

Conducting True Experiments on the Web

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With the success of the Internet, its wide proliferation, and the availability of Web application software for generating and conducting experiments on the Internet, there are now very good reasons to turn to the Web for experimental data collection. Above all, as Reips (2007) put it, the ultimate reason for using the Internet to conduct experiments is

the fundamental asymmetry of accessibility (Reips, 2002b, 2006): What is programmed to be accessible from any Internet-connected computer in the world will surely also be accessible in a university laboratory, but what is programmed to work in a local computer lab may not necessarily be accessible anywhere else. A laboratory experiment cannot simply be turned into a Web experiment, because it may be programmed in a stand-alone programming language and lack Internet-based research methodology, but any Web experiment can also be used by connecting the laboratory computer to the Internet. Consequently, it is a good strategy to design a study Web based, if possible. (pp. 375–376)

This chapter covers methodological and practical information that helps researchers (a) identify how Internet-based experimenting can be a useful method for their research and (b) create and run their own Web experiments. We begin the chapter by reviewing differences and similarities between Web and lab experiments, because knowing these

is of utmost importance in the decision to transport the experimental method to an online environment. Benefits, challenges, and solutions that lead to a checklist of standards applicable to Internet-based experiments are discussed. From there, we introduce several techniques that have been shown to be useful in implementing the standards, in allowing researchers to either use classic features of experimental design and procedure on the Web or to tackle issues specific to Web experiments. A section on the variety of technical approaches to conducting Web experiments follows, which includes a discussion of the use of media and other stimuli in Internet-based experiments. Near the conclusion, we provide recommendations for programs and editors and a list of important and useful Web sites that were created in support of experimental Web research. To maximize the chapter's utility, we focus on the application of specific tools and sites for all stages of experimental research, most of which are accessible through the iScience Server at <http://iscience.eu>:

- generating the experiment: WEXTOR (<http://wextor.org>; Reips & Neuhaus, 2002);
- recruiting participants: exponnet list (<http://psych.hanover.edu/research/exponnet.html>; by John Krantz), web experiment list (<http://wexlist.net>; Reips & Lengler, 2005), Web Experimental Psychology Lab (<http://wexlab.eu>; Reips, 2001), online panels (Göritz, 2007);
- and analyzing log files: Scientific LogAnalyzer (<http://sclog.eu>; Reips & Stieger, 2004).

We selected these tools because (a) they cover a range of needs for Web experimenters; (b) they are user friendly and many operate fully automatically; and (c) they are maintained by researchers with a track record in the field. We also selected them because we have extensively used them in our own Web-based research (e.g., Krantz, Ballard, & Scher, 1997; Krantz & Dalal, 2000; Reips, 2009; Reips & Funke, 2008; Reips, Morger, & Meier, 2001; Schwarz & Reips, 2001). Broader reviews of Web experiment strategies are provided by Reips (2000, 2002a, 2002b, 2007).

It is important to know differences and similarities between Web and lab experiments because currently most new Web experimenters have previous experience with laboratory research. Entering the realm of Internet-based research with this background, one is likely to be highly successful when dealing with the relationship between experimenter and participant, and with experimental methodology and with computers, but one may be prone to step into some traps typically related to the psychology of Internet use and Internet-mediated communication (see, e.g., Joinson, McKenna, Postmes, & Reips, 2007), changes to the difficulties and practicalities of what can be done via Internet or not, and underestimating technological variance of hardware and software on

the Web (Reips, 2000, 2002a, 2002b; Schmidt, 2007). Many of the potential traps are related to the advantages and disadvantages of Internet-based experimenting that we discuss in response to the respective questions below, along with solutions to typical problems.

When designing a study, one must find an optimized balance between methodological advantages and disadvantages. We recommend including Internet-based experimenting within a multimethod perspective drawn from general concerns about overreliance on any single research method: validate findings with different methods in different settings. Design the study for the Web, and for comparison, run a subsample in a local laboratory—or even in two (for an example involving local laboratory groups in Vancouver, Canada, and Zurich, Switzerland, see Reips et al., 2001). Where differences between results from online and laboratory methods are found, there is often an obvious explanation in sampling, computer expertise, Internet expertise, or format (see chap. 3, this volume; the sections on disadvantages and techniques that follow; and Krantz & Dalal, 2000). Established recruitment practices from undergraduate student populations versus visitors of particular Web sites, for instance, may easily result in sampling differences that can alter response patterns (Reips, 2000).

Participation in Internet-based research is a form of computer-mediated communication, more specifically, Internet-mediated communication. Consequently, much of the research in this realm (e.g., Joinson et al., 2007) applies to the social psychology of the Internet-based experiment. After reading this chapter, you will know how to apply some of major issues related to this research.

Advantages of Internet-Based Experimenting

Conducting experiments via the Internet brings various benefits to the research (for summaries, see Birnbaum, 2004; Reips, 1995, 2000, 2002b). Main advantages are that (a) studies can be delivered to large numbers of participants quickly and with low effort; (b) when compared with laboratory research, Web experiments are more cost-effective in time, space, administration, and labor; and (c) one can recruit large heterogeneous or homogeneous samples, also of individuals with rare conditions of interest (Mangan & Reips, 2007; Schmidt, 1997).

Another advantage is that because of the anonymity of the setting, the Internet is particularly suited for studies on sensitive topics. For example, Mangan and Reips (2007) used the Web to reach and study people with *sexsomnia*. *Sexsomnia* is a medical condition in which one

engages in sexual behavior during one's sleep. Difficult cases are highly distressing and have forensic implications. Sexsomnia may be quite common but often goes unreported because of embarrassment and shame. Thus, little is known about this condition's demographics and clinical features. Through the Web, however, it was possible to contact and survey more than five times as many individuals from this difficult-to-reach clinical population than could be reached in all previous studies from 20 years of research combined.

