Internet-Based Psychological Experimenting

Five Dos and Five Don'ts

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Internet-based psychological experimenting is presented as a method that needs careful consideration of a number of issues—from potential data corruption to revealing confidential information about participants. Ten issues are grouped into five areas of actions to be taken when developing an Internet experiment (dos) and five errors to be avoided (don'ts). Dos include: (a) utilizing dropout as a dependent variable, (b) the use of dropout to detect motivational confounding, (c) placement of questions for personal information, (d) using a collection of techniques, and (e) using Internet-based tools. Don'ts are about: (a) unprotected directories, (b) public access to confidential data, (c) revealing the experiment's structure, (d) ignoring the Internet's technical variance, and (e) improper use of form elements.

Keywords: Internet-based research, online research techniques, configuration errors, web experiment

INTRODUCTION

The history of Internet-based research is still young, but its methods are already used widely and with great enthusiasm (Musch & Reips, 2000). However, much of the new methodology has not been integrated into the curricula in the behavioral and social sciences, neither for Internet-based surveying nor for Internet-based psychological experimenting.[1] In the 1970s, experimental laboratory research was revolutionized by the introduction of computers (e.g., Connes, 1972; Hoggatt, 1977). Computerized research allows for standardized and controlled presentation of stimuli, accurate measurements of response times, item-branching capabilities, elimination of transcription costs and errors, reduction of the tendency to respond in a socially desirable way (e.g., Booth-Kewley, Edwards, & Rosenfeld, 1992), and avoidance of experimenter biases and demand characteristics (Reips, 2000).

The Internet revolution in experimental research that happened in the mid-1990s of the past century immediately promised further methodological and procedural advantages (Buchanan & Smith, 1999; Hewson, Laurent, & Vogel, 1996; Reips, 1995, 1996, 2000; Schmidt, 1997; Smith & Leigh, 1997). Using the worldwide network for experimental research became the method of choice for a small number of pioneers and a method of appeal and many questions (if not questionable appeal) for a large number of social scientists. Within this article I am hoping to answer some of these questions.

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FIVE DOS IN INTERNET EXPERIMENTING

Naturally, there are a number of practical decisions that one has to make when setting up an Internet experiment or survey. What follows from promising financial incentives to participants? Is it better to place personal questions about demographic information at the beginning or at the end of a study? How is it best to deal with multiple submissions? Are there ways to prevent dropout and, if not, how will it influence data quality?

How to Make Use of Dropout:
Use It as a Dependent Variable!

Dropout is the type of noncompliance that is mainly about the decision not to continue participation, in contrast to the decision about beginning the participation in a study, which is called self-selection.[2] (For an elaborate discussion of five other forms of noncompliance in Internet studies, see Bosnjak [2001]). Dropout is mainly a problem if it is systematic: Some participants selectively drop out, for example, people who dislike the subject that an Internet study is about. If the systematic dropout coincides with an experimental manipulation, then the study in many cases is severely compromised.

Musch and Reips (2000) found that the average dropout rate in Internet experiments is 34% (median = 35%), with a range from 1% to 87%. The large range suggests that there are other motivational factors that influence dropout, some of which were examined empirically. Musch and Reips showed that completion of Internet experiments was 86% if some form of reward (individual payments or lottery prizes) was offered, up from 55% without such rewards. This result inspired Frick, Bächtiger, and Reips (2001) to test the following factors' influence on dropout rates experimentally: placement of assessment of personal information (PI) and information about financial incentives for participation (FI). They manipulated these two factors in an Internet experiment and found the following dropout rates: 5.7% in the condition with PI and FI at the beginning of the experiment, 13.2% with PI at the end and FI at the start, 14.9% with PI at the start and no FI, and 21.9% with PI at the end and no FI condition. Other evidence from their experiment suggests that there are other factors that potentially lead to a participant's dropout, and that early PI and FI reduce those factors' influence.[3] Dropout in self-selected within-subjects designs poses a serious threat to the validity of this type of research, unless an attempt is made to control for systematic dropout by varying the order of experimental conditions (which means introducing a between-subjects factor).

How to Make Use of Dropout:
Detect Motivational Confounding!

