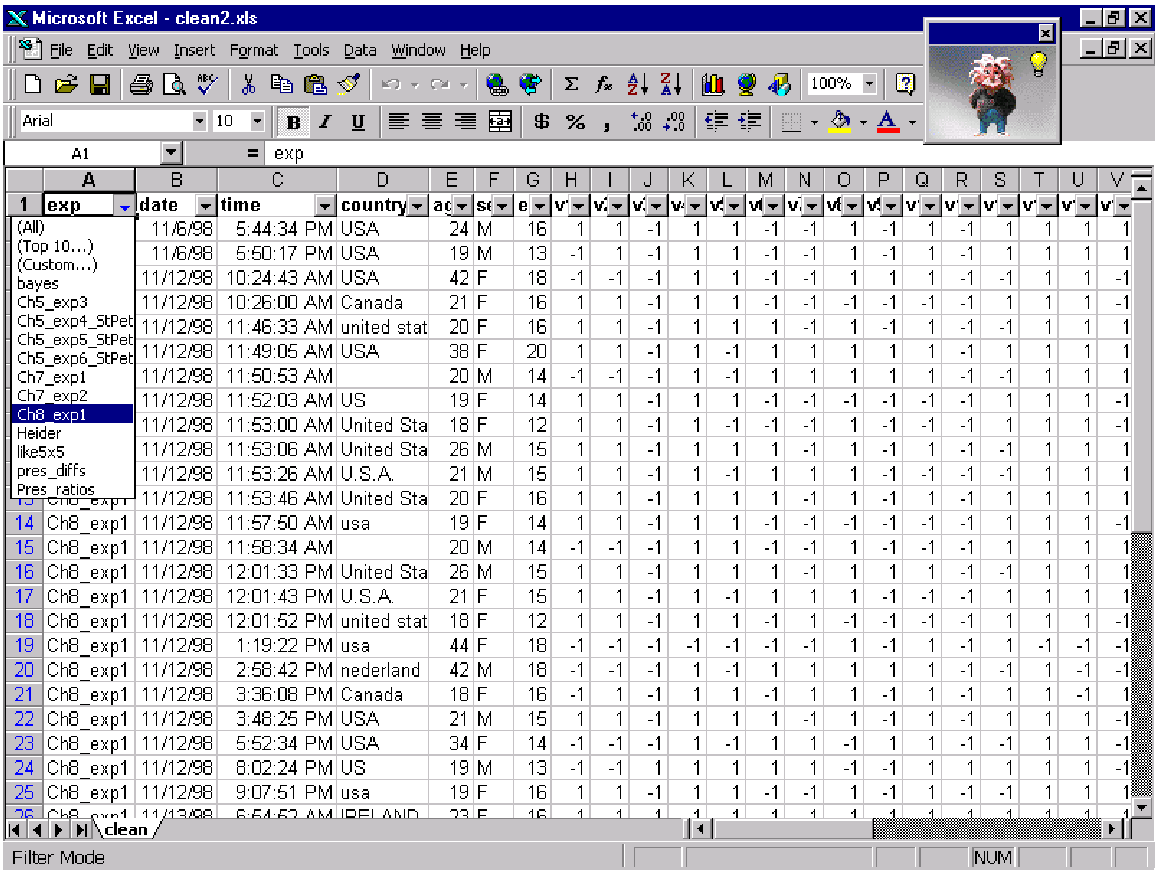