When discussing advantages of Internet-based experiments, sometimes the advantages of computerized assessment are mistakenly attributed to the new Internet method. However, many useful functionalities such as item branching, filtering, automatic checks of plausibility during data entry, and so on, were introduced to experimenting during the computer revolution in the early 1970s (see Drasgow & Chuah, 2006; Musch & Reips, 2000; Reips, 2002b). These functionalities are, of course, also available in Internet-based research and may combine well with Internet features. For example, depending on their IP address, participants can be routed to different Web pages (e.g., a researcher may want to create a different version for participants from the researcher's university). As with the research on sexsomnia mentioned previously, Internet-based methods facilitate research in areas that were previously difficult to reach or inaccessible (e.g., Bordia, 1996; Rodgers et al, 2001). Meta-analyses reveal that Internet-based methods are usually valid (e.g., Krantz & Dalal, 2000) and sometimes even generate higher data quality than laboratory studies (Birnbaum, 2001; Buchanan & Smith, 1999; Reips, 2000). Many other benefits of Internet-based methods are frequently listed (e.g., Birnbaum, 2004; Reips, 1995, 2000, 2002b, 2006; Rhodes, Bowie, & Hergenrather, 2003), among them

- *Participant-related advantages:*
 - the ease of access for participants (physically, psychologically, culturally) and
 - truly voluntary participation (unless participants are required to visit the Web site).
- *Methodological improvements compared with laboratory experiments:*
 - detectability of confounding with motivational aspects of study participation;
 - avoidance of time constraints; and
 - reduction of experimenter effects (even in automated computer-based experiments, there is often some kind of personal contact, not so in most Web experiments), in particular a reduction of demand characteristics.
- *Generalizability and external validity:*
 - better generalizability of findings (e.g., Horswill & Coster, 2001),
 - greater external validity through greater technical variance,

- generalizability of findings to more settings because of high external validity, and
- ease of cross-method comparison (compare with sample tested in the laboratory).
- *Visibility and public control:*
 - greater visibility of the research process (Web-based studies can be visited by others, and their links can be published in articles resulting from the research);
 - heightened public control of ethical standards.

Drawbacks of Internet-Based Experimenting

Potential disadvantages of Internet-based experimenting, on the one hand, reside in the traps mentioned initially that may catch a researcher who is habitually following certain laboratory procedures. On the other hand, disadvantages come with the Internet setting and the technologies involved. Experience has shown that frequently voiced concerns regarding Internet-based experiments, such as multiple submissions (thereby missing representativeness of Internet users) and dishonest or malicious behavior (false responses, “hacking”), are not as frequent and not as problematic as previously considered (Birnbaum, 2004; Birnbaum & Reips, 2005). Some of the real issues, such as interactions between psychological processes in Internet use and the widely varying technical context, tend to be overlooked, though, and are discussed below, along with solutions (Reips, 2002a, 2002b, 2007; Schmidt, 2007).


Computer anxiety, lack of experience with the Internet, or both, may lead to substantially different results for Internet-based studies than for studies administered on paper (Whitaker & McKinney, 2007). Buchanan and Reips (2001) were able to show that users logging onto an online version of the IPIP Big Five personality test (Buchanan, Johnson, & Goldberg, 2005) via a Macintosh computer scored significantly higher on Openness to Experience than did those using a PC. Also, they showed that people who had JavaScript turned off were more educated, on average. This means that the more complex the technology involved in programming a Web study, the more samples are likely to be biased demographically and psychologically.

Despite these findings, converging evidence shows that Internet-based research methods often result in qualitatively comparable results to traditional methods (e.g., Krantz & Dalal, 2000; Luce et al., 2007; cf. Buchanan et al., 2005), even in longitudinal studies (Hiskey & Troop,

2002). Some of the cases in which differences have been found may be explained by frequent configuration errors in Internet-based research (Reips, 2002a), which we present along the way as part of a step-by-step guide to conducting a Web experiment in the next section.

In the remainder of the chapter, we provide a brief user guide to conducting an Internet-based experiment. We do so by describing each step when using WEXTOR. This tool has been developed by pioneers of Internet-based experimenting, has many important techniques built in, and is constantly being expanded to integrate new ones. Because Internet-based experimenting can be markedly different from lab and field experimenting, Reips (2002b) proposed 16 standards or guidelines that may help researchers and reviewers of manuscripts that are based on Internet-mediated research. The first standard is to use such a Web-based software to create your experimental materials, because it implements procedures for Web experiments that guard against typical problems.

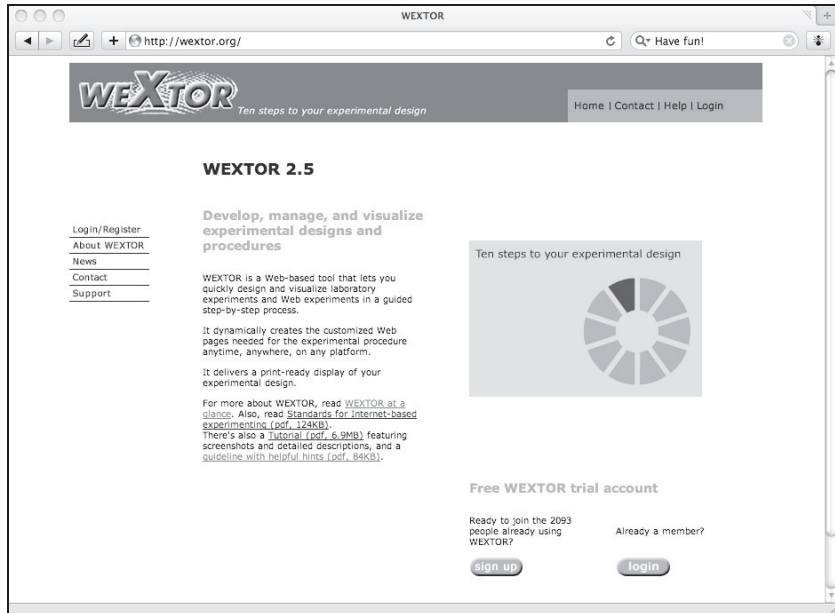
Using WEXTOR to Build a Web (or Lab) Experiment

We use WEXTOR to recreate the 2×2 factorial Experiment 1 about information leakage (McKenzie & Nelson, 2003; Reips, 2003). The Web experiment is on display at ://tinyurl.com/25ftae. WEXTOR was created by researchers to implement usability and advanced techniques, and to be low tech (static HyperText Markup Language [HTML] and JavaScript only). It is important to know that for your specific experiment, there may be alternatives: Check whether the advantages of dynamic HTML (PHP, Perl) or non-HTML scripting languages such as Java and plugins such as Authorware, Flash, or Shockwave outweigh their disadvantages. But it is important to realize that with more advanced methods, generally the participant population becomes more restricted.

Researchers log on to <http://wextor.org> (see Figure 13.1). They click on “Sign up” and provide a unique user name, password, and e-mail address, then receive an e-mail with an activation code that needs to be used just once after clicking on “Login.” From then on, only login and password will be needed; free 6-month trial accounts are available. Once logged in, click on “Create/modify an experimental design.” On the new screen, type a name for your new experiment (e.g., “cup”), then click “Create.” Follow the steps below.

1. Define the types and number of factors in your design. Select “2” between-subjects factors, “0” within-subject, and “no” quasi-experimental factors for this experiment. Then click the

FIGURE 13.1



WEXTOR, the Web (and lab) experiment generator.