In between-subjects designs, dropout can be turned into a tool for detecting confounding. The less free participants are to leave the experimental situation, the less likely it is that compliance-related confounding variables would become salient. Consequently, the high level of volunteer willingness in Internet experiments allows for detecting confounds with variables that potentially decrease compliance. Participants in a less motivating, boring, or very difficult experimental condition might very likely drop out of an Internet experiment. In a laboratory experiment these participants might have stayed due to, for example, course credit considerations. In this case, the laboratory experiment data would be contaminated by motivational confounding, whereas the Internet experiment data would allow for detection of this effect. Only between-subjects Internet experiments with voluntary participation have

a built-in detection device for this type of confounding; within-subject designs need to be turned into mixed designs by at least adding the between-subjects factor "order of level presentation." The detection device works with the exception of the rare case when participants drop out of different conditions for different reasons (Birnbaum & Mellers, 1989). Therefore, it is best to check dropouts for any correlations of demographic or other background variables with the experimental conditions. Of course, this procedure requires assessment of these variables before introduction of conditions. It is good practice to always report dropout rates for all conditions in Internet-based research!

Place Questions for Personal Information at the Beginning of Your Internet Study

The evidence described above suggests that placing questions for personal information at the beginning of an Internet study will lower dropout rates. Frick et al. (2001) also found better compliance (more complete responses) for those participants who were asked the questions for personal information at the beginning of the experiment. This example illustrates a whole class of "new sources of measurement error" (Dillman & Bowker, 2001) that needs to be addressed in Internet research.

Use Techniques That Help Ensure Quality in Data Collection Over the Internet

During several years of practice with Internet-based research, a number of techniques were developed that help in avoiding methodological pitfalls when collecting data online. Such techniques include: (a) warm-up for avoiding dropout during the experimental stage; (b) high hurdle moves dropout to the beginning of an Internet-based study; (c) subsampling helps control for consistency of data and allows for an estimate of false responses; (d) using the multiple site entry technique helps detect potential sampling problems including those originating from self-selection; (e) single-use password techniques ensure data integrity; (f) personalized Universal Resource Locators (URLs) help track response patterns and allow avoiding multiple submissions when used in combination with the fifth point; (g) analyzing dropout to control for motivational confounding; (h) nonobvious file naming; (i) providing contact information; (j) randomization and pseudo-randomization of conditions and items, for example, to avoid context effects (Reips, in press-a); and (k) dropout reducing design, unless dropout is a dependent variable. For an introduction to these techniques, see Reips (2000, in press-b).

Use Internet-Based Tools and Services to Develop and Announce Your Study

The Internet holds a number of web sites that list and sometimes review software for Internet studies, for example, WebSM for Internet survey software (`http://www.websm.org/companiesoft.html`). Despite 7 years of Internet experimenting, software that is specially designed for Internet-based experimenting is still rare. Seeing the need, we developed WEXTOR, a web-based system for developing experiments and Internet experiments (Reips & Neuhaus, 2000, in press). WEXTOR also visualizes and teaches experimental design and is available at `http://www.genpsylab.unizh.ch/wextor/index.html`.

Once an Internet experiment is designed and online, it needs to be announced. Good places for such announcements are lists of Internet-based experiments, such as the web experiment list (`http://www.genpsy.unizh.ch/Ulf/Lab/webexplist. html`) or the American Psychological Society (APS) experiment list (`http://psych. hanover.edu/APS/exponnet.html`) maintained by John Krantz. Virtual laboratories such as the Cognitive Psychology Online Laboratory (Francis, Neath, & Surprenant, 2000), PsychExps (McGraw, Tew, & Williams, 2000), or the Web Experimental Psychology Lab (Reips, 2001a) offer more service than these lists, but they also require more commitment from researchers. The Web Experimental Psychology Lab is available at `http://www.genpsylab.unizh.ch`. It went online in 1995 and invites participation by or cooperation with other researchers conducting Internet experiments that can be hosted by the lab. Even after completion, most Internet experiments are accessible in the Web lab's archive.[4] Once a study is online, one may use a free tracking service (e.g., Extreme Digital, 2001) to collect Internet traffic data in addition to relying on one's own server log files.

FIVE DON'TS IN INTERNET EXPERIMENTING

There are an increasing number of Internet studies; however, very few institutions are teaching the specifics of the new related methods. As a consequence, five configuration errors can frequently be observed, some of which may have severe consequences. These typical errors are presented below.

Do Not Allow External Access to Unprotected Directories

Allowing external access to unprotected directories is considered configuration error number one (Reips, 2001b). Making this configuration error may have very severe consequences. A possible ethically and legally critical consequence of this error is the direct worldwide accessibility to confidential participant data. A second, less important problem with unprotected directories may be that participants are able to see an Internet experiment's structure. Knowing an experiment's structure may influence one's behavior in that experiment. Unfortunately, this severe error is highly frequent: In the second half of the year 2000, up to one third of external Internet experiments submitted to the Web Experimental Psychology Lab were subject to the problem! What can be done to avoid Configuration Error I? On many systems, a quick fix to the problem is placing a file named `index.html` into each of the directories. Also, one should contact the local web administrator and have that person and some Internet-witty colleagues and friends check the study for security problems.