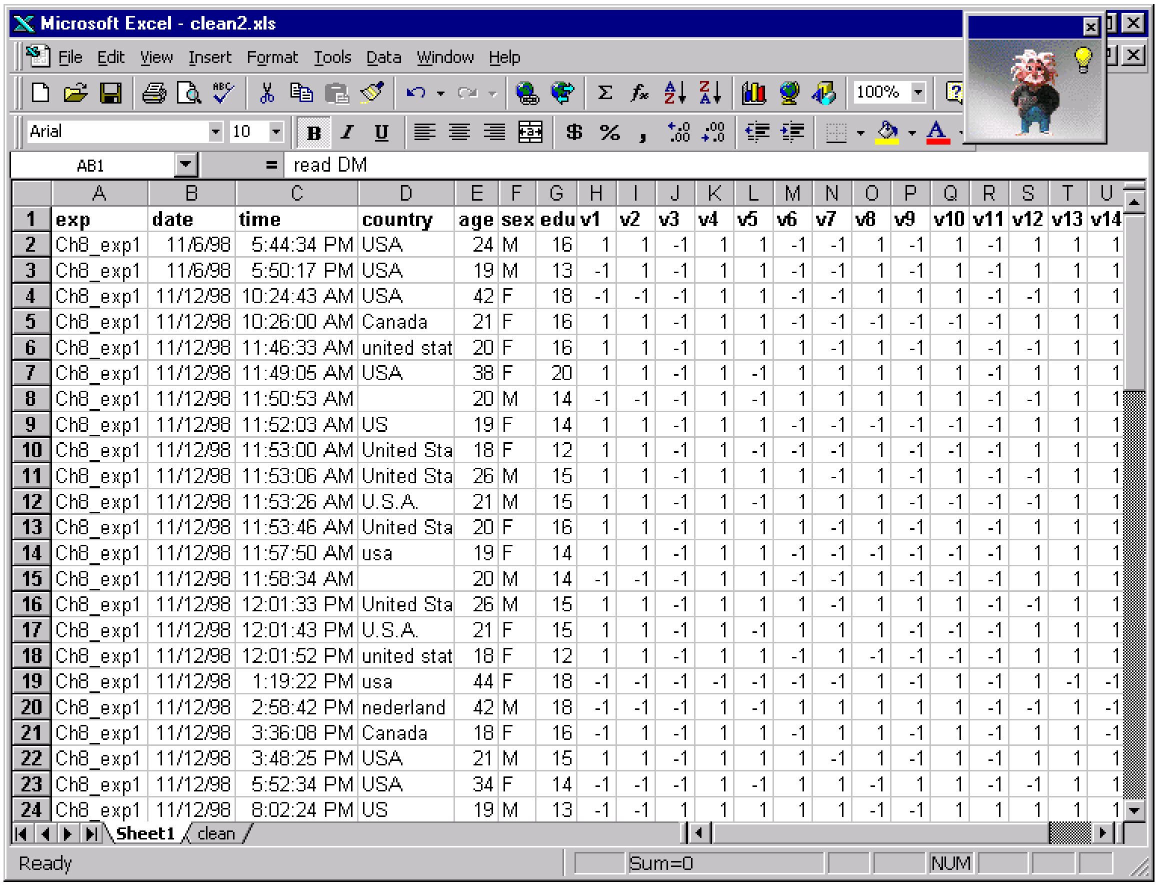