- ">" button to advance to the next step (do this after each step below).
2. Name the two factors "point of reference" and "order of answer options," or something similar. For each factor, type "2" where it says "Number of levels."
 3. Name the levels "4-->2" and "0-->2" for "point of reference," "full first," and "empty first" for "order of answer options."
 4. Name your experimental conditions. It is best to change nothing here; WEXTOR provides a naming proposal that avoids a frequently observed configuration error in Internet-based experimenting, namely, researchers' tendency to name their pages and folders too obviously (Configuration Error III; Reips, 2002a). Notice that the names proposed by WEXTOR follow Standard 11 (i.e., unobtrusive naming) recommended by Reips (2002b): They begin with a logical part that helps you identify the experimental condition (11, 12, 21, 22) and continue with three random characters that keep your participants from jumping pages or conditions. Obvious file naming like "a1.html, a2.html, a3.html, b1.html, b2.html" or "dissonance_study/control_cond/b3.html"

may reveal the experiment's topic, structure, or even the manipulation to participants.

5. Read about the standard pages included with each experiment. They serve some important functions, such as screening for a working Web browser, providing a form for informed consent, ensuring random distribution of participants to conditions, and so on. Add the number of additional Web pages you will need per condition.¹ It helps to get a piece of paper and briefly sketch the screens your participants will see to determine the number of pages needed. Think of one page per screen view and be advised that it is better to follow a "one-item-one-screen" philosophy rather than accumulating a lot of material on one page to measure dropout and time in a meaningful way (Reips, 2000, 2002b; chap. 3, this volume). Also, consider the warm-up technique and other types of drop-out control here that is explained at the end of this chapter. Do not worry if you pick the wrong number of pages; this can be changed later. For this experiment, choose "1."
6. Name your pages. It is best to keep the names WEXTOR proposes for the five standard pages and the suffixes, unless you would like to host the resulting experiment on your own server. You could also specify an automatic timing out for each of your pages. For this experiment, leave it at "0" and name Web page 1 "task" (.html).

Skip Steps 7 and 8; there are no within-subjects or quasi-experimental (natural) factors.

9. In Step 9a, view your experimental design either in list format (see Figure 13.2; great for methods sections in reports)² or in visual format (see Figure 13.3; great as a flowchart for the procedures section). Pick a style ("skin," implemented as a Cascading Style Sheet) for the layout of your pages, then open a preview in Step 9b by clicking "View." In 9b, you add content to your Web page by clicking on its name (do so now); editing of the standard pages is done later. First, choose "Plain text," then hit the "Add" button; a form appears. Leave the variable name as-is. Enter the following text to the second field:

¹ Note that WEXTOR does not provide an option for entering different numbers or names of pages for different conditions, because this would introduce a confound that has been shown to be of strong influence (see chap. 3, this volume). In exceptional cases, different page counts or names could be tolerated; the design is to be adapted by hand after download in Step 10.

² The list format also contains a code plan that you should review for variables and answer options once finished with all of Step 9.

FIGURE 13.2

Your experimental design

Your experiment consists of 2 factors:

Between-subjects factors

Factor 'point of reference'

- 4-->2
- 0-->2

Factor 'order of answer options'

- full first
- empty first

Experimental conditions

Experimental condition 1-1: 11cf69

- factor point of reference, level 4-->2
- factor order of answer options, level full first

Experimental condition 1-2: 12b006

- factor point of reference, level 4-->2
- factor order of answer options, level empty first

Experimental condition 2-1: 21a92d

- factor point of reference, level 0-->2
- factor order of answer options, level full first

Experimental condition 2-2: 222f7b

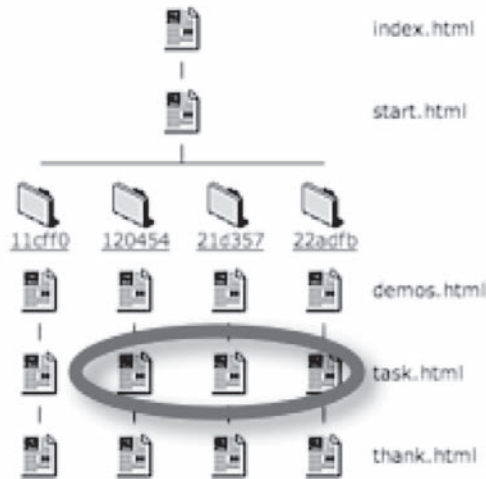
- factor point of reference, level 0-->2
- factor order of answer options, level empty first

Automatically generated list of design in Step 9a.

“Imagine a 4-ounce measuring cup in front of you that is completely filled with water up to the 4-ounce line. You then leave the room briefly and come back to find that the water is now at the 2-ounce line.” The description field at the bottom is for your own notes; they will appear in the code plan in 9a. Confirm the entry, then choose “Radio buttons in vertical order” and hit “Add.” Enter “What is the most natural way to describe the cup now?” in the second field and choose “2” answer options. On the subsequent screen, type “The cup is 1/2 full” and “The cup is 1/2 empty,” confirm, and hit “view” in the upper right corner. A preview of the page will be shown in a pop-up

FIGURE 13.3

Visual display of your experimental design

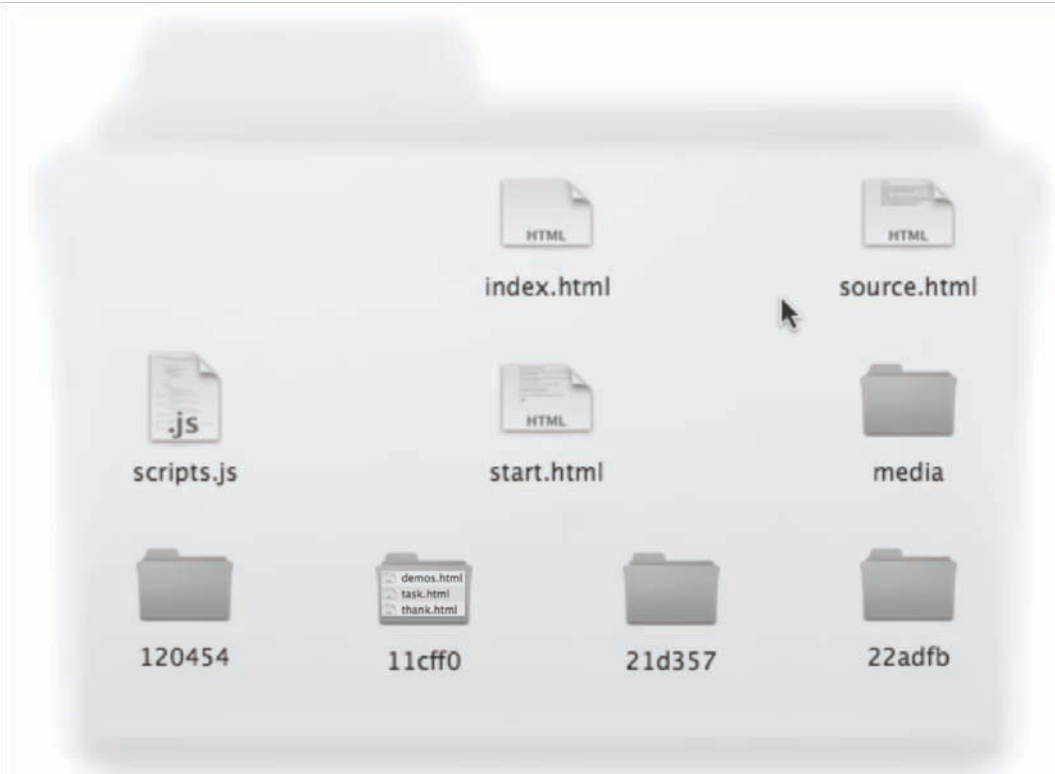


Automatically generated visual display of design and procedure in Step 9a. Pages resemble screens; folders resemble conditions.