Even without making a configuration error, confidential data might become available to knowledgeable people on the Internet (e.g., hackers). Web server programs and the operating systems they are running on can become vulnerable to intruders (see Figure 1; see also Dickey, 1999). It is an Internet researcher's responsibility to make the right choice of operating system and web server to protect participant data.

Do Not Allow Public Display of Confidential Participant Data Through URLs

This frequent configuration error may happen if the GET method is used for transmitting data that participants put into form fields (so-called search arguments) on a web page.[5] If data transmission occurs via the GET method, then search arguments collected from a web page
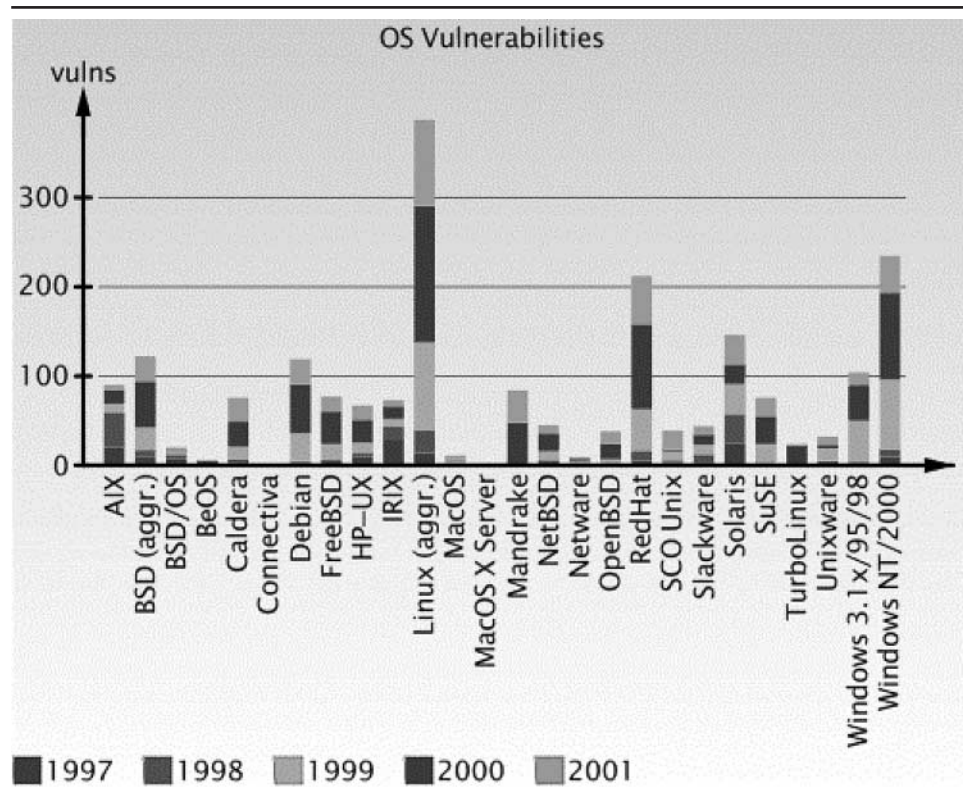
Figure 1:   Vulnerabilities in Operating Systems
SOURCE: Permission to reprint granted from Securityfocus.com (n.d.).

may be written to a third-party web server log file, for example, a search engine or a web site visit counter. This will routinely happen if the link to the external web server is on the last page of an Internet experiment (nothing one would consider unusual) and if some data were collected on the previous page. What can be done to avoid Configuration Error II? Consider using the POST method for data transmission or make sure no critical information is asked on the second-to-last page of an Internet study.

Do Not Accidentally Reveal
the Experiment's Structure

For one's own orientation during the design process, it seemingly helps to name and number elements of an Internet study in a logical and consecutive manner (e.g., `A1.html`, `A2.html`, `B1.html`, `B2.html`). However, if directories, file names, and form elements are constructed this way, then changing just one character in a name will call another existing file. The participant would then produce data in two different experimental conditions or find out about the experiment's structure. Knowing the experiment's structure may change participant behavior and thus introduce a bias. Configuration Error III is probably not much of a problem in most cases, as only very few participants may make an attempt to change URLs.

One should routinely check the experiment log files for patterns if structure-relevant naming is used in the study materials (Configuration Error III could also be exploited by automatic robots and scripts). Of course, best practice is to avoid structure-relevant naming at all and use a mixture of logical and random letters and numbers, such as automatically implemented by WEXTOR (Reips & Neuhaus, 2000, in press).