Figure 8.4. Appearance of the file after the data have been filtered, copied, and pasted into a new, inserted worksheet.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	exp	date	time	country	age	sex	edu	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14
2	Ch8_exp1	11/6/98	5:44:34 PM	USA	24	M	16	1	1	-1	1	1	-1	-1	1	-1	1	-1	1	1	1
3	Ch8_exp1	11/6/98	5:50:17 PM	USA	19	M	13	-1	1	-1	1	1	-1	-1	1	-1	1	-1	1	1	1
4	Ch8_exp1	11/12/98	10:24:43 AM	USA	42	F	18	-1	-1	-1	1	1	-1	-1	1	1	1	-1	-1	1	1
5	Ch8_exp1	11/12/98	10:26:00 AM	Canada	21	F	16	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	1	1
6	Ch8_exp1	11/12/98	11:46:33 AM	united stat	20	F	16	1	1	-1	1	1	1	-1	1	-1	1	-1	-1	1	1
7	Ch8_exp1	11/12/98	11:49:05 AM	USA	38	F	20	1	1	-1	1	-1	1	1	1	1	1	-1	1	1	1
8	Ch8_exp1	11/12/98	11:50:53 AM		20	M	14	-1	-1	-1	1	-1	1	1	1	1	1	-1	-1	1	1
9	Ch8_exp1	11/12/98	11:52:03 AM	US	19	F	14	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	1	1
10	Ch8_exp1	11/12/98	11:53:00 AM	United Sta	18	F	12	1	1	-1	1	-1	-1	-1	1	-1	-1	-1	1	1	1
11	Ch8_exp1	11/12/98	11:53:06 AM	United Sta	26	M	15	1	1	-1	1	1	1	-1	1	-1	1	-1	-1	1	1
12	Ch8_exp1	11/12/98	11:53:26 AM	U.S.A.	21	M	15	1	1	-1	1	-1	1	1	1	-1	-1	-1	-1	1	1
13	Ch8_exp1	11/12/98	11:53:46 AM	United Sta	20	F	16	1	1	-1	1	1	1	-1	1	-1	1	-1	1	1	1
14	Ch8_exp1	11/12/98	11:57:50 AM	usa	19	F	14	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	1	1
15	Ch8_exp1	11/12/98	11:58:34 AM		20	M	14	-1	-1	-1	1	1	-1	-1	1	-1	-1	-1	1	1	1
16	Ch8_exp1	11/12/98	12:01:33 PM	United Sta	26	M	15	1	1	-1	1	1	1	-1	1	1	1	-1	-1	1	1
17	Ch8_exp1	11/12/98	12:01:43 PM	U.S.A.	21	F	15	1	1	-1	1	-1	1	1	1	-1	-1	-1	1	1	1
18	Ch8_exp1	11/12/98	12:01:52 PM	united stat	18	F	12	1	1	-1	1	1	-1	1	-1	-1	-1	-1	1	1	1
19	Ch8_exp1	11/12/98	1:19:22 PM	usa	44	F	18	-1	-1	-1	-1	-1	-1	-1	1	-1	1	-1	1	-1	-1
20	Ch8_exp1	11/12/98	2:58:42 PM	nederland	42	M	18	-1	-1	-1	1	-1	1	1	1	1	1	-1	-1	1	-1
21	Ch8_exp1	11/12/98	3:36:08 PM	Canada	18	F	16	-1	1	-1	1	1	-1	1	1	-1	1	-1	1	1	-1
22	Ch8_exp1	11/12/98	3:48:25 PM	USA	21	M	15	1	1	-1	1	1	1	-1	1	-1	1	-1	1	1	1
23	Ch8_exp1	11/12/98	5:52:34 PM	USA	34	F	14	-1	-1	-1	1	-1	1	1	-1	1	1	-1	-1	1	1
24	Ch8_exp1	11/12/98	8:02:24 PM	US	19	M	13	-1	-1	1	1	1	1	1	-1	-1	1	1	1	1	1