window. Before you advance to 9c, note that two pieces have appeared under “Modify item.” You could skip Step 9c by just advancing to Step 10, but you should note the default settings here could be changed to turn off client-side millisecond resolution response time measurement (standard server-side measurement of resolution in seconds is always provided), modify session ID length for enhanced control of multiple submissions, add *soft form validation* (i.e., the participant is warned if not all available form fields are filled in; this warning, however, is only shown once for each page to avoid provoking the participant to drop out), or add a high hurdle (Reips, 2000, 2002a).

10. Here, you download your complete experimental materials as a zip-compressed file. Decompress to your desktop; you now have a folder with the same name as your experiment (e.g., “cup”) that contains five files, a folder for each condition and one for media files (“media” or “img”); see Figure 13.4. To test your experiment in its current state, open “index.html” in a

FIGURE 13.4



WEXTOR-generated experiment folder containing all subfolders, files, and scripts to run the experiment.

Web browser. Because WEXTOR creates static HTML pages, you can perform this testing and the next few steps even without being connected to the Internet.

11. One by one, load “task.html” from folders 12, 21, and 22 (marked in Figure 13.3) into an HTML editor (Dreamweaver, UltraEdit, BBEdit, NVU1.0, NotePad—but not MS Word; for an overview of HTML editors, see chap. 3, this volume) and change according to “Experimental conditions” in Figure 13.2. This means changing the instruction sentence in 21 and 22 to “. . . that is completely empty down to the 0-ounce line . . . to find that there is now water up to the 2-ounce line.” and changing the order of the answering options in 12 and 22. Make sure you exchange not only the text but also the radio buttons next to it, so “The cup

is 1/2 full” is consistently coded as “0” (or “1”). Feel free to also edit the `demos.html` and `start.html` pages—note the simple but powerful seriousness check technique (Reips, 2002a) on `start.html` (see Figure 13.5 and text below for an explanation). Answers to this question will allow you to later skip analyzing data from those who did not really intend to participate but still had a look at your experiment pages. Test your experiment while it remains on your desktop and make any necessary changes.

12. Zip-compress your folder with everything in it and log into WEXTOR. After login, click on “Upload an experiment, download data.” Upload the zipped file; WEXTOR will then provide you with a link to your Web experiment. It is now fully functional and accessible on the Web around the world. The two next procedures to follow are pretesting and recruitment.

Pretesting and Recruitment

A procedure that is very important in Internet-based research is extensive pretesting. Pretest your experiment for clarity of instructions and availability on different platforms. Pretest in up to three waves: (a) Ask two or three people to take part in your experiment while you observe them; (b) send the link to your experiment to a few colleagues and friends only and ask them for feedback; and (c) once you begin recruiting real participants, soon check the data file for any problems.

FIGURE 13.5

How do you intend to browse the Web pages of this study?

I would like to seriously participate now.

I would like to look at the pages only.

Please click on the following button to start with the experiment.

Seriousness check technique.

PREPARATION FOR RECRUITMENT OF YOUR PARTICIPANTS

Use the *multiple-site entry technique* (Reips, 2000, 2002a; for examples of successful implementations, see e.g., Horstmann, 2003; Janssen, Murre, & Meeter, 2007; Rodgers et al., 2003): For each source of recruitment (e.g., Web sites, forums, newsletters, e-mail lists, target groups) append a unique string of characters to the URL (e.g., “. . .index.html?source=studentlist”). Your data file will contain a column (“source”) containing an entry of the referring source for each participant (“studentlist”) for later comparison by subgroup (i.e., referring link). This technique provides you with indicators for effects of presence and impact of self-selection or contamination of samples. The technique may also be used to strategically segment a sample (Whitaker & McKinney, 2007).

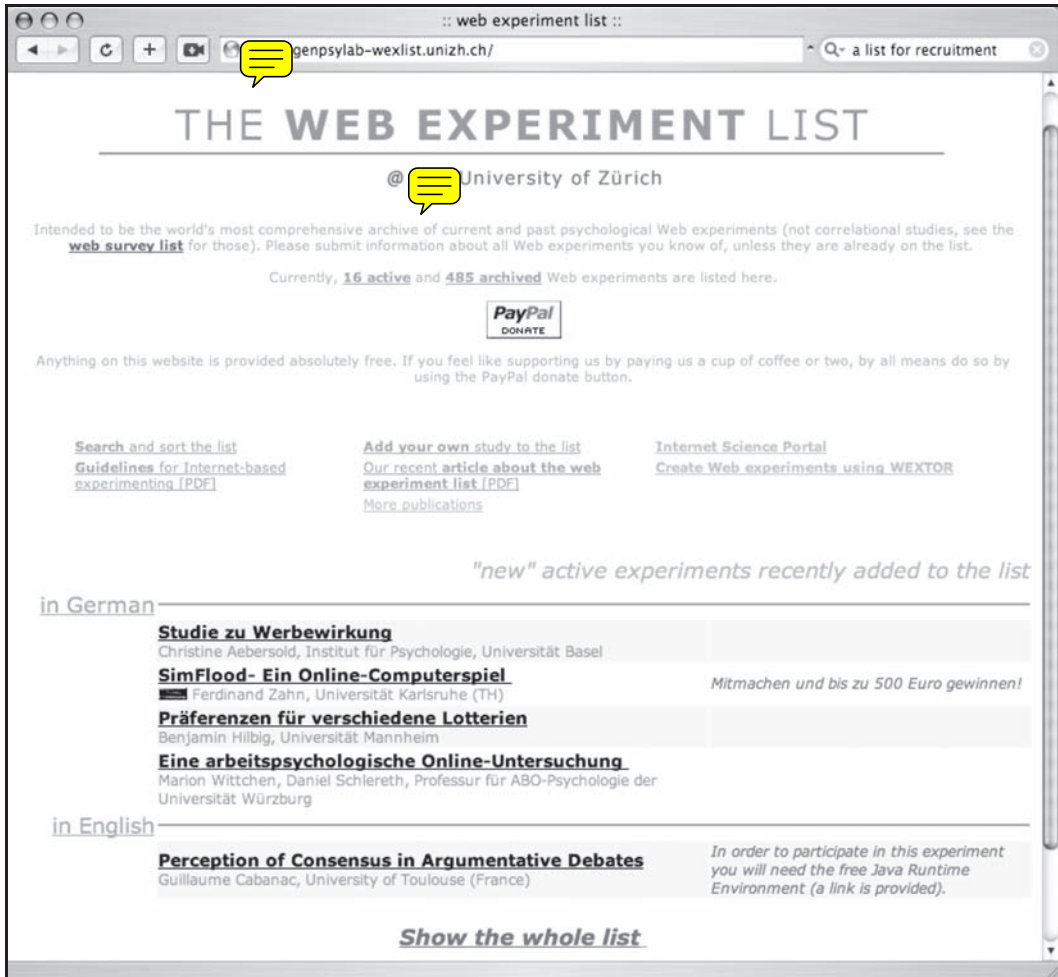
The Web continues to be the primary route for recruitment (Musch & Reips, 2000; Reips & Lengler, 2005). Good places to announce one’s Web experiments are the *exponnet site* and the *Web experiment list* (see Figure 13.6).

