# Chapter 7: Images and Logical Thinking

This chapter reviews a study in logical thinking, and it will cover the study, from putting the experiment on the Web to analyzing the data. First, you will learn how to incorporate images in your Web experiments and how to create an image map so that a mouse click on one part of a picture will have a different action from clicking on another part. Second, you will learn how to set up and run a reliable psychological demonstration of a systematic flaw in human reasoning. Third, this chapter will show you how to analyze the data for the logic problem, which are included on the CD that accompanies this book.

## A. Displaying Images with HTML

The `IMG` tag, which displays images, is used in the following example:

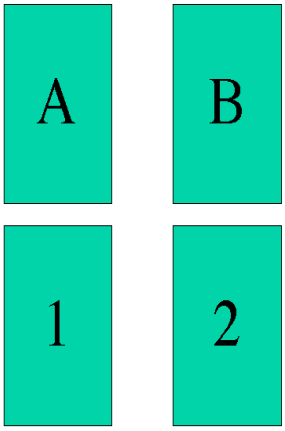
```
<IMG SRC="cards.gif" ALT="4 cards showing..." ALIGN="left" WIDTH=160 HEIGHT=120 BORDER=0>
```

The SRC gives the filename of the image, *cards.gif*. This image, shown in Figure 7.1, was created in PowerPoint. It represents four cards used in a classic study of human reasoning, by Wason (1960).

Insert Figure 7.1 here.

The text in `ALT="4 cards showing: A, B, 1, and 2"` specifies a verbal description of the image that would be useful to a person who has images turned off.

Figure 7.1. The image in file, *cards.gif*. This graphic was created in PowerPoint. The document was saved as HTML, and the image file was renamed.



**B. A Problem in Logic**

Do people understand each other? Do people understand simple sentences of the form, "All As are B," or "if A then B?" Do people understand what it means if somebody says, "All dogs have noses?" Load the experiment, *Ch7_exp1.htm*, and complete the task. The text of the experiment reads,

"There is a deck of cards, each of which has a number on one side of the card and a letter on the other side. This fact is a given, and you can assume it is true. Four of these cards are dealt onto a table, showing the following face up: 1, 2, A, and B. Conjecture: "For these four cards, every card with an even number on one side has a vowel on the other." Question: What is the smallest set of cards that must be turned over to test the conjecture? Definitions: Vowel = a letter in the set {A, E, I, O, U}. An Even Number is divisible by 2 without remainder,{...-4, -2, 0, 2, 4,...}. Test: An experiment that would refute (disprove) the conjecture, if the conjecture were false."

There are 16 possible meanings of the sentence, "Every card with an even number on one side has a vowel on the other." These possible meanings are revealed by the experiments that test (might disprove) the sentence. For each card, one either needs to check it (turn it over) or not. Because there are 4 cards, there are $2^4 = 16$ possibilities. These 16 possibilities, from turning over none to turning over all 4 are listed as choices in the selection menu. (In this case, a pull-down selection is appropriate, because there is a finite list of all possible answers.)

In my Introductory Psychology classes, every student is required to "vote" for one of the 16 possible meanings. The correct answer is 2 and B. We need to turn over the 2 to see if there is a vowel on the other side; if not, then the conjecture is disproved. We also need to turn over the B, to check if there is an even number on the other side; if it is even (e.g., 2), the conjecture

is also disproved, because there would be an even number without a vowel on the other side. We do not need to turn over the 1, since a vowel or consonant would be compatible with the conjecture; similarly, we need not turn over the vowel, since there may be either an odd or even number on the other side without contradiction.

In a class of 100 college freshmen and sophomores, about two or three people get the problem right, and the rest split up into many *different* ideas of what the sentence means. People not only do not understand the sentence the way a person trained in logic understands it, they also have many different opinions of its meaning. Demonstrations like this make one realize that communication is partly an illusion. The HTML (with abbreviated instructions) is given in Figure 7.2. Insert Figure 7.2 about here.

The new idea in Fig. 7.2 is the use of an image. A version of the experiment that includes the environmental hidden available in PolyForm (Appendix A) is in *Ch7_exp2.htm*, on the CD. The correct answer is explained in *Ch7_ex1.htm*, which gives feedback on each card, in order to construct an informal "truth table." A truth table is a systematic listing of the truth status of each possible situation. This online example illustrates the use of image maps.