Notice that the original data are still on the worksheet called "*clean*" (see the tabs at the bottom of the worksheet). Clicking on a tab will show the data on that sheet. By double-clicking on the *Sheet1* tab, you can rename it *Ch8_exp1*.

I. A Pivot Table Report for Decision Making

To address the original questions of the research, you will create cross tabulations using the Pivot Table Report. To illustrate, consider Choices 5 and 11 of the experiment. These choices are as follows:

5. Which do you choose?

I:	.05 probability to win $12	*J*:	.10 probability to win $12
	.05 probability to win $14		.05 probability to win $90
	.90 probability to win $96		.85 probability to win $96

11. Which do you choose?

U:	.05 probability to win $12	*V:*	.05 probability to win $12
	.05 probability to win $14		.05 probability to win $12
	.05 probability to win $96		.05 probability to win $90
	.85 probability to win $96		.85 probability to win $96

The responses were coded so that preference for the first gamble (shown here on the left) was coded as a –1, and choice of the second gamble was coded as + 1.

Note that gamble *I* is the same as *U* and that *J* is the same as *V*, except that identical consequences in *U* and *V* have been combined in Choice 5 by adding their probabilities. Many decision theories, including the Rank-Dependent Utility theory of Equation 8.3, imply that people will choose *I* over *J* and *U* over *V* because *I* dominates *J* and *U* dominates *V*. However, according to the configural weight TAX model, with parameters of Birnbaum (1999a), people might choose *U* over *V*, and yet choose *J* over *I*. In Section F, you used Netscape to load *taxcalculator.htm*, and you found that the TAX model, unlike CPT and EV, predicts that *J* has a higher value than *I*. You can enter the four outcome gambles of *U* and *V* to check that the TAX model also predicts that people will choose *U* over *V*.

The accuracy of this prediction can be examined in a Pivot Table Report of the data. First, click the mouse in A1. Then, from the **Data** menu, select *Pivot Table Report*. A series of "Wizard" dialogs appear, which are shown in Figures 8.5—8.9. The procedure is similar to that described in Chapter 6.

Insert Figure 8.5—8.9 about here.

Figure 8.5. Pivot Table Wizard, Step 1. Choose *Microsoft Excel list or data base*, then click *Next*.

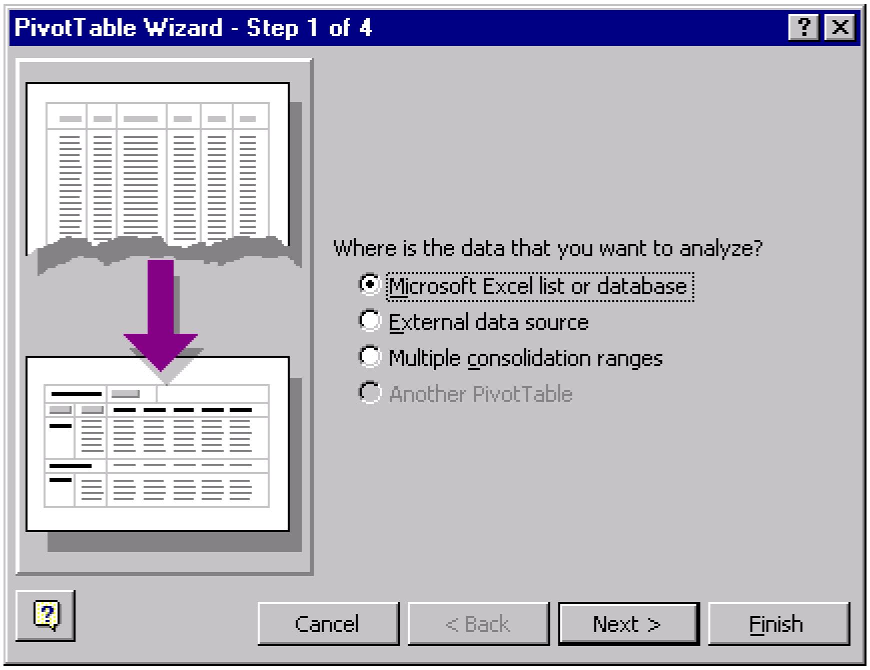


Figure 8.6. A range box appears; the program may correctly anticipate the range. If not, enter the range of cells, including all of the data, or click in the box, and use the mouse pointer to select the range in the worksheet. Click *Next*.

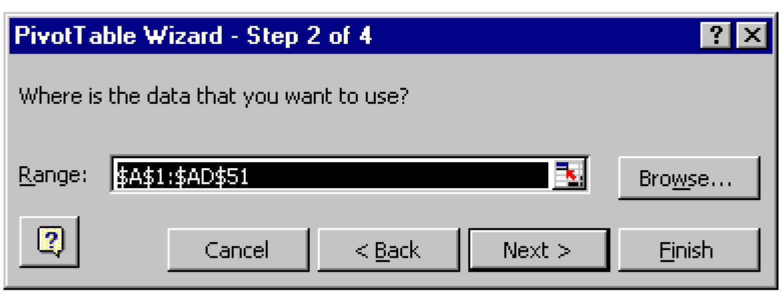


Figure 8.7. In Step 3 of the Pivot Table Wizard, drag *sex* from the right to the PAGE box, drag *V5* to the ROW, drag *V11* to the COLUMN, and drag *V5* again to the DATA field. If ”Sum of V5” is showing or another function besides “Count of V5,” then double click on it, which will bring up the dialog of Figure 8.8.

