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# BEHAVIORAL RESEARCH AND DATA COLLECTION VIA THE INTERNET


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In the past decade it has become possible to collect data from participants who are tested via the World Wide Web (WWW) rather than in the lab. Although this mode of research has some inherent limitations due to lack of control and observation of conditions, it also has a number of advantages over lab research. Many of the potential advantages have been well described in a number of publications (Birnbaum, 1999b, 2000a, 2000b, 2001a, 2001b, 2004a, 2004b; Krantz & Dalal, 2000; Reips, 1995, 1997, 1999, 2000, 2001a, 2001b, 2003; Reips & Bosnjak, 2001; Schmidt, 1997a, 1997b). Some of the chief advantages are that (a) one can test large numbers of participants very quickly, (b) one can recruit large heterogeneous samples and people with rare characteristics, and (c) the method is more cost-effective in time, space, and labor in comparison with lab research. This chapter will provide an introduction to the major features of the new approach and illustrate the most important techniques in this area of research.

## OVERVIEW OF INTERNET-BASED RESEARCH

The process of Web-based research, which is the most frequent type of Internet-based research, can be described as follows: Web pages containing surveys and experiments are placed in Web sites available to participants via the Internet. These Web pages are hosted (stored) on any server connected to the WWW. People are recruited by special techniques to visit the site. People anywhere in the world access the study and submit their data, which are processed and stored in a file on a secure server. (The server that hosts or delivers the study to the participant and the server that receives, codes and saves the data are often the same computer, but they can be different.)

The Internet scientist plans the study following guidelines while striving to avoid pitfalls (Birnbaum, 2001a, 2004a, 2004b; Reips, 2002b, 2002c; Reips & Bosnjak, 2001). The researcher creates Web pages and other files containing text, pictures, graphics, sounds, or other media for the study. He or she will upload these files to the host server (as needed) and configure the data server to accept, code, and save the data. The researcher tests the system for delivering the experiment and for collecting, coding, and saving the data. The Web researcher must ensure that the process is working properly, recruit participants for the study, and finally retrieve and analyze the data. Although this process may sound difficult, once a researcher has mastered the prerequisite skills, it can be far more efficient than traditional lab methods (Birnbaum, 2001a; Reips, 1995, 1997, 2000).

## PSYCHOLOGICAL RESEARCH ON THE WEB

To get an overall impression of the kinds of psychological studies that are currently in progress on the Web, visit studies linked at the following sites:

*Web experiment list*: http://genpsylab-wexlist.unizh.ch/
*Psychological Research on the Net*: http://psych.hanover.edu/research/exponnet.html

*Web Experimental Psychology Lab*: http://www.psychologie.unizh.ch/sowi/Ulf/Lab/WebExpPsyLab.html
*Decision Research Center*: http://psych.fullerton.edu/mbirnbaum/decisions/thanks.htm

The number of studies conducted via the WWW appears to have grown exponentially since 1995, when psychologists began to take advantage of the new standard for hypertext markup language (HTML) that allowed for convenient data collection (Musch & Reips, 2000). Internet-based research has become a new topic in psychology. The basics of authoring Web-based research studies will be described in the next sections.

## CONSTRUCTING WEB STUDIES FOR THE INTERNET

There are many computer programs that allow one to create Web pages without knowing HTML. These programs include Adobe GoLive, Macromedia Contribute, Macromedia Dreamweaver, and Microsoft FrontPage (not recommended), among others. In addition, programs intended for other purposes, such as Open Office and Microsoft Word, PowerPoint, and Excel allow one to save documents as Web pages. Although these programs can be useful on occasion, those doing Web research really need to understand and be able to compose basic HTML. While learning HTML, it is best to avoid these authoring programs. If you already know how to use these programs, you can study HTML by using them in source code mode, which displays the HTML, rather than the "what you see is what you get" display.

There are many free, useful tutorials on the Web for learning about HTML and many good books on the subject. Birnbaum (2001a, chaps. 2-4) covers the most important tags in three chapters that can be mastered in a week, with a separate chapter (chap. 5) for the technique of Web forms, which is the technique that made Web research practical, when this technique was supported by HTML 2, introduced in late 1994.

## WEB FORMS

There are three aspects of Web forms that facilitate Internet-based research. First, forms support a number of devices by which the reader of a Web page can send data back to the author of a page. Forms support two-way communication of information, with the possibility for dynamic communication.

Second, Web forms allow a person without an e-mail account to complete a form from a computer that is not configured to send e-mail. For example, a person at a local library, in an Internet café, or in a university lab could fill out a Web form on any Internet-connected computer and click a button to send the data. This means that participants can remain anonymous.

Third, Web forms can deliver their data to a program on the server that codes and organizes the data and saves them in a convenient form for analysis. In fact, server-side programs can even analyze data as they come in and update a report of cumulative results.

The Web form is the HTML between and including the tags, <FORM> and </FORM>, within a Web page. The response or input devices supported by forms allow the users (e.g., research participants) to type in text or numerical responses, click choices, choose from lists of selections, and send their data to the researcher. Table 26.1 shows a very simple Web form. You can type this text, save it with an extension of ".htm," and load it into a browser to examine how it performs. Table 26.1, along with other examples and links, is available from the following Web site, which is associated with this chapter: http://psych.fullerton.edu/mbirnbaum/handbook/.

In this example, there are four input devices: a *hidden* value, an *input text box*, a *submit button*, and a *reset button*. The hidden input records a value that may be used to identify the data; in this case, the value is "MyTest1." The value of the submit

TABLE 26.1. Bare Bones Web Form

```
<html>
<head>
<title>
My First Form
</title>
</head>
<body>

<form method="post" action="mailto:mbirnbaum@fullerton.edu" enctype="text/plain">
<input type="hidden" name="00exp" value="MyTest1">
1. What is your age?
<input type="text" name="01age" size="4" maxlength="6">
<input type="submit" value="Send the Data">
<input type="reset" value="start over">
</form>

</body>
</html>
```

button or reset button is what is displayed on the buttons, but the value of a text box is whatever the viewer types in that field. When the reset button is clicked, the form is reset; that is, any responses that were typed in or clicked are erased.

When the submit button is clicked, the *action* of the form is executed. In this example, the *action* sends e-mail with the two variables to the e-mail address specified. You should change this to your own e-mail address, load the form in the browser, fill in your age, and click the submit button. If your computer is configured to send e-mail, you will receive an e-mail message with your responses in the message. The encryption type attribute can be erased (save the file and reload it in the browser), and you will see the effect that this attribute has on how the e-mail appears.

## Server-Side Scripting to Save the Data

Although sending data by e-mail may be useful for testing Web forms or for small efforts, such as collecting RSVPs for a party, it is neither practical nor secure to collect large amounts of data via e-mail. Instead, we can let the Web server write the data to its log file for later analysis (see "How to analyze log files," p. 484) or we can use a computer program to code the data and save them in a file, in a form ready for analysis. To do this, we use a CGI (common gateway interface) script (e.g., in Perl or PHP) that codes, organizes, and saves the data safely to a secure server (see Schmidt, 1997a, 2000). The ACTION of the form is then changed to specify the uniform resource locator (URL) address of this script.

For example, revise the FORM tag in Table 26.1 as follows:

```
<FORM METHOD='post' ACTION='http://psych.
fullerton.edu/cgi-win/polyform.exe/generic'>
```

In this example, the ACTION specifies an address of a script that saves the data to a file named *data.csv* on the *psych.fullerton.edu* server. The script residing at this address is a generic one that accepts data from any form on the Web, and it arranges the data in order of the two leading digits in each input variable's NAME. It then redirects the participant to a file with a generic "thank you" message.

## Downloading Data by FTP

To view the data, one can use the following link in a browser that supports file transfer protocol (FTP). This link specifies an FTP site with a username of "guest" and password of "guest99": ftp://guest:guest99@psych.fullerton.edu.

From this FTP site, you can download the file named "data.csv." This file can be opened in a text editor or in Excel, among other applications. At or near the end of the file will appear a line that contains the hidden value ("MyTest1") and the datum that you typed in for age.

### *Obtaining and Using a Dedicated FTP Program.*

Although most browsers support FTP, it is more convenient to use a program dedicated to FTP that supports additional features. There are several FTP programs that are free to educational users, such as Fetch for the Mac and WS FTP LE for Windows PCs. These free programs can be obtained from Download.Com, which has the following URL: www.download.com.

FTP is not only useful for downloading data from a server, but it can also be used to upload files to a Web server, in the case of a server administrated by another person. In a later section, we describe advantages of installing and running your own server. However, many academic users are dependent on use of a department or university server. Others have their Web sites hosted by commercial Internet service providers. In these cases, the academic researcher will upload his or her Web pages by means of FTP to the server and download data by FTP from the server.

## The Hidden Input Device

The display in the browser (Figure 26.1) shows the text in the body of the Web page, the text input box, submit button, and reset button. Note that the hidden input device does not display anything; however, one can view it by selecting *Source* (or *Page Source*) from the *View* menu of the browser, so it would be a mistake to think that such a "hidden" value is truly hidden.

The term *hidden* unfortunately has the connotation that something sneaky is going on. The first author was once asked about the ethics of using hidden values in questionnaires, as if we were secretly reading the participant's subconscious mind without his or her knowledge or consent. In reality, nothing clandestine is going on. Hidden variables are routinely used to carry information such as the name of the experimental condition from one page to the next, to hold information from a JavaScript program that executes an experiment, or to collect background conditions such as date and time that the experiment was completed. In this example, the hidden variable is used simply to identify which of many different questionnaires is associated with this line of data. This value can be used in Excel, for example, to segregate a mixed data file into subfiles for each separate research project (Birnbaum, 2001a).