Do Not Ignore the Technical Variance
Inherent in the Internet

Configuration Error IV results from ignoring the technical variance present in the Internet. In reality, this is a whole group of configuration errors addressing lack of attention to differences in web browsers, net connections, hardware components, and so forth. For example, dropout can result from interactions between certain web browser versions and incompatible elements on web pages (Schwarz & Reips, 2001). Time measurements are often inaccurate (Eichstaedt, 2001). The only solution to Configuration Error IV is a general awareness of technical variance during the building stages of the web site associated with one's Internet study. It is advised to test a site with a variety of different web browsers running under different operating systems. These tests should be performed under different network conditions, for example, by slow modem and by T1 line.

Do Not Bias Results Through
Improper Use of Form Elements

There are several ways how improper use of form elements may lead to biased results. Unfortunately, this fifth configuration error is highly frequent. For example, if a preselected neutral choice is missing in multiple choice questions, then each time a respondent does not make a choice will be counted as one of the options. Preselected neutral choices could be labeled "choose here" or plainly be left empty. Birnbaum (2001) recommended placing a preselected, unlabelled neutral radio button in front of the question whenever radio buttons are used as the answering format. This format easily allows the respondent to spot questions that have not been answered yet.

For many purposes, it may be wise to separate intention from carelessness: The case in which no answer is given should be preselected and could be named "choose here" in pop-up menus, whereas the case in which a respondent explicitly does not intend to give an answer would be labeled "do not want to answer." Figure 2 shows proper and improper ways of labeling a pop-up menu.

A second source of error from improper design of form fields frequently happens when creating the HTML code for several questions or scales within the same web page. The naming of form elements needs to be done very carefully, so as to not give identical names to more than one element. For example, consider the following scenario: A set of radio buttons in a question for the respondent's gender on top of the page is named "sex" (with the values "m," "f," and "do not want to answer"). None of the answers is preselected. Further down the page, the respondent is asked about his or her frequency of sex per week. If the corresponding set of radio buttons were also named "sex," then each time a respondent would respond to this question the earlier answer in the gender question would be erased, because web browsers would treat all answers from both questions as belonging to the same set. This configuration error can lead to subtle biasing of results, especially with questions for information often considered private, such as in our example. If men tend to answer more frequently to ques-
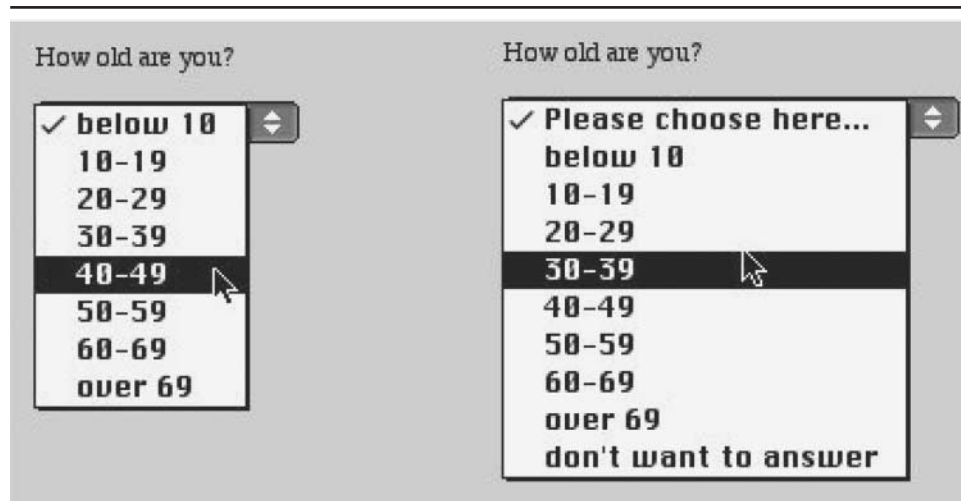
Figure 2:   Improper (left side) and Proper (right side) Ways of Labeling Pop-Up Menus in Internet-Based Research

tions for sexual behavior than women, then the number of men participating in the study will be more underestimated than the number of women. Also, if missing cases are excluded or extrapolated during statistical analyses, all conclusions on gender differences for the other questions will be based on only those people who did not respond to the frequency of sex question.

CONCLUSION

Internet-based research is prone to a number of configuration errors and also offers the chance to utilize Internet-specific characteristics to the advancement of scientific methods. Many of the necessary techniques, the dos, are still not widely known, and many configuration errors, the don'ts, are made. Therefore, an effort should take place to speedily include the new Internet-related methods, such as web-based psychological experimenting, in university curricula.