Figure 7.2. HTML for *Ch7_exp1.htm* (abbreviated).

```
<H3>Test of Reasoning</H3><P>There is a deck of cards, each of which has a
number on one side of the card and a letter on the other. Four of these
are:</UL></P>
<IMG SRC="cards.gif" ALT="4 cards showing: A, B, 1, and 2" ALIGN="left"
WIDTH=160 HEIGHT=120 BORDER=0>
<P><B>Conjecture:</B> "For these four cards, every card with an even number on
one side has a vowel on the other."</P>
1.<B>What is the smallest set of cards that must be turned over in order to
test the conjecture? <BR>
Select your answer from the following pull-down menu:</B>
<INPUT TYPE="hidden" NAME="00exp" VALUE="Ch7_exp1">
<SELECT NAME="01ans">
    <OPTION SELECTED VALUE="">Pull down here to select
    <OPTION VALUE="0">None
    <OPTION VALUE="1">1
    <OPTION VALUE="2">2
    <OPTION VALUE="A">A
    <OPTION VALUE="B">B
    <OPTION VALUE="12">1 & 2
    <OPTION VALUE="1A">1 & A
    <OPTION VALUE="1B">1 & B
    <OPTION VALUE="2A">2 & A
    <OPTION VALUE="2B">2 & B
    <OPTION VALUE="AB">A & B
    <OPTION VALUE="12A">1 & 2 & A
    <OPTION VALUE="12B">1 & 2 & B
    <OPTION VALUE="1AB">1 & A & B
    <OPTION VALUE="2AB">2 & A & B
    <OPTION VALUE="12AB">ALL FOUR: 1 & 2 & A & B
</SELECT>
```

## C. Image Maps

Figure 7.3 illustrates the use of an image map in *Ch7_ex1.htm*.

Figure 7.3. Illustration of the use of image maps. This HTML is part of *Ch7_ex1.htm*.

```
<H3>Here is an Image Map</H3>
<B>Conjecture: All Cards with an Even Number on one side have a Vowel
on the Other.
<HR>
```

```
Click on the Cards to check which we need turn over to TEST this
conjecture</B>
<P>
<IMG SRC="cards.gif" ALT="4 cards showing A, B, 1, 2"  WIDTH=250
HEIGHT=200 USEMAP="#mapdemo">
<MAP NAME="mapdemo">
<AREA SHAPE="rect" COORDS="0,0,125,100" HREF="SayA.htm">
<AREA SHAPE="rect" COORDS="125,0,250,100" HREF="SayB.htm">
<AREA SHAPE="rect" COORDS="0,100,125,200" HREF="Say1.htm">
<AREA SHAPE="rect" COORDS="125,100,250,200" HREF="Say2.htm">
</MAP>
<HR>
```

When the user clicks on the image, the action depends on where the mouse pointer was when it was clicked. Try it out by loading *Ch7_ex1.htm* in your browser.

This example illustrates how one can define a map on an image, and use the location of the mouse pointer to branch to one of several actions. The `IMG` tag now contains a notation (`USEMAP="#mapdemo"`) linking to `MAP` with the same name. The coordinates are pairs of *x* (horizontal) and *y* (vertical). The coordinate system places (0, 0) at the upper left-hand side of the image. The *x* coordinate measures the horizontal distance to the right, and the *y* coordinate measures the vertical distance *downward*. The use of positive numbers to go *down* requires an adjustment for those trained in other coordinate systems.