## Input Devices

In addition to the text box, which allows a participant to type in a number or short answer, there are four other popular input devices. The *textarea* input device is a rectangular box suitable for obtaining a longer response such as a paragraph or short essay. For multiple choice answers, there are radio buttons, pull-down selection lists, and check boxes. Check boxes, however, should not be used in behavioral research. The problem with a check box is that it has only two states—it is either checked or unchecked. If a checkbox is unchecked, one does not know if the participant intended "no" or just skipped over the item. For a "yes" or "no" answer, one must allow at least three possibilities: "yes," "no," and "no answer." In some areas of survey research, one may need to distinguish as many as five distinct responses for a yes/no question, "yes," "no," "no response," "don't know", and "refuse to answer." Such multiple-choice questions can be better handled by radio buttons than by check boxes.

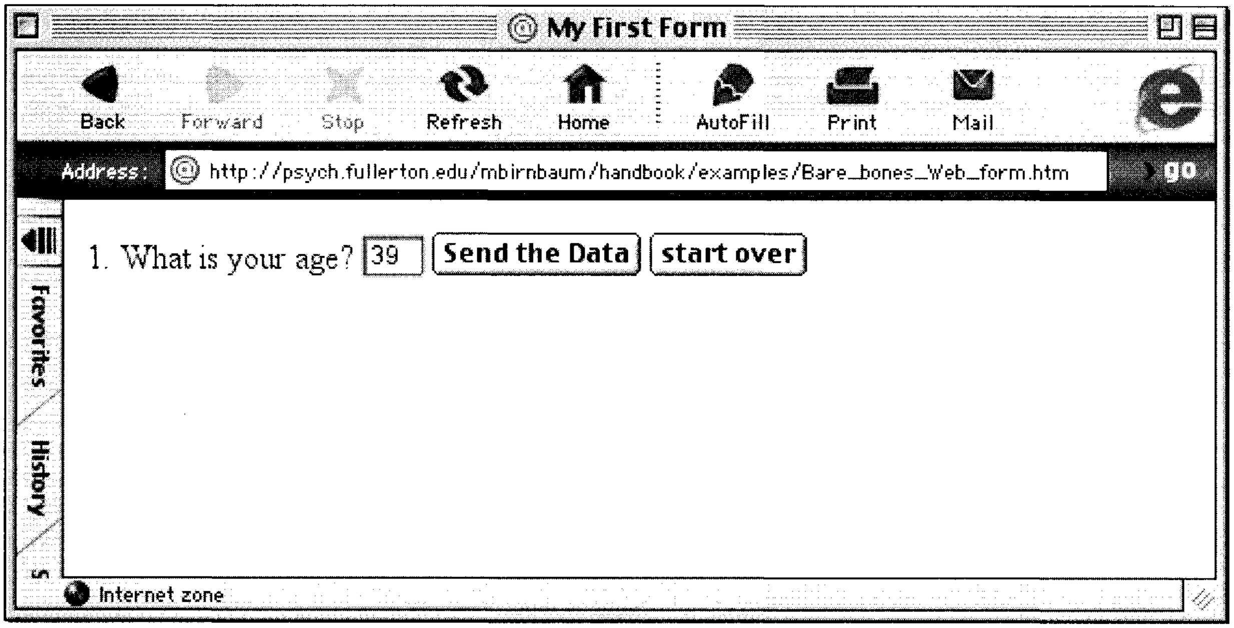


FIGURE 26.1. Appearance of basic Web form in the browser window.

With radio buttons, one can construct a multiple-choice response device that allows one and only one answer from a potential list. The basic tags to create a yes/no question with three connected buttons are as follows:

```
<INPUT TYPE=radio NAME=02v2 VALUE="" checked>
  2. Do you drive a car?
<BLOCKQUOTE>
<BR><INPUT TYPE=radio NAME=02v2 VALUE="1" >No.
<BR><INPUT TYPE=radio NAME=02v2 VALUE="2" >Yes.
</BLOCKQUOTE>
```

In this example, the first radio button will be already checked, before the participant responds. If the participant does not respond, the value sent to the data is empty (there is no space between the quotes); SPSS and certain other programs treat this null value as a missing value. To *connect* a set of buttons, as in this example, they must all have the same *name* (in this example, the name is `02v2`). When one button is clicked, the dot jumps from the previously checked button (the nonresponse, or null value) to the one clicked. If the respondent clicks "No," the data value is "1" and if the respondent clicks "Yes," the data value is "2."

We suggest that you follow this convention for yes/no responses: use larger numbers for positive responses to an item. In this case, the item measures driving. This convention helps prevent the experimenter from misinterpreting the signs of correlation coefficients between variables.

The selection list is another way to present a multiple choice to the participant, but this device is less familiar to both researchers and participants. Selection lists are typically arranged to initially display only one or two options, which, when clicked, will expand to show other alternatives. The list remains hidden or partially revealed until the participant clicks on it, and the actual display may vary depending on how far the participant has scrolled before clicking the item. In addition, there are really two responses that the participant makes in order to respond to an item. The participant must drag a certain distance and then release at a certain choice. Because of the complexities of the device, precautions with selection lists can be recommended.

First, like any other multiple-choice device, it is important not to have a legitimate response preselected, but rather to include an option that says something like "Choose from this list" displayed and which returns a "missing" code unless the participant makes a choice (Birnbaum, 2001a; Reips, 2002b). If a legitimate answer is preselected, as in the left side of Fig. 26.2, the experimenter will be unable to distinguish real data from those that result when participants fail to respond to the item. The illustration on the right side of the figure shows a better way to handle this list. Reips (2002b) refers to this all-too-common error (of preselected, legitimate values) as "configuration error V."

Another problem can occur if the value used for missing data is the same as a code used for real data. For example, the first author found a survey on the Web in which the participants were asked to identify their nationalities. He noted that the same code value (99) was assigned to India as to the preselected "missing" value. Fortunately, the investigator was warned and fixed this problem before much data had been collected. Otherwise, the researcher might have concluded that there had been a surprisingly large number of participants from India.

Second, part of the psychology of the selection list is how the choice set and arrangement of options is displayed to the participant. It seems plausible that options that require a long scroll from the preset choice would be less likely to be selected (Reips,

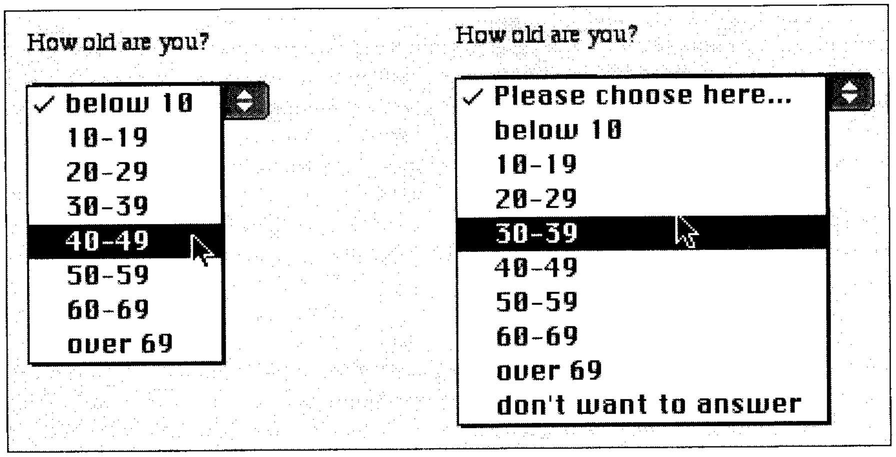


FIGURE 26.2. Improper drop-down selection list (left side) and a better way (right side). The preselected option should be neutral, and the respondent should be given an option to express a deliberate nonresponse (Reips, 2002b).

2002a). The experimenter communicates to the participant by the arrangement of the list and by the placement of the nonresponse option relative to the others. Birnbaum (2001a, chap. 5) reported an experiment showing that mean responses can be significantly affected by the choice of options listed in a selection list. Birnbaum compared data obtained for the judged value of the St. Petersburg gamble from three groups of participants who received different selection lists or a text input box for their responses. The St. Petersburg gamble is a gamble that pays $2 if a coin comes up heads on the first toss, $4 if the first toss is tails and the second is heads, $8 for tails-tails-heads, and so on, doubling the prize for each additional time that tails appears before heads, ad infinitum. One group judged the value of this gamble by means of a selection list with values spaced in equal intervals, and the other had a geometric series with values spaced by equal ratios. A third group had a text box instead of a selection list and requested the participant to respond by typing a value. The mean judged value of this gamble was significantly larger with the geometric series than with equal spacing; furthermore, these values differed from the mean obtained with the text box method. The results, therefore, depend on the context provided by the response device.

In laboratory research on context effects (Parducci, 1995), it has been shown that the response that one assigns to a stimulus depends on two contexts: the context of the stimuli (the frequency distribution and spacing of the stimulus levels presented) and the context provided by the instructions and response mode. Parducci summarized hundreds of studies that show that the stimulus that is judged as "average" depends on the endpoints of the stimuli, their spacing, and their relative frequencies. Hardin and Birnbaum (1990) showed that the response one uses to evaluate a situation depends on the distribution of potential responses incidentally shown as examples. It might seem, therefore, that one should try to "avoid" contextual effects by providing no other stimuli or responses; however, the head-in-the-sand approach yields even more bizarre findings.

To show what can happen when an experimenter tries to "avoid" contextual effects, Birnbaum (1999a) randomly assigned participants to two conditions in a Web study. In one condition, participants judged "how big" is the number 9, and in the other condition, they judged "how big" is the number 221. He found that 9 is significantly "bigger" than 221. Birnbaum predicted that the result would occur based on the idea that each stimulus carries its own context, and even though the experiment specified no context, the participants supplied their own. So, one cannot avoid contextual effects by impoverished between-subjects designs.