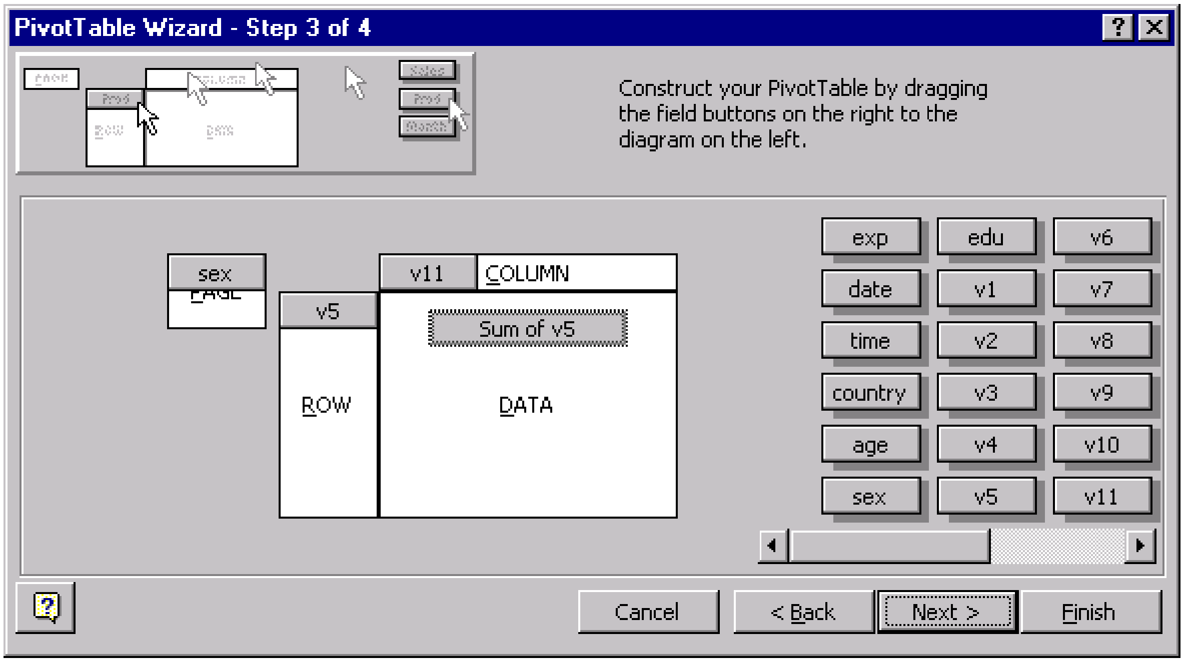


Figure 8.8. Select *Count* from the menu and click *OK*. Then drag *edu* (education) to the PAGE box in Figure 8.7, and click *Next*.

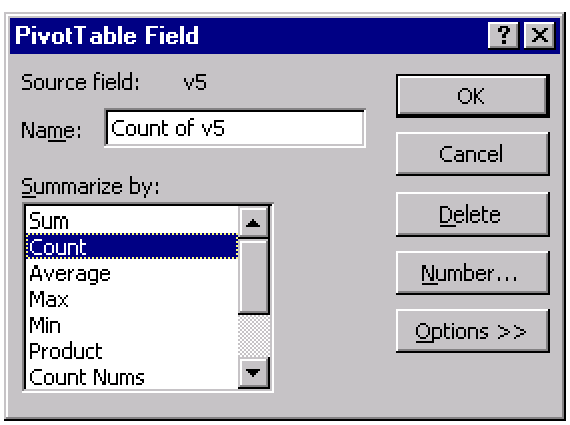


Figure 8.9. Select *New worksheet*, and click *Finish*.