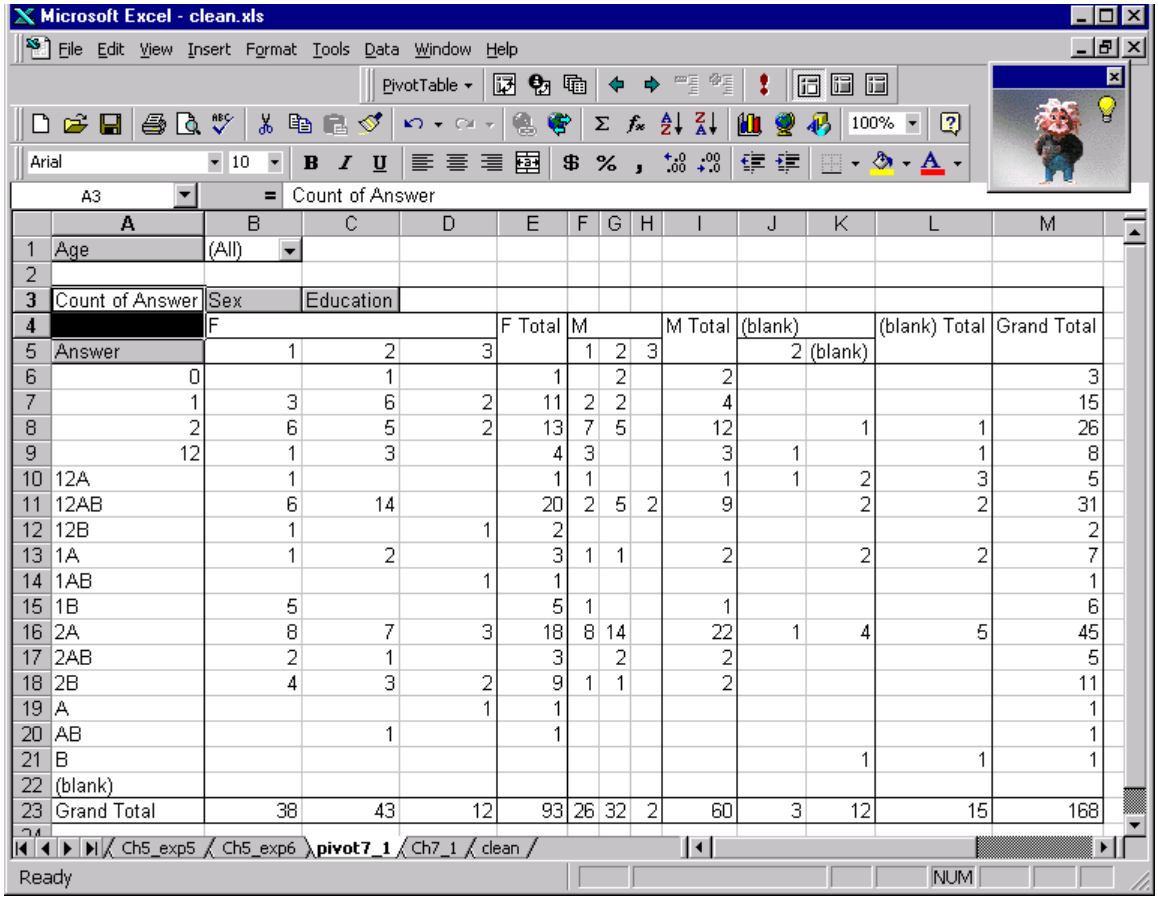
The lines ending in `HREF=SayA.htm` are links that cause a click on a part of the image to link to different files, according to which part of the image is clicked. There are four files, each with the appropriate message for one card, and each page has a link to return to the page of feedback. Another example on your CD uses JavaScript alerts, which will be discussed in Chapter 18.

**D. A Pivot Table for the Logic Problem**

Follow the steps in Chapter 6 to make a Pivot Table for these data. In this case, let the *Rows* depict the *Answer*, and move *Sex* and *Education* to the *Columns*. The example in Figure 7.4 shows how the Pivot Table appears in Excel. Try rearranging the table to explore the data. Try dragging *Education* up to the Page (that will leave sex as the only column variable). Or try dragging *Sex* up to the page position, which will leave *Education* as the only column variable. No matter how you look at it, very few people understand the sentence, *All As are B*. Some authors consider this finding evidence of a positive bias—people have trouble with negative thinking. *All As are B* is the same as *not B implies not A*. In other words, *If A then B* is the same as *if not B then not A*. This basic principle of logic or comprehension appears to be very difficult for college students untrained in logic.

Insert Figure 7.4 about here.

Figure 7.4. Pivot Table of Logic Problem. Only 11 of 168 chose the correct answer (2B). Four other answers were more popular (1, 2, 12AB, and 2A) than the correct answer (2B). No answer is agreed upon by more than 27% of the sample. Education is coded as follows: 1 = High School graduate; 2 = 1—3 years of college; 3 = college graduate; 4 = Master's degree; 5 = doctorate. None of these participants had higher degrees.



Microsoft Excel - clean.xls

File Edit View Insert Format Tools Data Window Help

PivotTable

Arial 10

A3 = Count of Answer

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Age | (All) | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | Count of Answer | Sex | Education | | | | | | | | | | |
| 4 | | F | | | F Total | M | | | M Total | (blank) | | (blank) Total | Grand Total |
| 5 | Answer | 1 | 2 | 3 | | 1 | 2 | 3 | | 2 | (blank) | | |
| 6 | 0 | | 1 | | 1 | | 2 | | 2 | | | | 3 |
| 7 | 1 | 3 | 6 | 2 | 11 | 2 | 2 | | 4 | | | | 15 |
| 8 | 2 | 6 | 5 | 2 | 13 | 7 | 5 | | 12 | | 1 | 1 | 26 |
| 9 | 12 | 1 | 3 | | 4 | 3 | | | 3 | 1 | | 1 | 8 |
| 10 | 12A | 1 | | | 1 | 1 | | | 1 | 1 | 2 | 3 | 5 |
| 11 | 12AB | 6 | 14 | | 20 | 2 | 5 | 2 | 9 | | 2 | 2 | 31 |
| 12 | 12B | 1 | | 1 | 2 | | | | | | | | 2 |
| 13 | 1A | 1 | 2 | | 3 | 1 | 1 | | 2 | | 2 | 2 | 7 |
| 14 | 1AB | | | 1 | 1 | | | | | | | | 1 |
| 15 | 1B | 5 | | | 5 | 1 | | | 1 | | | | 6 |
| 16 | 2A | 8 | 7 | 3 | 18 | 8 | 14 | | 22 | 1 | 4 | 5 | 45 |
| 17 | 2AB | 2 | 1 | | 3 | | 2 | | 2 | | | | 5 |
| 18 | 2B | 4 | 3 | 2 | 9 | 1 | 1 | | 2 | | | | 11 |
| 19 | A | | | 1 | 1 | | | | | | | | 1 |
| 20 | AB | | 1 | | 1 | | | | | | | | 1 |
| 21 | B | | | | | | | | | | 1 | 1 | 1 |
| 22 | (blank) | | | | | | | | | | | | |
| 23 | Grand Total | 38 | 43 | 12 | 93 | 26 | 32 | 2 | 60 | 3 | 12 | 15 | 168 |