In a study with (short) drop-down menus that showed strong context effects in one-page versus multiple-page Web surveys, Reips (2002a) found no significant difference between drop-down (preselected choice at top) versus pop-up (preselected choice at bottom) menus in choices made on the menu. Nevertheless, it would be dangerous to assume that this finding (of nonsignificance) guarantees immunity of this method from this potential bias, particularly for long drop-down menus.

Because the list of options and their spacing, order, and relative position of the initial value may all affect the results, we recommend that the selection list be used only for obtaining responses when the options are nominal, when there is a fixed list of possible answers, and the participant knows the answer by heart. For example, one might use such a device to ask people in what nations they were born. Although the list is a long one, one hopes that people know the right answer and will patiently scroll to the right spot.

There is a lot of potential human factors research that could be done on selection lists, and much about their potential contextual effects is still unknown (see Birnbaum, 2001a; Dillman & Bowker, 2001; and Reips, 2002a, for early investigations). Some findings on the quality of data obtained by browser-based methods are available. Birnbaum (1999b) presented the same browser-based questionnaire on two occasions to 124 undergraduates in the laboratory. In the main body of the experiment, participants were to choose between pairs of gambles by clicking a radio button beside the gamble in each pair that they would prefer to play. In this part of the experiment, people agreed on average in 82% of their choices. With a multiple-choice response for gender, 2 of 124 participants switched gender from the first to second occasion; one switched from male to female and one made the opposite switch. In the choices between gambles, we assume that people were unsure of their choices or changed their minds, but in case of gender, it seems clear that people made errors. Every person agreed on his or her age, which was typed into a text box on each occasion. However, six people gave different answers for the number of years of education, which was also typed into a box.

Once it is realized that people can make errors with any response device, we see the need to design Web studies to allow for such inconsistent behavior. For example, suppose a researcher wants to study smoking behavior, and suppose there are different questionnaires for people who are smokers, for those who never smoked, and for those who quit smoking and no longer smoke. If a participant makes an errant click, that person might be sent to the wrong questionnaire, and most of the questions may be inappropriate for that person. Similarly, a survey of early sexual experiences might have different questions for males and females, since males will be asked about wet dreams and females about menstruation. If a person makes an error in one item, and if that item is used to send people to different questionnaires, that could ruin the rest of his or her data.

One approach to this problem of human errors is to build some redundancy and cross examination into questionnaires and methods of linking people to different instruments. Example 3.2 (available from http://psych.fullerton.edu/mbirnbaum/handbook/) illustrates a number of techniques that can be used to check and recheck before sending people to different questionnaires. One device is the JavaScript prompt that provides cross-examination when a person clicks a link to identify his or her gender. If the person clicks "male," the prompt opens a new box with the question, "Are you sure you are male?" requiring a yes/no answer before the person can continue. A similar check cross-examines those who click "female." A second technique illustrated in the example is to provide HTML links that provide a second chance to link to the correct gender. Here, the person who clicks "male" then receives a page with a link to click "if you are female," which would send the person to the female questionnaire, which also has a second chance to revert.

## CREATING SURVEYS AND EXPERIMENTS WITH SIMPLE DESIGNS

Typing HTML for a questionnaire can be tedious, and typing errors in HTML can introduce errors that would make it impossible to get meaningful data. Therefore, any Web page designed to collect data should be thoroughly tested before it is placed on the Internet for data collection. Birnbaum's (2000b) SurveyWiz and FactorWiz are programs that were written to help researchers avoid making mistakes in HTML coding. These programs are freely available on the Web, and they create sets of radio buttons and text boxes that will properly code and return the data. Still, when editing HTML files (for example, by importing them into Microsoft FrontPage or Word or by copying and pasting items without properly changing the names), there is potential for introducing errors that can ruin a study. More about checks to be conducted before collecting data on the WWW will be presented in a later section.

The leading digits on the name attribute are used by the default, generic CGI script that organizes and saves the data for SurveyWiz and FactorWiz. This particular script requires that leading digits on variable names be sequential and start at 00. However, the HTML need not be in that order. That means that one could cut and paste the HTML to rearrange items, and the data will still return to the data file in order of the leading digits (and not the order within the HTML file of the items). This device is also used by Birnbaum's (2000b) FactorWiz program. FactorWiz creates random orders for presentation of within-subjects factorial designs. Although the items can be put in as many random orders as desired, the data always return in the same, proper factorial order, ready for analysis by ANOVA programs.

### Using SurveyWiz

Instructions for using SurveyWiz and FactorWiz are given in Birnbaum (2000b, 2001a) and within their files on the Web, which can be accessed from http://psych.fullerton.edu/mbirnbaum/programs/.

SurveyWiz3 provides a good way to learn about making a survey for the Web. It automatically prepares the HTML for text answers and rows of radio buttons. One can add a preset list of demographic items by clicking a single button. The program is easy to use and is less likely to lead to errors than commercial programs such as FrontPage. For example, suppose we want to calculate the correlation between the number of traffic accidents a person has had and the person's rated fear while driving.

In SurveyWiz, one simply enters the survey name and short name and then types the questions, one at a time. In this case, the two questions are "In how many accidents have you been involved when you were the driver?" to be answered with a text box, and "I often feel fear when driving," to be answered with a category rating scale. Table 26.2 shows a Web form created by SurveyWiz3, which illustrates text input, rating scales, pull-down selection list, and a textarea for an essay of comments. Here, hidden variables are used to store the survey name, the date, time, and remote address (IP address) of the participant. A text input box is used to obtain the number of accidents, a scale of radio buttons is used to collect a self-rating of fear and of gender, a selection list is used to obtain education, and a textarea is used to invite comments.

Birnbaum's (2000b) FactorWiz program allows one to make within-subjects experimental factorial designs, with randomized order for the combinations. The program is even

TABLE 26.2. Web Form Illustrating Input Devices

```
<HTML>
<HEAD>
<TITLE>Driving Survey</TITLE>
</HEAD><BODY BGCOLOR='papayawhip'>
<FONT FACE=Arial>
<H3> Instructions for Driving Survey</H3>
<BR>Please answer these questions honestly.
<BR>
<HR>
<FORM METHOD='post' ACTION='http://psych.fullerton.edu/cgi-win/polyform.exe/generic'>
<INPUT TYPE=hidden NAME=00exp VALUE=driving_srvy1 >
<INPUT TYPE=hidden NAME=01Date VALUE=pfDate>
<INPUT TYPE=hidden NAME=02Time VALUE=pfTime>
<INPUT TYPE=hidden NAME=03Adr VALUE=pfRemoteAddress>
<P>1. In how many accidents have you been involved when you were the driver?
<INPUT type=text NAME=04v1 SIZE=8 MAXLENGTH=20><BR>
<P><INPUT TYPE=radio NAME=05v2 VALUE=""checked>
2. I often feel fear when driving.<BR>
strongly disagree
<INPUT TYPE=radio NAME=05v2 VALUE=1>
<INPUT TYPE=radio NAME=05v2 VALUE=2>
<INPUT TYPE=radio NAME=05v2 VALUE=3>
<INPUT TYPE=radio NAME=05v2 VALUE=4>
<INPUT TYPE=radio NAME=05v2 VALUE=5>
strongly agree<BR>
<HR>
<INPUT TYPE=radio NAME=06sex value='0' CHECKED>
3. Are you Male or Female?<BR>
<BLOCKQUOTE>
<INPUT TYPE=radio NAME=06sex value='F'>Female<BR>
<INPUT TYPE=radio NAME=06sex value='M'>Male
</BLOCKQUOTE>
<P>4. What is your age?
<INPUT TYPE=TEXT NAME=07Age SIZE=2 maxlength=3> years.<BR>
<P>5. What is the highest level of education you have completed? <BR>
<SELECT NAME=08Ed >
   <OPTION VALUE=""SELECTED>Choose from this list
   <OPTION VALUE=11> Less than 12 years
   <OPTION VALUE=12> Graduated High School (12 years education)
   <OPTION VALUE=14> Some College (13-15 years education)
   <OPTION VALUE=16> Graduated from College (Bachelor's degree)
   <OPTION VALUE=18> Master's degree
   <OPTION VALUE=19> Advanced Grad School beyond Master's degree
   <OPTION VALUE=20> Doctoral Degree (Ph.D., M.D., J.D., etc.)
</SELECT><BR>
<P>6. Nationality (country of birth):
<INPUT TYPE=text NAME=09Cn SIZE=20 MAXLENGTH=30><BR>
<P>7. COMMENTS:<BR>
<TEXTAREA NAME=10CM ROWS=5 COLS=60 WRAP=virtual></TEXTAREA><BR>
<P>Please check your answers. When you are done, push the button below.
<P><INPUT TYPE='submit' VALUE='finished'>
<H2>Thank You!</H2>
</FORM>
</FONT>
</BODY>
</HTML>
```

easier to use than SurveyWiz once its concepts are understood. Information on how to use the program is contained in Birnbaum (2000b, 2001a) and in the Web files containing the programs. Both SurveyWiz and FactorWiz create studies that are contained within a single Web page. To construct between-subjects conditions one might use these programs to create the materials in the various conditions and use HTML pages with links to assign participants to different conditions. However, when there are a large number of within and between subjects factors, when the materials should be put in separate pages so that response times and experimental dropouts can be traced, it becomes difficult to keep all of the files organized. In these cases, it is helpful to use WEXTOR (Reips & Neuhaus, 2002), a program available on the Web that organizes experimental designs and keeps the various pages properly linked (see the following section).

Another free program for making surveys is Schmidt's (1997b) WWW Survey Assistant. This program is more powerful than SurveyWiz, but also more difficult to learn. The program builds not only Web pages, but also CGI (Perl) scripts to save and even make computations on the data. There are also a number of commercial applications that we cannot recommend, because they are expensive and no better than open source, free ones.