Once recruitment is completed, the data can be downloaded from WEXTOR, if WEXTOR was used for hosting of the Web experiment. Data are available in log file format (each access to an item—HTML page, image, and so on—is recorded in a separate line) that can be analyzed with Scientific LogAnalyzer and in semicolon-delimited data file format, suitable for import to spreadsheet software like Excel or SPSS. The data file contains all form data submitted by participants, the path taken through the experiment (e.g., showing whether the “Back” button was used), two different measures of response times per Web page, information about operating system and browser, and a quick view of dropout, among other information.

Techniques

WEXTOR automatically applies several techniques in the background that have been proposed for Internet-based experimenting (Reips, 2000, 2002a, 2002b) and promise to be useful to researchers and supportive to the method’s quality. Some of these techniques have empirically been shown to work, for example, the seriousness check, compliance through early placement of demographic questions (Frick, Bächtiger, & Reips, 2001), the warm-up technique (Reips et al., 2001), double response time measurement (Reips, 2009), and the multiple-site entry technique (Hiskey & Troop, 2002).

FIGURE 13.6



The Web experiment list for recruitment and archiving of Web experiments. Currently, the searchable site contains more than 600 Web experiments, the sister site Web survey list contains more than 450 Web surveys.

TECHNIQUES OF EXPERIMENTAL DESIGN AND PROCEDURE

WEXTOR applied the following in your experiment:

- early versus late placement of demographic questions, resulting in lower dropout and better data quality (Frick et al., 2001), and
- meta tags to keep search engines away from all pages except the first page, so participants do not enter the study on one of the

FIGURE 13.7

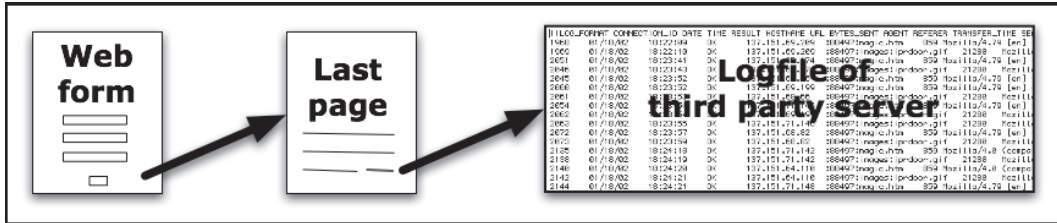


Illustration of Configuration Error II (Reips, 2002a). Study data may easily get transferred to third parties via the “referrer” information in the HTTP protocol, for example, via a link on a study’s last page.

later pages and to prevent the study materials from being cached (good in case you make any changes to your pages):

```

<meta http-equiv=
pragmacontent="no-cache">.
    
```

Reips (2002a) discussed several potential issues with Web experimental design and recommended the following techniques as solutions:

- Protection: Unprotected directories or the wrong choice of operating system and Web server combined with sloppy maintenance may compromise the confidentiality of participant data (Configuration Error I).
- Data transmission procedure: If data transmission occurs via the *GET method*,³ then participants’ form input collected from a Web page may be written to a third-party Web server log file (Configuration Error II). This will routinely happen if the link to the external Web server is two pages after the one with the critical form input, for example, on the last page of an Internet experiment (not unusual; see Figure 13.7). Solutions to the problem are links to other sites only where no data are forwarded to third-party sites and use of the POST method for data transmission.
- Technological variance: Reips (2002a) also discussed a general class of problems coming from the human tendency to ignore the substantial variance in technologies and appearances of Web pages in different browsers (Configuration Error IV). It should thus be standard procedure to pretest one’s Web experiments on a variety of browsers on different operating systems.

³ With the GET method, form data are appended to the URL of the next Web page that is called on by pressing the “Submit” button. Contrary to the past, when POST was inaccessible to the user, both POST and GET data format can be manipulated or switched client side in modern browsers by using add-ons like Tamper Data (<https://addons.mozilla.org/de/firefox/addon/966>).

- Form design: Improper use of form elements (Configuration Error V), unfortunately, is a frequent problem in Internet-based research. For example, in drop-down menus, researchers trained in paper-based questionnaires design all-too-often forget to implement a preselected default option such as “please choose here.” If such an option is missing, then each person who skips the question will be counted in for the first option in the list. A response option also considered important is something like “I don’t want to answer” or “I don’t know how to answer this”—such options will generally help in avoiding wrong or missing answers and therefore lead to better data quality.

For more details on meta tags, question order, and techniques of experimental design with regard to types and formats of *dependent variables* available in Internet research, see chapter 3, this volume. Chapter 3 also explains other issues of design and formatting in Internet-based research.

TECHNIQUES OF DROPOUT HANDLING (WARM-UP, HIGH HURDLE, REPORTING, DROPOUT CURVES)

Dropout (attrition) may be considered a problem in any study, even though it is important to keep in mind that dropout in Internet-mediated research can also be seen as an asset because the higher voluntariness on the Web creates enough variance to use dropout as a detection device or as a dependent variable. Dropout is particularly valuable in experimental research, in which different conditions are compared (Reips, 2000, 2002a, 2002b). Similar accounts can be made for other types of nonresponse (e.g., item nonresponse; Bosnjak, 2001). In this section, we describe several techniques that may be used, depending on whether the researcher intends to reduce, control, or use dropout or its influence.