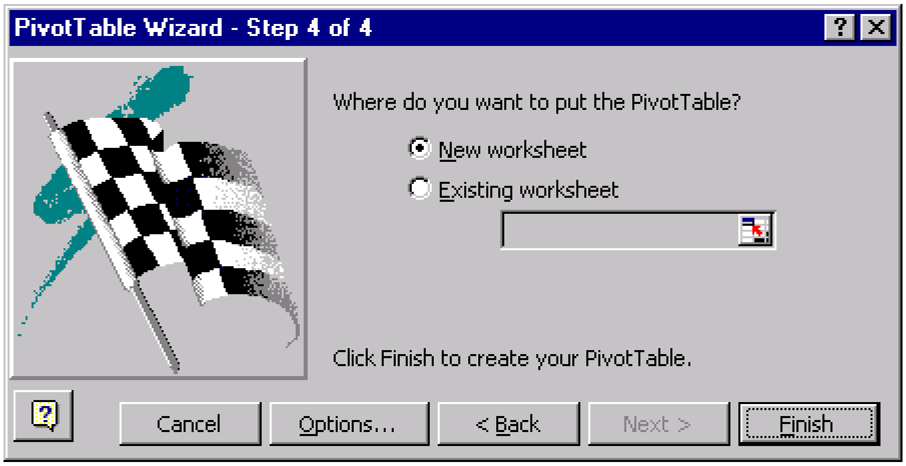
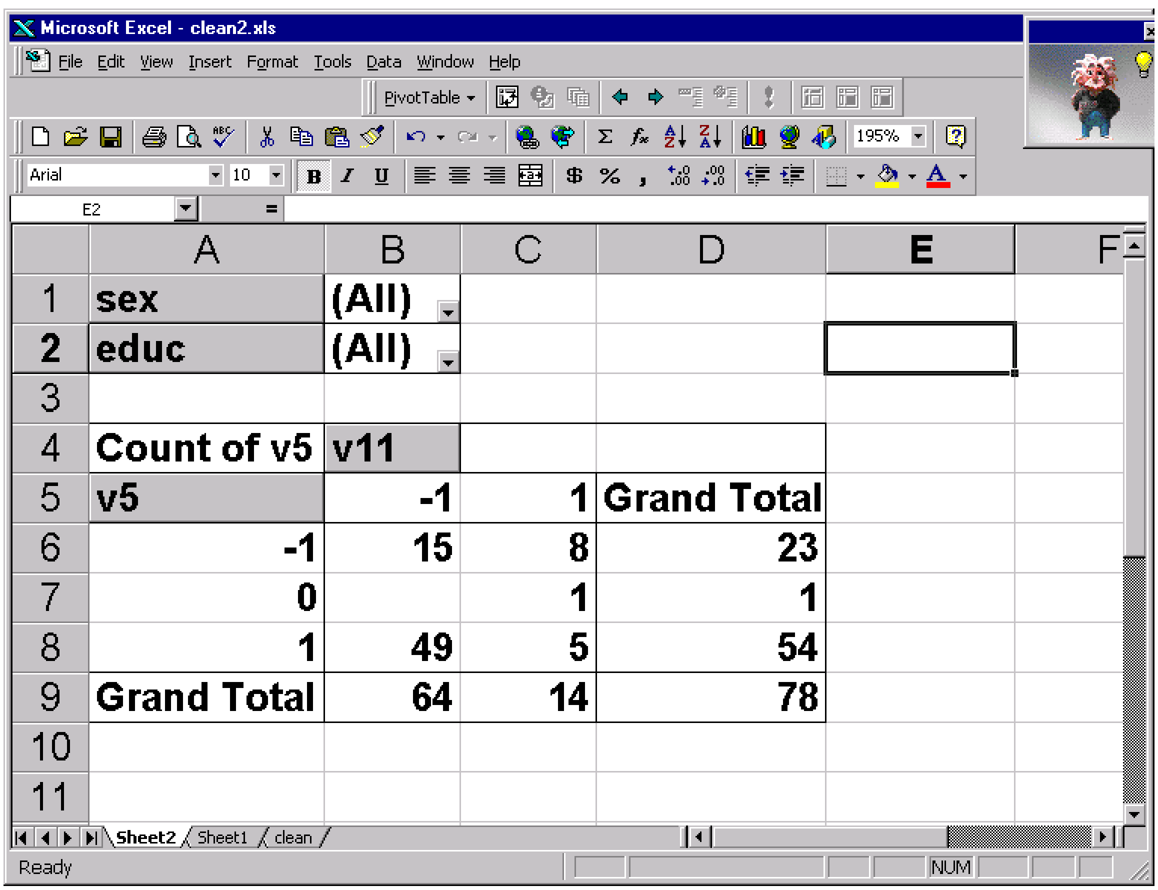