## CREATING WEB EXPERIMENTS WITH COMPLEX DESIGNS

Reips and his group built several tools that help Web experimenters in all stages of the process: learning about the method, design and visualization, recruitment, and analysis of data. A visual representation of the process in form of a flowchart can be viewed from the link on the companion Web site. All of Reips' tools are Web-based and therefore platform independent; they can be used from any computer that is connected to the Internet. If you prefer a multiple-page survey with dropout measure, individualized random ordering of questions, and response time measurement, then you may want to use WEXTOR, a program reviewed in this section.

WEXTOR, by Reips and Neuhaus (2002), is an Internet-based system to create and visualize experimental designs and procedures for experiments on the Web and in the lab. WEXTOR dynamically creates the customized Web pages needed for the experimental procedure. It supports complete and incomplete factorial designs with between-subjects, within-subjects, and quasi-experimental factors, as well as mixed designs. It implements client-side response time measurement and contains a content wizard for creating interactive materials, as well as dependent measures (graphical scales, multiple-choice items, etc.), on the experiment pages.

Many human factors considerations are built into WEXTOR, and it automatically prevents several methodological pitfalls in Internet-based research. This program uses nonobvious file naming, automatic avoidance of page number confounding, JavaScript test redirect functionality to minimize dropout, and randomized distribution of participants to experimental conditions. It also provides for optional assignment to levels of quasi-experimental factors, optional client-side response time measurement, and randomly generated continuous user IDs for enhanced multiple submission control, and it automatically implements the meta tags described later in this chapter. It also implements the warm-up technique for dropout control (Reips, 2000, 2002b) and provides for interactive creation of dependent measures and materials (created via content wizard).

The English version of WEXTOR is available at http://genpsylab-serv2.unizh.ch/wextor/en/index.php. Academic researchers can sign up free and can then use WEXTOR to design and manage experiments from anywhere on the Internet using a login/password combination. Figure 26.3 shows WEXTOR's entry page.

The process of creating an experimental design and procedure for an experiment with WEXTOR involves 10 steps. The first steps are decisions that an experimenter would make whether using WEXTOR or any other device for generating the experiment, such as listing the factors or levels of within- and between-subjects factors, deciding what quasi-experimental factors (if any) to use, and specifying how assignment to conditions will function. WEXTOR produces an organized, pictorial representation of the experimental design and the Web pages required to implement that design. One can then download the experimental materials in one compressed archive that contains all directories (folders), scripts, and Web pages.

After decompressing the archive, the resulting Web pages created in WEXTOR can then be further edited in an HTML editor and afterward the whole folder with all experimental materials can be uploaded to a Web server. This can be done by FTP as previously described for the case of an experimenter who does not operate the server, or it can be done by simply placing the files in the proper folder on the server, as described in the next section.

Some research projects require even greater power to allow dynamic tailoring of an experiment to the participant's sequence of responses. Table 26.3 shows a list of various tools and techniques used to create the materials for running experiments via the Web. In Web research, there are often a number of different ways to accomplish the same tasks. Table 26.3 provides information to compare the tools available and help determine which application or programming language is best suited for a given task.

Certain projects require a programming language such as CGI programming, JavaScript, Java, or Authorware programs. Programming power is usually required by experiments that rely on computations based on the participant's responses, randomized events, precise control and measurement of timing, or precise control of psychophysical stimuli. The use of JavaScript to control experiments is described by Birnbaum and Wakcher (2002), Birnbaum (2002), and Baron and Siepmann (2000). JavaScript programs can be sent as source code in the same Web page that runs the study. This allows investigators to openly share and communicate their methods. That way, it becomes possible to review, criticize, and build on previous work.

Java is a relatively new programming language, and like JavaScript, it is intended to work the same for any browser on any computer and system. The use of Java to program cognitive psychology studies in which one can accurately control stimulus presentation timing and measure response times is described by


FIGURE 26.3. The entry page to WEXTOR.

Francis, Neath, and Suprenant (2000). Eichstaedt (2001) shows how to achieve very accurate response time measurement using Java.

Authorware is an expensive but powerful application that allows one to accomplish many of the same tasks as one can do with Java, except it uses a graphical user interface in which the author can program processes and interactions with the participant by moving icons on a flow line. This approach has been used to good effect by McGraw, Tew, and Williams (2000; see also Williams, McGraw, & Tew, 1999). Additional discussion of these approaches is given in various chapters of Birnbaum (2000a) and in Birnbaum (2001a, 2004a, 2004b).

JavaScript, Java, and Authorware experiments run client-side. That means that the experiment runs on the participant's computer. This can be an advantage in that it frees the server from making calculations and having a lot of traffic delays sending information back and forth. It can also be a disadvantage if the participant does not have compatible languages or plug-ins. At a time when Internet Explorer had a buggy version of JavaScript and JavaScript tended to produce error messages on people's computer screens, Schwarz and Reips (2001) found that JavaScript caused a higher rate of dropout in Web studies compared with methods that did not require client-side programming. However, in recent years, JavaScript and Web browsers have become less error-prone. Among the client-side programming options, JavaScript is probably the most widely used one.

There are certain tasks, such as random assignment to conditions, that can be done by HTML; by JavaScript, Java, Authorware; or by server-side programs. By doing the computing on the server side, one guarantees that any user that can handle Web pages can complete the study (Schmidt, 2000). On the other hand, server-side programs may introduce delays as the participant waits for a response from the server. When there are delays, some participants may think the program has frozen and may quit the study. There are, however, certain tasks that can and should only be done by the server, such as saving data or handling issues of security (e.g., passwords, using an exam key to score an IQ test or academic exam, etc.). Perl and PHP

TABLE 26.3. Purpose of Various Techniques and Tools to Create Materials for Web-based Research

| Technique/Tool | Purpose | Pros | Cons/Considerations |
|---|---|---|---|
| HTML (basics) | To create Web content | Basic to everything on the Web | Takes a day or two to learn the most important tags |
| HTML Forms | To transmit data to and from participant. | Basic device used in Web research | Takes a day to learn the basics |
| WYSIWYG Web Editors | To create Web content, including HTML Forms | Help people who do not know HTML to make Web pages. Easy to make good-looking pages without understanding. Easy to learn. | Can create headaches for researchers. Students often fall into traps from which they cannot escape or may even remain unaware of fatal errors that spoil their project. |
| SurveyWiz | Creates one-page HTML surveys | Easy to learn and use. Creates surveys with text boxes and scales of radio buttons. | Limited in what it does. |
| FactorWiz | Creates one-page, within-subjects factorial designs with up to six factors. | Easy to learn. Creates random orders of factorial material. | Limited in what it does. Must be used repeatedly to create between-subjects conditions. |
| WWW Survey Assistant | Creates a variety of surveys and CGI scripts. | More powerful than SurveyWiz | More difficult to learn than SurveyWiz. |
| WEXTOR | Creates multipage, between-subjects, within-subjects, quasi-experimental, or mixed factorial designs. Download complete code, ready to be put on server. | Easy to learn. Many human factors considerations built in, prevents methodological pitfalls in Internet-based research. | Cannot do certain things that can be done with Java or Authorware. |
| LogAnalyzer | For analysis of log files (turns raw server data into files in "one participant per line" format) | Handles any type of log file. Includes module for dropout analysis. Calculates response times. Highly flexible. | One must ensure that the server saves the key information in the log file. |
| CGI Scripting (e.g., Perl, PHP) | Control the server, save data, security (e.g., passwords, on-line exams). Server side programming. | Automation of many necessary processes such as saving data. Works for any participant. | Not easy to learn. Constant version updating necessary, due to security risks. May function more slowly than client side programs. |
| JavaScript | Powerful programming language. Include dynamic interaction with participant. Control and measure time. | Client-side, hence requires JavaScript turned on in the participant's Web browser. | May not work properly in certain Web browsers. |
| Authorware | Construct experiments requiring timing, graphics, dynamic interactions. | Products look good. Runs client side. Can do same tasks as Java, but easier to learn. GUI. | Expensive. Plug-in download necessary on part of the participants. |
| Java | Powerful programming language, object-oriented. | Free. Usually preinstalled on computers. Precompiled applets run on client side. | Very difficult to learn, may not work as expected with some Web browsers/operating systems |

are the two most popular programming languages that can be used to write server-side programs. Of course, to program the server, one needs to have access to the server.

## RUNNING YOUR OWN SERVER

Running a Web server and making documents available on the Web has become increasingly easy over the years, as manufacturers of operating systems have responded to demand for these services. Even if there is no preinstalled Web server on your system, installing one is neither complicated nor expensive. Thanks to contributions by an active open-source community, there are free servers that are reliable and secure, along with free programming languages such as Perl and PHP that allow one considerable power for running and managing research from the server side (Schmidt, 2000).

The free Apache Web server, available for a wide range of operating systems, can be downloaded from http://www.apache.org/. On this Web site there is also up-to-date documentation of the details of the installment process. Schmidt has provided tutorials on installation of the free Apache server with Perl for PC in the Advanced Training Institute's Web site (http://ati.fullerton.edu). He also has written a Perl script that works with SurveyWiz and FactorWiz. Göritz (2004) has contributed tutorials on Apache, PHP, and MySQL, including PHP scripts that also work with SurveyWiz and FactorWiz.

Running your own Web server (rather than depending on your institution) conveys several advantages (Schmidt, Hoffman, & MacDonald, 1997). First of all, you can have physical access to the server, allowing you to directly observe and control it. You can, for example, easily add and delete files to your Web site by moving files from folder to folder; you can disconnect the server, modify it, and restart it.

Second, Web servers of institutions are restricted because they have to fulfill many tasks for different purposes. Consequently, many settings are designed to satisfy as many requirements as possible (one of which is reducing the likelihood of getting the network supervisors into trouble). On your own server, you can install and configure software according to the requirements of your research (for example, you should change the server's log file format to include the information mentioned in the section on how to analyze log files).