Reips (2000) listed various background factors that are likely to influence participation and dropout, among them: (a) creating an attractive Web site, (b) emphasizing the site’s trustworthiness, (c) providing a gratification, (d) offering feedback, (e) using a Web design that results in systematic shortening of loading times, (f) providing participants with information about their current position in the time structure of the experiment, and (g) using the high-entrance-barrier or high-hurdle technique.

The *high-hurdle technique* (Reips, 2000) is built on the assumption that participants vary interindividually in their motivation to participate in a Web experiment and that those with lower motivation are more likely to terminate their participation in case of difficulties. Instead of letting the lower motivated participants advance considerably into the study, a motivationally high hurdle is set at the beginning. Only mod-

erately to highly motivated participants are expected to “jump” over it and continue with the study. Theoretically, the hurdle should move dropout from later pages to the hurdle and possibly increase data quality, because lower motivation to participate may also cause participants to respond carelessly.

The technique has been used repeatedly (e.g., Hänggi, 2004; Peden & Flashinski, 2004; Roman, Carvalho, & Piwek, 2006). When the technique is implemented through artificially increased loading times on the first study page, Göritz and Stieger (2008) recently showed that it indeed leads to a higher dropout at the hurdle, but later dropout and data quality appear to be independent of the hurdle.

A simple, but highly effective, technique is the *seriousness check*. Visitors to the first page of the experiment are greeted with the item depicted in Figure 13.5 that you saw on the start.html page in the experiment you created with WEXTOR. Musch, Bröder, and Klauer (2001), who first used this technique, placed the item at the end of their study. Experiments by Reips showed marked differences in dropout that can be predicted using the seriousness check item. If the nonserious answer is defined as an exclusion criterion, a large portion of dropout can be avoided. Experiments built with WEXTOR contain the seriousness check by default.

The *warm-up technique* avoids dropout during the actual experimental phase of a study by presenting the participants with tasks and materials before the experimental manipulation is introduced. Because most who drop out will do so on the first few pages of a Web study, their dropout cannot be attributed to the experimental manipulation if the warm-up technique is used (Reips, 2002a, 2002b). Dropout during the actual experiment was shown to be negligible (about 2%) in a Web experiments on list context effects by Reips et al. (2001).

Dropout is a valuable asset if used as a dependent variable, and it can be used as an indicator for *motivational confounding*, that is, a confounding of experimental manipulation with motivation, task difficulty, or both (Reips, 2000, 2002b). The issue is related to the voluntariness of and eagerness for participation in Internet-based experiments. In the typically remote, anonymous setting in which these experiments take place, there are fewer reasons that keep a participant from dropping out if he or she wishes to do so than in traditional laboratory experiments. There, the levels of a participant’s motivation to engage in the experimental task might be confounded with levels of the independent variable, because those participants who are in the less motivating condition usually will not indicate so by leaving the situation.

By implementing a between-subjects design in the Web experiment, a difference in dropout can thus be used to detect such a motivational confounding. Furthermore, dropout curves can be used to detect differences in task difficulty or task attractiveness. Put as a general rule

for experimenting: The less free participants are to leave the experimental situation, the less likely it is that motivation-related confounding variables will become salient (Reips, 2002b).

A Final Word on Technology

Internet-mediated research may take a variety of technological approaches, such as client side, server side, or a combination of both. Technologies may include HTML, XML, PHP, JavaScript, Java, Flash, and Shockwave, for example. Whichever technology is used on computers, there are several general problems with computer-based research, in particular on Windows (e.g., Myors, 1999; Krantz, 2000; Plant, Hammond, & Whitehouse, 2003; Plant & Turner, 2007). In addition, keep in mind that

- different versions of operating systems differ in vulnerability (Reips, 2002a);
- CRT and LCD monitors show considerable variation in intensity and color both between monitors and across the screen of a single monitor (Krantz, 2000, 2001);
- LCD monitors fare even worse in terms of timing accuracy (Plant & Turner, 2007); and
- computer mice, even of the same model, differ in timing (Plant et al., 2003).

Whenever such hardware and software issues affect an individual computer that is used as the sole device for an entire experiment, then the research is bound to be compromised. Thus, the Internet setting with participants all using their own computers is beneficial in this respect.

Many experiments demand the use of a stimulus that is manipulated in accord with the independent variable being studied. As such, the media capability of the Web is more important for experiments than many other types of research designs. Chapters discussed many of the issues related to the use of Web media for research purposes, and those issues are relevant here. Particularly, consider how media and the variation in access to or software for the media can cause confounds in an experiment. However, the low-tech principle discussed previously in this chapter also applies, perhaps even more strongly, to media. One of the primary ways connections vary is in media capability. As technology on the Web has advanced quickly, the ability of individual people on the Web to use that technology increases much more slowly,

on average. The more important external validity is to the experiment, the simpler the media used should be.

We, for our part, favor the low-tech principle: Turn to solutions that do not need runtime environments or plugins, whenever possible. In plain text: Use HTML, XML, or PHP and maybe JavaScript. JavaScript seems to be sufficiently accurate and precise for millisecond reaction time measurement (Galesic et al., 2007; Reips, 2009; also see Reips et al., 2001), and it is built into every Web browser.

Additional Resources

META SITE

iScience Server (<http://iscience.eu>). This is a free portal to many of the services mentioned below. Hosted by Reips at the University of Deusto in Bilbao, Spain—after three years at the University of Zurich, Switzerland.

STUDY GENERATORS AND EDITORS

WEXTOR: <http://wextor.org>. This free Web application (with a small fee for comfort features), creates laboratory experiments and Web experiments and will work with between-subjects, within-subjects, quasi-experimental, and mixed designs. Many techniques important to Web research are built in. Its user friendly step-by-step process is also great for teaching students. WEXTOR stores and hosts the experimental designs, so you can work on and run your experiments using any type of browser from any computer.

FactorWiz: <http://psych.fullerton.edu/mbirbaum/programs/factorWiz.htm>. This freeware generates HTML pages to conduct within-subject factorial experiments with random order of conditions.

idex: <http://psych-iscience.uzh.ch/idex/index.html>. This freeware is a Web service to create arcade-style game-based Web experiments. Data are immediately available for download.

VAS Generator: <http://www.vasgenerator.net/>. This free web service easily creates visual analogue scales for Web use.

Generic HTML Form Processor: <http://www.goeritz.net/brmic/>. This “Citeware” collects data from Web questionnaires using PHP.

Scientific LogAnalyzer: <http://sclg.eu>. This program is free for small log files in academic use and can analyze any type of log file. It also does dropout analysis.

EXAMPLES, RECRUITMENT, AND ARCHIVING

Decision Research Center: <http://psych.fullerton.edu/mbirnbaum/decisions/thanks.htm>. Several student experiments that are research projects in judgment and decision making, supervised by Michael Birnbaum, one of the leading experts in Internet-based data collection. He writes on the Web page introducing the Decision Research Center: "As with any content you find on the Internet, after you link to a study, you should read the materials and decide for yourself if you want to participate."