Figure 8.10. The Pivot Table for V5 and V11 of the decision making experiment.



	A	B	C	D
1	sex	(All)		
2	educ	(All)		
3				
4	Count of v5	v11		
5	v5	-1	1	Grand Total
6	-1	15	8	23
7	0		1	1
8	1	49	5	54
9	Grand Total	64	14	78

After the pivot table has been constructed, you can drag a variable from the ROW to COLUMN. You can drag it away, which will eliminate it from the table. Note that the “PAGE” variables, sex, and education, list “all” indicating that both sexes are included and all education levels. To see the results for just females, for example, click on the down arrow, and select F. The table then displays the results for only females. You can do the same to examine the results for just males, or for different levels of education. You can also select *Pivot Table Report* again and create another table.

The table shows that of the 78 subjects, 54 chose *J* over *I* on Choice 5, representing 70% violations of stochastic dominance on this choice! These results are similar to those reported by Birnbaum and Navarrete (1998) who tested undergraduates in a much longer study. However, on Choice 11, 64 chose *U* over *V*; in other words, 82% *satisfied* stochastic dominance, (only 18% violated stochastic dominance). To ask if the rate of 70% is significantly different from 18%, one can use the test of correlated proportions.

J. Statistical Test of Correlated Proportions

This test is a binomial sign test that compares the number who violated dominance on Choice 5 *and* satisfied it on Choice 11 (49) against the number who had the opposite reversal of preferences (8). The binomial sign test then asks the question, what is the probability of getting this split (49 to 8) if these $n = 57$ who switched preferences were equally likely to have switched in either direction? In other words, this equals the probability of tossing 57 coins and finding 49 or more are “Heads.” The binomial distribution has a mean, $\mu = np$, where n is the number of independent trials and p is the probability (in this case, $p = ½$ so $\mu = (57)(½) = 28.5$, and it has a standard deviation, $\sigma = \sqrt{np(1-p)}$. In this case, $\sigma = \sqrt{57(.5)(.5)} = 3.77$. For small *n*, ($n < 30$), one can look up the cumulative probabilities in a binomial table. As *n* gets large, the binomial can be approximated by the normal distribution, so $z = \frac{X - \mu}{\sigma}$ can be compared to the standard normal distribution, in which the probability is .95 that *z* will fall between –1.96 and 1.96. For this case, $z = 5.43$ [$z = (49 - 28.5)/3.77$]; because such an extreme value of *z* is extremely unlikely by chance, one can reject the null hypothesis that these two types of violation of stochastic dominance are equally probable. Instead, the data show that significantly more people violated stochastic dominance on Choice 5 than on Choice 11.

What is going on here? The configural weight, TAX model assumes that people average the values of the information with weights that are affected by the probabilities and the ranks of the payoffs. Lower-valued consequences take weight (attention) from higher valued consequences. Because *J* has two good outcomes ($90 and $96) whereas *I* only has one good outcome ($96), this configurally weighted average gives *J* a higher value than *I*. However, when the outcomes are split in Choice 11, corresponding outcomes receive the same weight, so higher consequences produce higher averages. The TAX model satisfies dominance for Choice 11 even though it violates it in Choice 5.