Third, you can have greater control and access to the server if you operate it yourself. The institution's administrators may end up hindering research more than any help they might provide with technical issues. You can try to explain your research goals and provide assurances that you would not do anything to weaken the security of the system or to compromise confidential files. Still, some administrators will resist efforts by researchers to add CGI files that save data to the server, for example, fearing that by error or intent, you might compromise the security of the system. Some institutional review boards (IRBs) insist that administrators deny researchers complete access to the server for fear of compromising privacy and security of data collected by other researchers who use the same server.

Currently, by far the easiest way to publish Web pages is in Apple's Macintosh OS X operating system. In the next section you will learn how this can be done. On the PC, you may follow the descriptions provided by Schmidt (2003) and Göritz (2004).

## Place Your Materials in the Designated Folder

In your private area (Home) under Mac OS X there is a folder called "Sites". Put the folder with your materials (in this example the folder is named, "my_experiment") in the Sites folder. Figure 26.4 shows the respective Finder window. No other files need to be installed if you created your experiment with SurveyWiz, FactorWiz, or WEXTOR. (In case you are an advanced user of Internet technology and you would like to use Perl or PHP scripts for database-driven Web studies you need to configure the system accordingly. On the Macintosh, Perl, PHP, and mySQL are built in, but they need to be configured using procedures described in more detail in the section on installing a Perl script and in the Web site that accompanies this chapter. For Windows PCs, see the tutorials by Schmidt, 2003, and Göritz, 2004.)

## Turning on the Web Server in Mac OS X

The Apache Web server comes already installed on new Macintosh computers. Turning on the Web server under Mac OS X takes three mouse clicks: First you need to open the System Preferences (Click 1), then click on "Sharing" (Click 2, see Fig. 26.5), and then click on "Personal Web Sharing (Click 3, the "Services" tab will be preselected), as shown in Fig. 26.6.

Before you can actually make anything available on the Web using the built-in Apache Web server you need to make sure that your computer is connected to the Internet. However, you can always test your site by "serving" the pages to yourself locally, that is, view them as if you were surfing in from the Web. Here is how you do this:

- Open a Web browser
- Type "http://localhost/~USERNAME/my_experiment/" into the browser's location window (where USERNAME is your login name).

The exact address will actually be shown at the bottom of the system preferences window (not shown here to preserve privacy).

## Where to Find the Log Files

The default storage for the log files created by the Apache server that comes with Mac OS X is /var/log/httpd/access_log. It is a text file readable in any text editor. A nice freeware application to read log files is LogMaster (go to www.versiontracker.com for

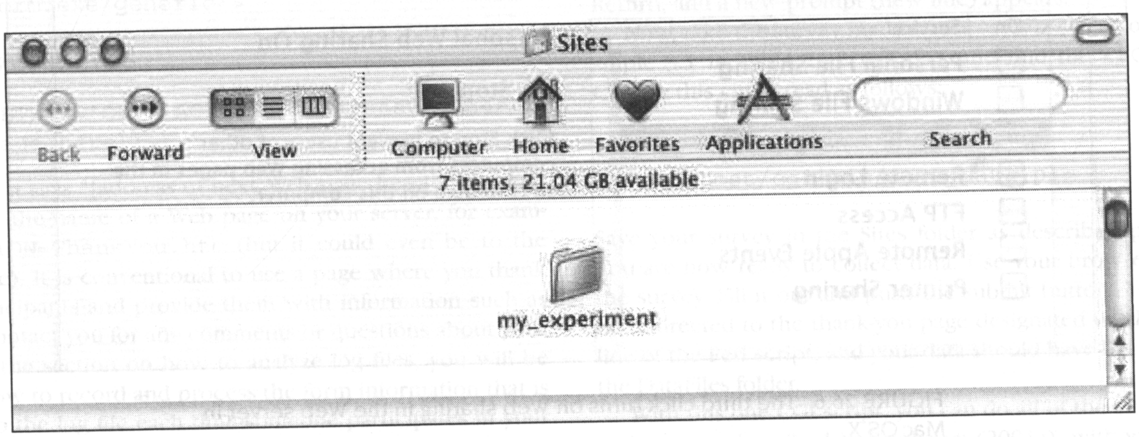


FIGURE 26.4. Web pages go in the Sites folder.

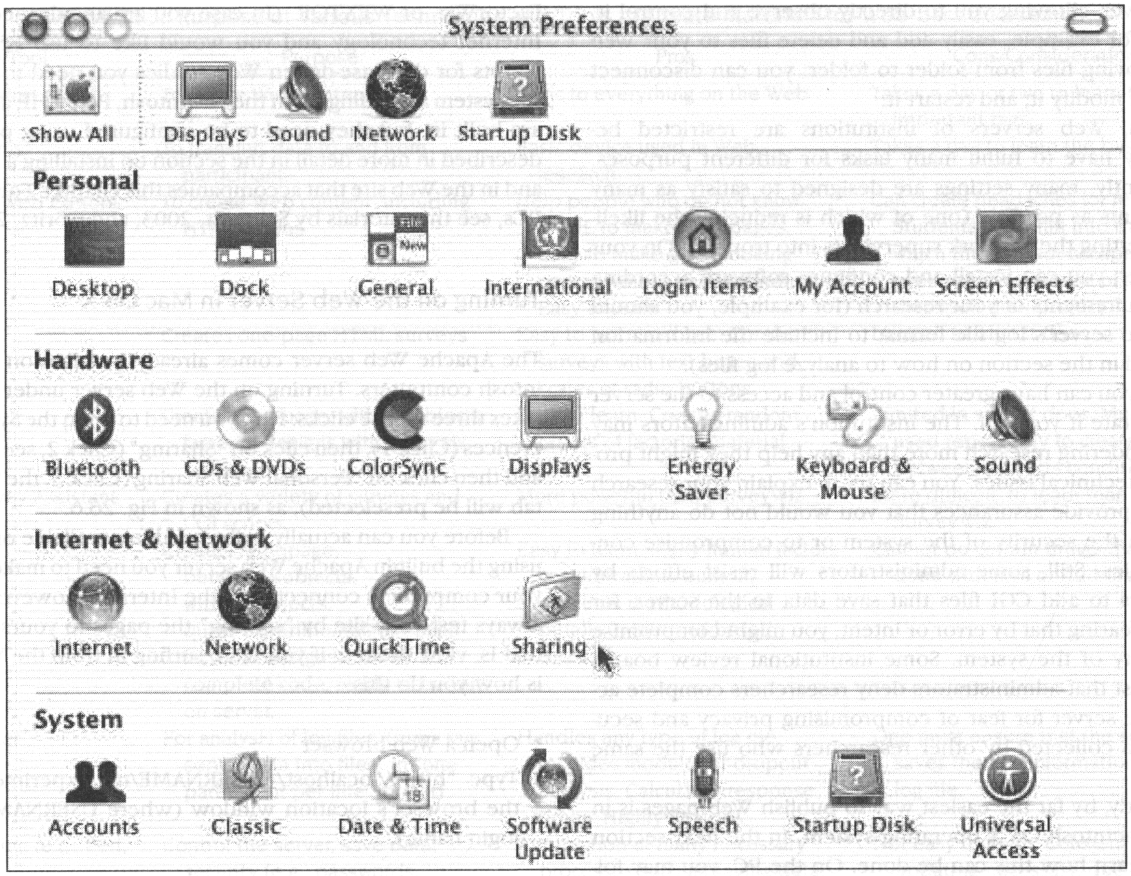


FIGURE 26.5. The second of three clicks to turn on the Mac server is to click on Sharing in the System preferences.

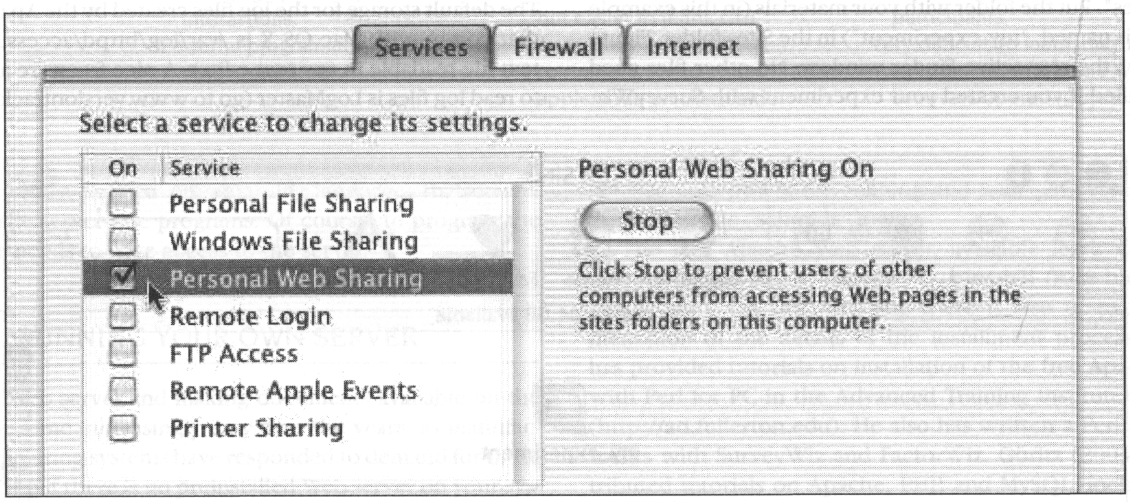


FIGURE 26.6. The third click turns on Web sharing in the Web server in Mac OS X.

download). You can directly copy the log file and upload it to Scientific LogAnalyzer (Reips & Stieger, 2004) for further analysis (see next section).