Ch5_exp5 Ch5_exp6 pivot7_1 Ch7_1 clean

Ready NUM

## E. Summary

In this chapter, you learned about a systematic flaw in human reasoning. People have trouble understanding sentences of the form, *if A then B.* You also learned about how to set up an experiment on this problem (incorporating images), and how to use an image map to give interactive feedback on the problem. The tags featured in this chapter are in the following table.

| | |
|---|---|
| `<IMG`<br>`SRC="cards.gif"`<br>`ALT="description"`<br>`ALIGN="left"`<br>`WIDTH=160 HEIGHT=120 BORDER=0`<br>`USEMAP="#ref">` | `Places images in HTML file.`<br>`File name of image.`<br>`verbal description of the image.`<br>`Specifies alignment.`<br>`specifies dimensions.`<br>`reference to MAP #ref` |
| `<MAP NAME=ref></MAP>` | `Define an image map` |
| `<AREA SHAPE="rect"`<br>`COORDS="x1,y1,x2,y2"`<br>`HREF="filename.htm">` | `Defines a portion of a map, where mouse click will send to the link specified in HREF.` |

## F. Exercises

1. Load the file *Ch7_exp1.htm*. Look at the file in a text editor as well. The only new technique in this experiment is the use of an image. Try changing the values of the `HEIGHT`, `WIDTH`, `ALT`, and `BORDER` attributes, to see their effects on the display in the browser. Try `HEIGHT=200 WIDTH=50`, then try `HEIGHT=50 WIDTH=200`. Also try `ALIGN=left`, `ALIGN=right`, and `ALIGN=middle`, to see their effects. To center the image, use `DIV` (See Chapter 4).

2. Open the file *Ch7_exp2.htm* in your browser. This second version illustrates the use of hidden PolyForm variables that were covered in Chapter 5 (see also Appendix A). Collect some data using this version of the program, and examine the data file, *data.csv*.

3. Download software to create or to convert images. Practice working with photographs and with graphic images in these programs. If you are interested in visual perception, motion perception, art, or multimedia, then these programs will be useful to you. If you are very interested in using visual images and animations in your experiments, you may want to acquire commercial software. But check the free software first. More information on graphics will be given in Chapter 14.

4. There are two sets of data on the logic problem on the CD in the file, *logic1.csv* and *logic2.csv*. Load these data into SPSS or Excel. Next, construct cross tabulation tables in SPSS or PivotTable reports in Excel showing how the answer depends on education. Examine the HTML in *Ch7_exp1.htm*, and you will see that education is defined by a series of radio buttons as follows: 1 = High School graduate; 2 = 1—3 years of college; 3 = college graduate; 4 = Master's degree; 5 = doctorate. You should be able to construct two tables analogous to that shown in Figure 7.4. How do the results for the second sample compare to those from the first sample?

5. Project idea: Change the logic problem in systematic ways to investigate the effects of different logical questions. For example, it has been argued that "if then" statements are better understood as "permissions" than when stated as logical properties. For example, suppose someone says, "You are a bouncer at a bar. Your job is to make sure that nobody under 21 is drinking." Which people do you check? Over 21, Under 21, Drinkers, non-drinkers? Or: " You work at the Post office. All sealed letters must have first class postage. Which envelopes do you need to turn over to check? Sealed, unsealed, those with first class stamps, those with less than first class stamps? The conjecture is that people understand the idea that *All As are B* better when it is part of a statement of <u>permission</u> than when it is stated as *if A then B, All As are B.* It is also observed that people are quite poor in understanding the problem when it is phrased as a

causal proposition. For example, suppose someone conjectures that all abusers are themselves victims of child abuse. Suppose the police have four lists of people in their files: victims of abuse, perpetrators of abuse, people who not victims, and people who are not abusers. Which cases do we need to check to find out of all abusers were victims? Try out these variations of the logic problems. Can you use permission language to re-write the logic problem, "All even numbers have vowels," so that most people get it right? Can you find a way to get people to understand sentences of the form, *All As are B,* or *if A then B*?