Online Psychology Research UK: <http://onlinepsychresearch.co.uk/>. A Web site maintained by Kathryn Gardner at the University of Central Lancashire that is "designed to help researchers in the UK recruit UK participants (international researchers who wish to recruit UK participants are also welcome)." It limits participation to people for whom English is their native language.

Psychological Research on the Net ("Exponnet site"): <http://psych.hanover.edu/research/exponnet.html>. One of the most comprehensive Web sites listing online psychology related studies. The Web site is maintained by the second author at Hanover College.

Socialpsychology Network: <http://www.socialpsychology.org/expts.htm>. A Web site devoted to listing Internet-based data collection efforts specifically in the area of social psychology.

Web Experiment List: <http://wexlist.net>. Together with the "Exponnet list" mentioned above this is the largest list of Internet-based research studies on the Web. Researchers can fill in their own studies to be listed. Studies can be searched by category, language, status (active or not), and type (experiment or correlational study).

Web Experimental Psychology Lab: <http://wexlab.eu>. This was the first virtual laboratory with real data collection via experiments on the World Wide Web, founded in 1995 by the first author. Then located at the University of Tübingen, Germany, it moved to the University of Zurich, Switzerland, in 1997, and since 2009 is located at the University of Deusto in Bilbao, Spain.

Birnbaum, M. H. (2004). Human research and data collection via the Internet. *Annual Review of Psychology*, *55*, 803–832. This article is a comprehensive review of Internet-based research.

Reips, U.-D. (2002b). Standards for Internet-based experimenting. *Experimental Psychology*, *49*, 243–256. The article reviews methods, techniques, and tools for Internet-based experimenting and proposes 16 standards.

Reips, U.-D. (2006). Web-based methods. In M. Eid & E. Diener (Eds.), *Handbook of multimethod measurement in psychology* (pp. 73–85). Washington, DC: American Psychological Association. The chapter discusses Web-based research in the context of multi-method measurement.

References

- Birnbaum, M. H. (2001). A Web-based program of research on decision making. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 23–55). Lengerich, Germany: Pabst Science.
- Birnbaum, M. H. (2004). Human research and data collection via the Internet. *Annual Review of Psychology*, *55*, 803–832.
- Birnbaum, M. H., & Reips, U.-D. (2005). Behavioral research and data collection via the Internet. In R. W. Proctor & K.-P. L. Vu (Eds.), *The handbook of human factors in Web design* (pp. 471–492). Mahwah, NJ: Erlbaum.
- Bordia, P. (1996). Studying verbal interaction on the Internet: The case of rumor transmission research. *Behavior Research Methods, Instruments, and Computers*, *28*, 149–151.
- Bosnjak, M. (2001). Participation in nonrestricted Web surveys: A typology and explanatory model for item nonresponse. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 193–208). Lengerich, Germany: Pabst Science.
- Buchanan, T., Johnson, J. A., & Goldberg, L. R. (2005). Implementing a five-factor personality inventory for use on the Internet. *European Journal of Psychological Assessment*, *21*, 115–127.
- Buchanan, T., & Reips, U.-D. (2001, October 10). Platform-dependent biases in online research: Do Mac users really think different? In K. J. Jonas, P. Breuer, B. Schauenburg, & M. Boos (Eds.), *Perspectives on Internet research: Concepts and methods*. Retrieved December 27, 2001, from <http://www.psych.uni-goettingen.de/congress/gor-2001/contrib/buchanan-tom>
- Buchanan, T., & Smith, J. L. (1999). Using the Internet for psychological research: Personality testing on the World Wide Web. *British Journal of Psychology*, *90*, 125–144.
- Drasgow, F., & Chuah, S. C. (2006). Computer-based testing. In M. Eid & E. Diener (Eds.), *Handbook of multimethod measurement in psychology* (pp. 87–100). Washington, DC: American Psychological Association.
- Frick, A., Bächtiger, M. T., & Reips, U.-D. (2001). Financial incentives, personal information, and dropout in online studies. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 209–219). Lengerich, Germany: Pabst Science.
- Galesic, M., Reips, U.-D., Kaczmirek, L., Czienskowski, U., Liske, N., & von Oertzen, T. (2007, September). *Response time measurements in the lab and on the Web: A comparison*. Paper presented at the annual meeting of the Swiss Society for Psychology, Zurich.
- Görizt, A. S. (2007). Using online panels in psychological research. In A. N. Joinson, K. Y. A. McKenna, T. Postmes, & U.-D. Reips (Eds.),

- The Oxford handbook of Internet psychology* (pp. 473–485). Oxford, England: Oxford University Press.
- Görizt, A. S., & Stieger, S. (2008). The high-hurdle technique put to the test: Failure to find evidence that increasing loading times enhances data quality in Web-based studies. *Behavior Research Methods*, *40*, 322–327.
- Hänggi, Y. (2004). Stress and emotion recognition: An Internet experiment using stress induction. *Swiss Journal of Psychology*, *63*, 113–125.
- Hiskey, S., & Troop, N. A. (2002). Online longitudinal survey research: Viability and participation. *Social Science Computer Review*, *20*, 250–259.
- Horstmann, G. (2003). What do facial expressions convey: Feeling states, behavioral intentions, or action requests? *Emotion*, *3*, 150–166.
- Horswill, M. S., & Coster, M. E. (2001). User-controlled photographic animations, photograph-based questions, and questionnaires: Three instruments for measuring drivers' risk-taking behavior on the Internet. *Behavior Research Methods, Instruments, and Computers*, *33*, 46–58.
- Janssen, S. M. J., Murre, J. M. J., & Meeter, M. (2007). Reminiscence bump in memory for public events. *European Journal of Cognitive Psychology*, *20*, 738–764.
- Joinson, A. N., McKenna, K. Y. A., Postmes, T., & Reips, U.-D. (Eds.). (2007). *The Oxford handbook of Internet psychology*. Oxford, England: Oxford University Press.
- Krantz, J. H. (2000). Tell me, what did you see? The stimulus on computers. *Behavior Research Methods, Instruments, and Computers*, *32*, 221–229.
- Krantz, J. H. (2001). Stimulus delivery on the Web: What can be presented when calibration isn't possible. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 113–130). Lengerich, Germany: Pabst Science.
- Krantz, J. H., Ballard, J., & Scher, J. (1997). Comparing the results of laboratory and World Wide Web samples on the determinants of female attractiveness. *Behavior Research Methods, Instruments, and Computers*, *29*, 264–269.
- Krantz, J. H., & Dalal, R. (2000). Validity of Web-based psychological research. In M. H. Birnbaum (Ed.), *Psychological experiments on the Internet* (pp. 35–60). San Diego, CA: Academic Press.
- Luce, K. H., Winzelberg, A. J., Das, S., Osborne, M. I., Bryson, S. W., & Taylor, C. B. (2007). Reliability of self-report: Paper versus online administration. *Computers in Human Behavior*, *23*, 1384–1389.
- Mangan, M., & Reips, U.-D. (2007). Sleep, sex, and the Web: Surveying the difficult-to-reach clinical population suffering from sexsomnia. *Behavior Research Methods*, *39*, 233–236.
- McKenzie, C. R. M., & Nelson, J. D. (2003). What a speaker's choice of frame reveals: Reference points, frame selection, and framing effects. *Psychonomic Bulletin & Review*, *10*, 596–602.
- Musch, J., Bröder, A., & Klauer, K. C. (2001). Improving survey research on the World Wide Web using the randomized response