To view the log file in Mac OS X, you would open the Applications folder, open the Utilities folder and double-click the Terminal application. A terminal window will open up. This window accepts old-fashioned line commands and, like old-fashioned programming, this Unix-like terminal is not forgiving of small details, like spaces, capitalization, and spelling.

Carefully type the following command:

```
open /var/log/httpd/access_log
```

Before you hit the return key, look at what you have typed and make sure that everything is exactly correct, including capitalization (here nothing is capitalized) and spacing (here there is a space after the word *open*). If you have made no typo, when you press the return key, a window will open showing the log file for the server.

The default logging format used by Apache is somewhat abbreviated. There is a lot of useful information available in the HTTP protocol that is important for behavioral researchers that can be accessed by changing the log format, for example to include information about the referring Web page and the user's type of operating system and Web browser. Methods for making these changes to the configuration of Apache server are given in the Web site that accompanies this chapter.

If you created your study with WEXTOR, you are ready to collect data. If you used surveyWiz or factorWiz, and if you want to save data to your own server, rather than download them from the *psych.fullerton.edu* server, you will need to make the adjustments in your HTML page(s) and server. There are two approaches. One is to use a CGI script to save the data, installing a CGI on your own server to replace the generic PolyForm script provided by Birnbaum (2000b); this technique will be described in the following section. The other approach is to send the data by "METHOD=GET" to the server's log file.

To use the "GET" method to send data to the log file, find the <FORM> tag of your survey:

```
<FORM METHOD='post'
ACTION='http://psych.fullerton.edu/cgi-win/
  polyform.exe/generic'>
```

and change it to

```
<FORM METHOD='GET' ACTION='[address of next
  Web page here]'>.
```

Where it says "[address of next Web page here]" you need to specify the name of a Web page on your server, for example, ACTION=ThankYou.htm (but it could even be to the same page). It is conventional to use a page where you thank your participants and provide them with information such as how to contact you for any comments or questions about your study. In the section on how to analyze log files, you will be shown how to record and process the form information that is written to the log file each time someone participates in your study.

## Installing a Perl Script to Save Data via CGI

The procedures for installing Perl with the Apache server for Windows PC are described in Schmidt (2003). This section explains how to use Perl on the Mac OS X.

First, create a folder to hold the data files. Open the icon for the Macintosh hard drive. From the File menu, select New Folder. A new folder will appear, which you should name DataFiles. Now click the folder once, and press the Apple Key and the letter "i" at the same time, which opens the Get Info display. Then click on the pop-up list and choose Privileges. Set the first two privileges to Read and Write and the third to Write Only (Dropbox).

Next, examine the Perl script in Table 26.4. This is a CGI script, written by Schmidt to emulate the generic PolyForm script used by Birnbaum (2000b, 2001a). This script will save data from a Web form to a new data file in the above folder. You can edit the first three lines to suit your own configuration and needs. For example, you can change the URL in the second line to the address of a thank-you page on your own server, or you can change the location on your computer where you wish to save the data by changing the third line.

The Perl script in Table 26.4 is also available from the Web site for this chapter, which will save you from typing. You should save this as a Unix text file, with an extension of ".pl". For example, you can save it as *save_data.pl*. This file should be saved in the following folder. From your Mac hard drive, open the *Library* folder, then open the *WebServer* folder, and then open *CGI-Executables*. Place save_data.pl in this folder.

Now you need to open the Terminal. Open the *Applications* folder and within it open the *Utilities* folder. Double-click the Terminal program and it will open. Type the following command:

```
chmod ugo+rwx /Library/WebServer/CGI-
  Executables/save_data.pl
```

Before you hit Return, study what you have typed. Be sure that the capitalization, spacing, and spelling are exactly correct. There should be a space after *chmod* and before */Library*. Hit Return, and a new prompt (new line) appears.

Now, take the survey made by SurveyWiz or FactorWiz (Example 3.1 in Table 26.2 will do), and find the <FORM> tag. Change this tag to read as follows:

```
<FORM METHOD='post' ACTION='http://
  Localhost/cgi-bin/save_data.pl>
```

Save your survey in the Sites folder as described previously. You are now ready to collect data. Use your browser to view the survey. Fill it out and push the submit button. You should be redirected to the thank-you page designated on the second line of the Perl script, and your data should have been saved in the DataFiles folder.

With this one CGI script, you can do all of the experiments and surveys described in Birnbaum (2001a), without needing

TABLE 26.4. CGI Script in Perl That Works With SurveyWiz and FactorWiz

```
#!/usr/bin/perl
$redirect_to = "http://psych.fullerton.edu/mbirnbaum/decisions/thanks.htm";
$path_to_datafile = "/DataFiles/";

use CGI;
$query = new CGI;

#timestamp the submission
($sec,$min,$hour,$mday,$mon,$year,$wday,$yday,$isdst) = localtime(time);
$mon++;

#determine the data filename, open and dump data
$filename = $query->param('00exp');
open(INFO, ">>$path_to_datafile/$filename.data");

foreach $key (sort($query->param))
        {
        $value = $query->param($key);

        #filter out "'s and ,'s
        $value =~ s/\"/\'/g;
        $value =~ s/,/ /g;
        if ($value !~ /^pf/)
        {
               print INFO "\"$value\", ";
        }
        else
        {
               # filter out items that need to be expanded at submission time pf*
               if ($value =~ /^pfDate/)
               {
                      print INFO "\"$mon/$mday/$year\", ";
               }
               if ($value =~ /^pfTime/)
               {
                      print INFO "\"$hour:$min:$sec\", ";
               }
               if ($value =~ /^pfRemote/)
               {
                      print INFO "\"",$query->remote_addr(),"\", ";
               }
               if ($value =~ /^pfReferer/)
               {
                      print INFO "\"",$query->referer(),"\", ";
               }
        }
        #print "$key:$value";
      }
print INFO "\"complete\"\n";
close (INFO);

print $query->redirect($redirect_to);
exit();
```

to install another script. The data will arrive in the designated folder on your server as comma separated values (CSV) files that can be easily imported to many statistical and spreadsheet applications. Methods for working with and analyzing data collected in this format are described in detail in Birnbaum (2001a).

## HOW TO ANALYZE LOG FILES

Scientific investigation relies on the principle of raw data preservation. Raw data need to be saved for scrutiny by other researchers from the community (American Psychological Association, 2001), for example to aid in reanalysis or meta-analysis. This principle applies to Internet-based research as well, where it can be argued that server log files, properly configured, are the raw data (Reips, 2001a; 2001b, 2002b; Reips & Stieger, 2004). In addition to all data sets from full participation, complete log files from a Web server used in an Internet-based investigation contain the following useful information:

1. Data about potential participants who decide not to participate (e.g., the number of people who see the link to a study, but do not click it)
2. Data about technical conditions during the investigation (i.e., the general Web traffic conditions at the server and the particular conditions of each request by a participant)
3. Data sets for those who provided incomplete information; partial nonresponses may reveal information about user type and potential problems (Bosnjak, 2001; Reips, 2002b)

Not reporting the information listed above, for example because one did not save it, carries the great danger of misleading scientists with respect to the main effects of variables (Birnbaum & Mellers, 1989; Reips, 2000, 2002c; Reips & Stieger, 2004). Even when dropout rates are equal in two groups, the observed trend may easily show the opposite of the true effect that one would have found had all data been complete. Because participants find it quite easy to quit Web studies, there can be sizeable attrition in such studies, and this attrition needs to be documented and reported. For more on drop-out analysis, see Frick, Bächtiger, and Reips (2001), Reips (2002b, 2002d), Reips and Stieger (2004), and Knapp and Heidingsfelder (2001).

Log files need to be configured so that the information needed will be saved. Often the log file format follows a common predefined format, for example the Webstar log file format. This log file format is used by the Web Experimental Psychology Lab and contains information in the following order: CONNECTION_ID DATE TIME RESULT HOSTNAME URL BYTES_SENT AGENT REFERER TRANSFER_TIME SEARCH_ARGS.

A platform-independent interactive Web site that helps Internet researchers in analyzing log files is Scientific LogAnalyzer (Reips & Stieger, 2004, http://genpsylab-logcrunsh.unizh.ch/). It was created to meet the needs of those who collect data on the Internet. Scientific LogAnalyzer provides an option for selecting the predefined format mentioned above, and it also contains procedures to identify and process any type of log file. To match a predefined format, the user may also rearrange columns in the log file before uploading it to Scientific LogAnalyzer, which can easily be done in text editors and spreadsheet programs.

Scientific LogAnalyzer has features important to behavioral and social scientists, such as handling of factorial designs, response time analysis, and dropout analysis. Scientific LogAnalyzer was developed to include calculation of response times, flagging of potential multiple submissions, selecting either first or last response from the same IP, marking of predefined IP addresses or domain names, and free definition of session timeout). The program is highly flexible on the input side (unlimited types of log file formats), while strictly keeping the traditional one-case-per-row output format. Other features include free definition of log file format; searching and identifying any combination of strings (necessary for organizing conditions in experiment data); computation of approximate response times; a module for analyzing and visualizing dropout; detection of multiple submissions; output in HTML and tab-delimited files, suited for import into statistics software; speedy analysis of large log files; and extensive help from an online manual.

## PRETESTING OF INTERNET-BASED RESEARCH

Before an experiment is placed on the Web, it is necessary to perform a number of checks to make sure that the study will yield useful data. First, one should be clear on how the data will be analyzed and that the study will answer the question it is supposed to answer. This check is basic and applies to lab research as well as Web research. Those who are unclear on how the data will be analyzed almost never devise a study that can be analyzed.

Second, one should conduct checks of the HTML and CGI script to code and save data to ensure that every possible response is properly coded and recorded in the proper place in the data file. One should check that every radio button (in a given item) functions properly and that answers to one question do not overwrite responses to another item. This is one of the advantages of using a Web service like FactorWiz (Birnbaum, 2000b) or WEXTOR (Reips & Neuhaus, 2002); these programs save time by automatically creating safe code.