Another way of looking at the results is to consider them evidence of event-splitting effects, which are violations of coalescing. Rank-dependent models imply that people should make the same choice in either Choice 5 or Choice 11, since the only difference is in how the events are split or coalesced. The data show significant violations of coalescing, which according to the configural weight model, are the cause of violations of stochastic dominance (Birnbaum & Navarrete, 1998).

Expected value, expected utility, and rank dependent expected utility theory (including cumulative prospect theory) all predict that people should make the the same decisions in Choices 5 and 11. These theories imply that people should prefer the dominant gamble in both choices. However, the configural weight, TAX model predicts that people will violate stochastic dominance in Choice 5, and that they will satisfy stochastic dominance in Choice 11. These results thus refute the descriptive accuracy of a class of theories of decision making, but the configural weight, TAX model remains a viable descriptive theory.

Birnbaum (in press-a; 1999b) reported Web studies involving over 1900 people in which systematic violations of stochastic dominance were observed; these studies yielded similar conclusions to those obtained from the sample of data included on your CD. Those studies also compared the results of highly educated people with those of college students tested in the lab. Data from the Internet were better educated and less likely to violate stochastic dominance than those from the lab, but both studies reached the same conclusions regarding the viability of the theories compared. Because the Web sample was so large and diverse, it was possible to separate the data for analysis within genders and education levels. It was found that violations of stochastic dominance were correlated with education: better educated people are less likely to violate stochastic dominance.

K. Summary

This chapter reviewed Expected Value, Expected Utility, and Rank-Dependent Expected Utility theories. These theories imply that decision makers should satisfy stochastic dominance. Procedures for conducting an experiment on decision making via the Web and for analyzing the data were described, and the materials used in the experiment were included on the CD. An on-line calculator that can be used to calculate the predicted values of gambles from three theories was described. Data included on your CD were analyzed to show that people violate stochastic dominance on certain choices where people are predicted to violate stochastic dominance by the configural weight, TAX model of Birnbaum and Navarrete (1998).

L. Exercises

1. Construct pivot table reports for other combinations of choices in the decision making experiment. For example, Choices 7 and 13 are like those of Choices 5 and 11, except the position of the dominant gambles has been reversed to counterbalance position in the choice. Do Choices 7 and 13 yield the same conclusions as Choices 5 and 11?
2. When you have your own scripts, you can use different scripts for different experiments, in which case you will not need to separate data by filtering. But even when a separate script is used for each experiment, filtering can be very useful for studying the data. For example, look at Choices 3 and 4 of the decision experiment. If a person violated transparent dominance on these choices, maybe that person did not understand the instructions. To check how the results would be changed by filtering on Choices 3 and 4, you could for example filter *v3* for –1 and *v4* for +1. How many people violated dominance on both Choice 3 and 4?
3. Create a Pivot Table of *v5* and *v7*. Look closely at the HTML, and you will see that choosing *J* in Choice 5 (+1) is a violation of stochastic dominance, and choosing *M* over *N* (–1) is a violation of stochastic dominance in Choice 7. From your Pivot

Table of Choices *v5* and *v7*, find out if significantly more people have two violations (+1 and –1 on *v5* and *v7*) than have no violations on those two trials (–1 and +1 on V5 and V7). The appropriate statistic in this case is the binomial test of correlated proportions. In this case, the statistic tests the proposition that the proportion of violations is .5; if significantly more people have two violations than have zero, it means that the overall probability of violations, averaged over V5 and V7, exceeds ½.

4. Analyze the data by SPSS, using crosstabs. You can import *Dmaking.csv* to SPSS.
5. Project idea: Can you think of some type of training that will cause people to have fewer violations of stochastic dominance? Design a between-subjects experiment in which different groups get different training. Then have both groups complete the experiment. See if the rate of violations is lower in the group with special training.
6. Project idea: Read Birnbaum (in press-a; in press-d), and try to devise new choices that will distinguish CPT from the configural weight TAX model. Before you run your experiment, use the calculator to make sure that at least two theories make different predictions.