- technique. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 179–192). Lengerich, Germany: Pabst Science.
- Musch, J., & Reips, U.-D. (2000). A brief history of Web experimenting. In M. H. Birnbaum (Ed.), *Psychological experiments on the Internet* (pp. 61–88). San Diego, CA: Academic Press.
- Myors, B. (1999). Timing accuracy of PC programs under DOS and Windows. *Behavior Research Methods, Instruments, and Computers*, *31*, 322–328.
- Peden, B. F., & Flashinski, D. P. (2004). Virtual research ethics: A content analysis of surveys and experiments online. In E. Buchanan (Ed.), *Readings in virtual research ethics: Issues and controversies* (pp. 1–26). Hershey, PA: Information Science.
- Plant, R. R., Hammond, N., & Whitehouse, T. (2003). How choice of mouse may affect response timing in psychological studies. *Behavior Research Methods, Instruments, and Computers*, *35*, 276–284.
- Plant, R. R., & Turner, G. (2007, November). *Precision psychological research in a world of commodity computers: New hardware, new problems?* Paper presented at the annual meeting of Society of Competitive Intelligence Professionals, Long Beach, CA.
- Reips, U.-D. (1995). The *Web experiment method*. Retrieved January 6, 2009, from <http://www.psychologie.uzh.ch/sowi/Ulf/Lab/WWWExpMethod.html>
- Reips, U.-D. (2000). The Web experiment method: Advantages, disadvantages, and solutions. In M. H. Birnbaum (Ed.), *Psychological experiments on the Internet* (pp. 89–114). San Diego, CA: Academic Press.
- Reips, U.-D. (2001). The Web Experimental Psychology Lab: Five years of data collection on the Internet. *Behavior Research Methods, Instruments, and Computers*, *33*, 201–211.
- Reips, U.-D. (2002a). Internet-based psychological experimenting: Five *dos* and five *don'ts*. *Social Science Computer Review*, *20*, 241–249.
- Reips, U.-D. (2002b). Standards for Internet-based experimenting. *Experimental Psychology*, *49*, 243–256.
- Reips, U.-D. (2003, September). *Seamless from concepts to results: Experimental Internet science*. Paper presented at the biannual conference on Subjective Probability, Utility and Decision Making (SPUDM), Zurich, Switzerland. Retrieved August 12, 2009, from http://www.psychologie.uzh.ch/sowi/reips/SPUDM_03/
- Reips, U.-D. (2006). Web-based methods. In M. Eid & E. Diener (Eds.), *Handbook of multimethod measurement in psychology* (pp. 73–85). Washington, DC: American Psychological Association.
- Reips, U.-D. (2007). The methodology of Internet-based experiments. In A. Joinson, K. McKenna, T. Postmes, & U.-D. Reips (Eds.), *The Oxford handbook of Internet psychology* (pp. 373–390). Oxford, England: Oxford University Press.
- Reips, U.-D. (2009). *Reaction times in Internet-based versus laboratory research: Potential problems and a solution*. Manuscript submitted for publication.

- Reips, U.-D., & Funke, F. (2008). Interval-level measurement with visual analogue scales in Internet-based research: VAS Generator. *Behavior Research Methods, 40*, 699–704.
- Reips, U.-D., & Lengler, R. (2005). The Web Experiment List: A Web service for the recruitment of participants and archiving of Internet-based experiments. *Behavior Research Methods, 37*, 287–292.
- Reips, U.-D., Morger, V., & Meier B. (2001). "Fünfe gerade sein lassen": *Listenkontexteffekte beim Kategorisieren* ["Letting five be equal": List context effects in categorization]. Unpublished manuscript, available at <http://tinyurl.com/24wfmw>
- Reips, U.-D., & Neuhaus, C. (2002). WEXTOR: A Web-based tool for generating and visualizing experimental designs and procedures. *Behavior Research Methods, Instruments, and Computers, 34*, 234–240.
- Reips, U.-D., & Stieger, S. (2004). Scientific LogAnalyzer: A Web-based tool for analyses of server log files in psychological research. *Behavior Research Methods, Instruments, and Computers, 36*, 304–311.
- Rhodes S. D., Bowie D. A., & Hergenrath, K. C. (2003). Collecting behavioural data using the World Wide Web: Considerations for researchers. *Journal of Epidemiology and Community Health, 57*, 68–73.
- Rodgers, J., Buchanan, T., Scholey, A. B., Heffernan, T. M., Ling, J., & Parrott, A. C. (2001). Differential effects of Ecstasy and cannabis on self-reports of memory ability: A Web-based study. *Human Psychopharmacology: Clinical and Experimental, 16*, 619–625.
- Rodgers, J., Buchanan, T., Scholey, A. B., Heffernan, T. M., Ling, J., & Parrott, A. C. (2003). Patterns of drug use and the influence of gender on self reports of memory ability in ecstasy users: A Web-based study. *Journal of Psychopharmacology, 17*, 389–396.
- Roman, N. T., Carvalho, A. M. B. R., & Piwek, P. (2006). *A Web-experiment on dialogue classification*. Paper presented at the Workshop on the Economics of Information Security (WEIS), Cambridge, England.
- Schmidt, W. C. (1997). World Wide Web survey research: Benefits, potential problems, and solutions. *Behavior Research Methods, Instruments, and Computers, 29*, 274–279.
- Schmidt, W. C. (2007). Technical considerations when implementing online research. In A. N. Joinson, K. Y. A. McKenna, T. Postmes, & U.-D. Reips (Eds.), *The Oxford handbook of Internet psychology* (pp. 461–472). Oxford, England: Oxford University Press.
- Schwarz, S., & Reips, U.-D. (2001). CGI versus JavaScript: A Web experiment on the reversed hindsight bias. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 75–90). Lengerich, Germany: Pabst Science.
- Whitaker, B. G., & McKinney, J. L. (2007). Assessing the measurement invariance of latent job satisfaction ratings across survey administration modes for respondent subgroups: A MIMIC modeling approach. *Behavior Research Methods, 39*, 502–509.