Third, one should test some participants in the lab. Observe them as they read and respond to the materials. Ask them to identify aspects of instructions that are unclear. Internet-based research does not have a lab assistant who can answer questions, so every question must be addressed in advance. Check if people are responding before they have scrolled to see the information that they are supposed to review before responding. One of the first author's students had placed a response device before the material the participant needed to read. During pilot testing, the first author observed a number of people who responded before they had scrolled to make visible what they were supposed to be judging.

Analyze the data from the pilot study to see that the coding and analysis will function properly. It is often when analyzing data that students discover problems with their studies. That is why some pilot data should be analyzed before the main study is run.

One can discover a lot by observing participants in pilot research. For example, in a study with the randomized response technique (e.g. Musch, Bröder, & Klauer, 2001), participants were supposed to toss two coins and then respond "yes" if both coins were heads, "no" if both coins were tails, and to tell the truth otherwise. The purpose of the technique is to allow an experimenter to assess a population statistic without knowing any person's true answer. For example, most people would be embarrassed to admit that they cheated on their income taxes, but with the randomized response technique there is no way to know if "yes" meant that the person did cheat or that the coins were both heads. If people follow instructions, this method allows the experimenter to subtract 25% "yes" answers (that occurred because of two heads) and 25% "no" (resulting from two tails), and double the remainder to find the correct proportions. For example, if 30% of the group say that they cheated on their taxes, it means that 10% of the population say they cheated. In our pilot test, however, only 1 of 15 participants took out any coins, and she asked first if she should actually follow the instructions. The first author urged his student to add stronger instructions and an extra pair of items at the end of the survey asking if the participant had actually used the coins, and if not, why not. About half said they had not followed the instructions, giving excuses such as "lazy" and "I had nothing to hide." This example should make one very concerned about what happens in studies that are not observed and still more concerned about studies that are launched without pilot testing.

It is also important to pretest the materials with different browsers and systems and with a small monitor, to make sure that everyone will see what they are supposed to see. Otherwise you would probably run into what the second author coined "configuration error IV" in Internet-based research—the all-too-common underestimation of the technical variance inherent in the Internet (Reips, 2002b). Consider adding items to your research instrument to ask about monitor sizes, volume settings, and other settings when you think these variables might make a difference to the results. Such information can be used to partition the sample for separate analysis. Considerations of delivery of psychophysical stimuli and a discussion of when such settings may or may not matter are reviewed by Krantz (2001).

## RECRUITING PARTICIPANTS FOR INTERNET-BASED RESEARCH

Participants can be recruited by traditional means, such as a course assignments, student participant pools, face-to-face requests, word of mouth, posters, flyers, newspaper advertisements, and so on. We will focus here on Internet methods such as recruitment via Web site, mailing list, online panel, newsgroup, e-mail, listings, and banner ads. Recruitment of Internet-based studies can be made much more effective by using one or several of the techniques that are described by Birnbaum (2001a) and by Reips (2000, 2002a, 2002b, 2002d).

### Recruitment via Web Site and Search Engines

One natural way to recruit participants is via one's own homepage. However, many personal home pages are rarely visited. Besides, visitors of your homepage may know too much about your research (or read about it on the page) to be suitable (i.e., naïve) participants for certain studies. A useful strategy to test whether such self-selection may be biasing your results is the *multiple site entry technique* (Reips, 2000, 2002c) that will be described later.

An institution's homepage, for example a university's, may be a better choice for recruiting large numbers of participants. In addition, an institution's homepage will often convey a more legitimate impression than a personal homepage. Indeed, it will not be easy in most cases to get agreement to announce your study unless a number of people have agreed that it is acceptable to do so.

One of the best places for recruitment are institutionalized Web sites for Internet-based experimenting, such as the *web experiment list*, the *Web Experimental Psychology Lab*, and the *Psychological Research on the Net list* by Krantz (1998), who published some of the first Web experiments (Krantz, Ballard, & Scher, 1997; Welch & Krantz, 1996). Some of these Web sites are visited by thousands of potential participants every month (Reips, 2001a, 2001b), and some managers even provide you with a free check of your experiment, before linking it. A link on a Web experiment site may also serve an archiving function as an example for future studies and as a reference in publications.

People coming to your study via one of these Web research sites are true volunteers who have already decided that they want to take part in one or more psychology studies and who chose your study from a list of ways to participate. So, the concerns one might have with respect to students who are participating only to fulfill an assignment are relieved with this source of participants.

To recruit participants by means of search engines, you can enhance your pages to help people find your study. Suppose you wanted to recruit people interested in psychology. To help those who are looking on the Web for *psychology*, you can put that word in the title of your site, add it to the early text in your site, and add meta tags including *psychology* as a key word.

Suppose you wanted to recruit people with rare characteristics, such as transvestites. You could include meta tags in your

TABLE 26.5. Use of Metatags to Recruit via Search Engine

```
<HTML>
<HEAD>
<META NAME="keywords" CONTENT="transvestites,cross-dressing,survey,early
  experiences,psychology,research">
<META NAME="description" CONTENT="research psychologists invite transvestites to complete a survey of early life
  experiences that we hope will contribute to understanding this condition"
<TITLE>Survey of Early Experiences of Transvestites</TITLE>
</HEAD>
<BODY>
(Further information on the study and a link to the study would be placed here)
</BODY>
</HTML>
```

TABLE 26.6. Use of Meta Tags in Pages After the Entry Page

```
<HTML>
<HEAD>
<meta name="AUTHOR" content="WEXTOR">
<meta name="ROBOTS" content="NONE">
<meta http-equiv="pragma" content="no-cache">
<meta http-equiv="expires" content="Thursday,
  1-Jan-1991 01:01:01 GMT">

<TITLE> </TITLE>
</HEAD>
(the body of the Web page goes here)
```

entry page in order to help these people find your study. Table 26.5 shows an example of a Web page that might be used to recruit participants to survey of memories of early experiences by transvestites. You should also consider using an informative title for the first page of your study. Reips (2002b) advises using uninformative page titles and page names for consecutive pages, to avoid the possibility that people will find these subsequent pages via search engines and enter the study somewhere in the middle. However, the first page that recruits participants can have an informative title without distracting the participant.

Meta tags can (and should) also be used to keep search engines *away* from all pages except the first page (you may even desire to keep search engines away from that page, if you would like to recruit via other means exclusively). The *robots* tag in Table 26.6 needs to be set to *none*, because the routines used by search engines to search the Web for new Web pages are called robots (and sometimes *spiders* and *crawlers*) and this technique informs them there is nothing for them.

A third important task that can be handled by meta tags is to prevent caches in search engines, mediating servers, and proxy servers from serving old versions of research materials after they have been updated. Caches contain stored files downloaded from the Web, which are stored for reuse later. For example, your Web browser may be configured to store HTML code, images, and other media from pages you visited in its own cache. Later, when you request that page again, the Web browser quickly checks in the cache if it holds any of the text and media (e.g., images) you are requesting and displays them to you. This way, the page can be displayed more quickly (than if you had to wait for all the same files to download again), and much unnecessary traffic is avoided.

However, the material loaded from the cache may be outdated: If an experimenter finds an error in his or her Internet-based study and replaced the Web page on the server, users may continue to see and even be served the old version. Why? Because of caches holding the old version in proxy servers. Proxy servers hold huge caches, but not only for one computer—they hold all of the WWW traffic going into and coming out of entire institutions. As you can imagine, there are some interesting analyses that can be performed with data collected on proxy servers (Berker, 1999, 2002). Table 26.6 shows two meta tags below the robots tag that will keep proxy servers from caching your Web pages. Web experiments created with WEXTOR automatically contain the meta tags described in this section.

## Recruitment via Other Means

In a survey of the pioneers of Web experimenters, Musch and Reips (2000) asked the question "In which media did you announce your experiment?" A surprisingly large number of Web experiments were not announced solely on the WWW. Researchers also used newsgroups (18 of 35 experiments), e-mails (15), and search engines (14) to advertise their Web experiments. Very few researchers used radio (1) or print media (2), although we now know that these off-line media can be extremely effective.

Birnbaum (2001a) gives a number of suggestions regarding recruitment. He recommends against sending e-mail messages to people who do not want to get e-mail from you. Unwanted e-mail is considered spam or electronic junk mail. Researchers should not do what looks like spamming or they will end up getting a bad reputation and giving Internet-based research a bad name. They may end up spending a lot of time responding to flames or hostile messages, which might be sent to thousands of people. Instead, a better method for recruiting from a listserv is to contact the organization the runs the listserv and ask this organization for help. If you can convince the officers of an organization that your research is serious and will be of value to the community that the organization serves, you can often get good help from them. They can post an announcement in their Web site, send invitations in their newsletter, and even post a message for you to their members via e-mail. For example, to recruit transvestites, you could contact organizations to which these people belong, show that your research would be of interest or benefit to the members, and ask the organization to recruit for you.

This suggestion was adopted by Drake (2001), a graduate student who was working with Birnbaum at the time. She wanted to recruit elderly people with interests in genealogy. She realized that members of her target group belong to organizations that have an Internet presence. Drake contacted an organization, which saw the potential interest and value of her research to its members and agreed to send an e-mail to the members on her behalf, vouching for her research and inviting participation. Within one week, she had more than 4,000 completed data records and many messages of encouragement and support.

*Newsgroups.* In the early days of the Internet, communications consisted largely of text-based materials. Many people had very slow connections and logged onto virtual bulletin boards via modem to upload and download messages. One of the largest bulletin board networks was (and is) USEnet. Most of the USEnet newsgroups were saved and made accessible on the WWW by deja.com (playing on the term *déjà vu*), a service that was later acquired by Google. Google now lists all available newsgroups as *Google groups* and makes them available for searches. For example, if you surf to Google groups and type in the words "Web experiment survey" the two first postings listed are those originally posted to the newsgroup "sci.psychology.research" by Musch and Reips, inviting Web experimenters to their survey mentioned above. The links within their postings still work, showing you precisely what was done in that study.

If you use newsgroups for recruitment of participants, then be aware of the following points:

- Your posting will stay forever (or at least indefinitely, until the newsgroup might be erased from the Internet)
- It will take several days, maybe weeks, until your posting is widely available
- Make sure your posting is considered adequate in the newsgroups you are posting to—ask the moderator first, if the newsgroup is moderated.

*Participant Pools and Panels.* Many colleges have established pools of students who volunteer to participate in studies. In some cases, the researcher can request a sample of participants stratified with respect to gender, for example. Such a traditional participant pool may be an effective way for recruitment in Web studies, especially at large colleges.

However, student samples have little variance in age or education, nor are students heterogeneous with respect to many other variables (Birnbaum, 2001a; Reips, 2000). Most are between 18 and 22 years of age, all are graduates of high school, and none are graduates of college. Psychology pools now contain about two thirds females, and at many schools, students who take psychology are more likely to be undecided majors than the typical student. Birnbaum (1999b) wanted to study correlates of education (especially education in decision making) and therefore needed to recruit off campus to obtain a sample that would show wide variation in education.

Using the Internet, a number of academic researchers and market researchers have created participant pools by means of the Internet of people with more heterogeneous characteristics than college students (Baron & Siepmann, 2000; Göritz, Reinhold, & Batinic 2002; Smith & Leigh, 1997). If nurtured properly, these online panels of volunteers for Web-research are a means of widely distributed easy access to a wide range of participants.

*E-mail.* One very effective way of recruiting participants are e-mails to mailing lists of people who want to receive your mail. At a recent conference (Subjective, Probability, Utility, and Decision Making, SPUDM, Zürich 2003), the second author heard an interesting paper on the first day of the conference and decided to replicate that study overnight. He was able to include the results in his talk on the second day of the conference, in order to demonstrate how much more efficient Web-based research can be in comparison with the methods used by the original authors (see link to presentation on companion Web site). Within 8 hours, complete data sets from 162 participants (compared to 64 in the original study) were recorded in the Web experiment, most of which were recruited via three mailing lists.

*Banner Ads.* People who visit tattoo and piercing sites may have different personalities from those of people who visit traditional family values sites. Buchanan (2000, 2001) has exploited this insight to form criterion groups from people who are recruited by different methods in order to validate personality tests. He has had some success comparing people recruited from different user groups. This technique is sometimes called the *multiple site entry technique* (Reips, 2000, 2002b), which is to recruit people via several different methods and compare data between these groups. Buchanan (personal communication, Oct 10, 2002) reported, however, that response to banner ads has been very meager and probably not worth the money (for similar results, see Tuten, Bosnjak, & Bandilla, 2000). Because banners usually represent commercial advertising, a banner ad for a scientific study is hard to distinguish from a deceptive come-on for a commercial message.

*Password Techniques.* Passwords can be used to control entry to a study or survey or they can be used to validate data from members of a voting body. Passwords are one way to determine if one person is trying to stuff the ballot box with multiple submissions of the same vote.

Password techniques (Reips, 2000; Schmidt, 2000) can be used to guarantee any degree of authenticity and originality of a participant's identity. In an experimental study on Internet-based versus paper-and-pencil-based surveying of employees, Reips and Franek (2004) printed anonymous individual codes for use in the (mailed) invitation to 655 employees. From the log analysis of the Internet-based data, it could be determined

- Whether any codes were used repeatedly (showing multiple submissions and permitting the investigators to include the first set only)
- Whether people without code tried to access the survey (using wrong codes or no codes).

There are many other methods for authenticating data (see Schultz, chap. 33, this volume) and detecting or preventing multiple submission of data. These are summarized in a number of papers, including Birnbaum (2004a, Table 1) and Reips (2002c, Table3).

## Ethics and Etiquette in Internet Science

It is difficult to injure someone via the Web, except by dishonesty, so the fundamental ethical principle for Web-based research is honesty. If you promise some benefit for participation, then you must follow through and provide that benefit. For example, if you promise to pay participants, then you must pay them. Failure to do so is fraud. If you promise to give participants a report of the results by a certain date, then you must provide them the report. (A good way to do this, incidentally, is to post the results to the Web and send the URL to those who requested the results (but do not send attachments). If you promise to provide a chance in a lottery to win a prize, then you must follow through and run the lottery and distribute the prizes that were promised.

If participation is not anonymous, and if you promise confidentiality, then you must do everything you can to secure the data and prevent them from becoming public. Birnbaum (2001a) lists a number of steps to provide security of the data on the server. Keep the door to the server locked and do not leave keys or passwords around. Record only what is necessary, keep personal information separate from other data if possible, and remove identifying information from stored data as soon as possible. The server should be kept up to date with respect to security from hackers.

Although Musch and Reips (2000) reported that early Web experimenters had not found hackers to be a problem, the potential is certainly there for an unfortunate incident. Reips (2002b) observed a high rate of insecure servers in Web studies (configuration error I): During routine checks of Web experiments by researchers who applied for inclusion in the Web Experimental Psychology Lab, Reips was able to download openly accessible data files in several cases. Apparently, many researchers were not aware of the vulnerabilities of their Web servers and operating systems and were surprised when he sent portions of their confidential data files to them. Based on statistics permanently collected by www.securityfocus.com ("bugtraq"), Reips (2002b) also noted the better track record of the Mac OS against vulnerabilities to hackers and viruses compared to Windows and other operating systems. Depending on the operating system used, an Internet scientist will have to invest less or more time in keeping up with newly discovered vulnerabilities and respective security developments.

It is good practice to avoid deception in any Web-based research, at all costs. One of the ethical reasons to do this is to keep a good reputation for Internet-based research. An ethics review board is concerned for the ethical treatment of participants, and certain deceptions would not be considered harmful to participants. However, studies involving deception might be harmful to other researchers who do not practice deception if Internet research should acquire a bad reputation. Therefore, one should consider the impact of one's research on other scientists (and indirectly on society) before one does anything to give Internet-based research a bad name. For more information on issues of deception and ethics of Web research, see Birnbaum (2004b).

In addition to ethical concerns in recruiting, there are issues of good manners and good taste. It is considered impolite to send people attachments they did not request. People now fear to open them because they may carry a commercial message, a worm, or a computer virus. And large attachments can fill up mailboxes, can be slow to download, and are generally seen as a kind of injury (or threat of injury) that you have inflicted on your recipients. Keep in mind that computers break down all the time. Suppose you opened an attachment from someone, and then your computer broke down. It would be natural to assign blame and seek justice, even though the evidence was mere coincidence. By means of the Internet, it is easy to reach a large number of people for good or ill, and therefore it is possible to annoy if not anger large numbers of people.

Instead of sending attachments, send a link to the file that you have uploaded to the WWW (via FTP for example). Web links to plain HTML are much safer to click than an attachment.

In your messages recruiting participants or reporting availability of results, you should include in all e-mail your correct name, e-mail and postal address, telephone number, and affiliation. Behaving politely in the Internet is not only a nice thing to do, it is also a necessity for the Internet researchers to avoid being confused with purveyors of spam, spoofers (senders of e-mail from fake addresses), or even worse. The impolite and ignorant behavior of a few spammers and malicious hackers have already destroyed much of the good spirit and free flow of communication on the Internet. E-mail is now filtered and even innocent messages and innocent attachments are disappearing into e-mail void as institutions try to protect themselves from the onslaught of the new barbarians.

*Polite Recruitment.* Similarly, it is important to be very careful when recruiting participants for your Internet-based study. Let others check the wording of your invitation before you send it off or post it. If you recruit participants via a mailing list or newsgroup, then first have the moderator of the list approve your posting. An even better solution is to ask someone else, such as the manager of a group, to send the announcement for you. That way, people will know that the announcement is legitimate, and if they consider your invitation to be spam, they will blame the moderator's judgment rather than yours.

Do not do anything that resembles a chain letter, commercial advertising, or spamming. Internet researchers have been blacklisted and e-mail bombed for recruiting too aggressively. Such cases are not only embarrassing and time consuming (responding to flames or angry messages attacking one's manners), but they also pose a threat to the reputation of the entire community. If you are in doubt that people want to receive your message, it is probably best not to send it.

A set of considerations (rules) for proper behavior on the Internet can be found at www.albion.com/netiquette/ and Internet research specific advice is available from Michalak and Szabo (1998).

## WHERE TO LEARN MORE

In addition to journals and professional books on the topic, there are two organizations holding conferences that provide good opportunities to meet and interact with people involved in psychological Internet-based research. The German Online Research (GOR) conference, was established in 1997 and is hosted jointly by the German Society for Online Research (DGOF) and local organization teams that differ from year to year. More than 300 participants attended GOR on average in the last few years.

The central purpose of GOR conferences is to provide a venue for the presentation of empirical studies that examine the Internet as both an instrument for and an object of scientific investigation. Topics of investigation presented include (but are not limited to) quality of Internet-based research, Internet research methods in market research and polling, computer-mediated communication, Web experiments, and marketing on the Internet.

Society for Computers in Psychology (SCiP) meetings take place on an annual basis in mid-November and are scheduled to occur in the same location as the Psychonomic Society and Society for Judgment and Decision Making (JDM) meetings, on the day preceding the annual meeting of the Psychonomic Society. This organization is somewhat older than GOR, but is devoted not only to Internet-based research but also to other applications of computers in psychological research and teaching. The primary journal of this organization is *Behavior Research Methods, Instruments, & Computers*.

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