NOTES

1. The term *Internet experiment* is largely synonymous with the widely used terms *web experiment*, *online experiment*, *web-based experiment*, *World Wide Web [WWW] experiment*, and *Internet-based experiment*, because experiments using Internet services other than the WWW (such as e-mail, ICQ, Telnet, Gopher, FTP, etc.) are rarely conducted. For consistency in this issue of *Social Science Computer Review*, the term *Internet experiment* is used in this article, although some of its content only applies to experiments conducted on the WWW.

2. A small percentage of dropout is caused by technical problems, for example, when Javascript is used in the study (Schwarz & Reips, 2001; see also Buchanan & Reips, 2001).

3. O'Neil and Penrod (2001) were not able to replicate these findings. Their experimental design differed in several important points from the one used by Frick, Bächtiger, and Reips (2001), however. Participants were asked to make a decision on severe issues (the application of the death penalty in a specific case), they were asked to answer dozens of questions (which they all had to complete to be able to continue doing the study), and the overall length of the study was close to an hour compared to about 4 minutes in the study by Frick et al. (2001). O'Neil and Penrod (2001) did not report absolute dropout rates.

4. See `http://www.genpsy.unizh.ch/Ulf/Lab/WebLabDokuE.html`.

5. The GET method is a request method in http—the WWW transmission protocol. The three most often used methods are GET, HEAD, and POST. The GET method is used to ask for a specific document—when you click on a hyperlink, GET is being used. Information from a form using the GET method is appended onto the end of the action address being requested; for example, in `http://www.genpsylab.unizh.ch?sscore=this`, the answer "this" in an item "sscore" was appended to the URL of the web page that a user's action (pressing a submit button, etc.) leads to.

REFERENCES

Birnbaum, M. H. (2001). *Introduction to behavioral research on the Internet*. Upper Saddle River, NJ: Prentice Hall.

Birnbaum, M. H., & Mellers, B. A. (1989). Mediated models for the analysis of confounded variables and self-selected samples. *Journal of Educational Statistics*, *14*, 146-158.

Booth-Kewley, S., Edwards, J., & Rosenfeld, P. (1992). Impression management, social desirability, and computer administration of attitude questionnaires: Does the computer make a difference? *Journal of Applied Psychology*, *77*, 562-566.

Bosnjak, M. (2001). Participation in non-restricted web surveys: A typology and explanatory model for item non-response. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 193-208). Lengerich, Germany: Pabst Science.

Buchanan, T., & Reips, U.-D. (2001). 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://server3.uni-psych.gwdg.de/gor/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.

Connes, B. (1972). The use of electronic desk computers in psychological experiments. *Journal of Structural Learning*, *3*, 51-72.

Dickey, C. E. (1999). *Web page hacker arrested, government sites becoming more secure*. Retrieved December 29, 2001, from `http://www.dtic.mil/armylink/news/Sep1999/a19990901hacker.html`

Dillman, D. A., & Bowker, D. K. (2001). The web questionnaire challenge to survey methodologists. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 159-178). Lengerich, Germany: Pabst Science.

Eichstaedt, J. (2001). Reaction time measurement by JAVA-applets implementing Internet-based experiments. *Behavior Research Methods, Instruments, & Computers*, *33*, 179-186.

Extreme Digital. (2001). *Extreme tracking*. Retrieved December 29, 2001, from `http://www.extreme-dm.com/tracking/`

Francis, G., Neath, I., & Surprenant, A. (2000). The Cognitive Psychology Online Laboratory. In M. H. Birnbaum (Ed.), *Psychological experiments on the Internet* (pp. 267-283). San Diego, CA: Academic Press.

Frick, A., Bächtiger, M. T., & Reips, U.-D. (2001). Financial incentives, personal information, and drop out in online studies. In U.-D. Reips & M. Bosnjak (Eds.), *Dimensions of Internet science* (pp. 209-219). Lengerich, Germany: Pabst Science.

Hewson, C. M., Laurent, D., & Vogel, C. M. (1996). Proper methodologies for psychological and sociological studies conducted via the Internet. *Behavior Research Methods, Instruments, & Computers*, *28*, 186-191.

Hoggatt, A. C. (1977). On the uses of computers for experimental control and data acquisition. *American Behavioral Scientist*, *20*, 347-365.

McGraw, K. O., Tew, M. D., & Williams, J. E. (2000). An online psychology laboratory. In M. H. Birnbaum (Ed.), *Psychological experiments on the Internet* (pp. 219-233). San Diego, CA: Academic Press.

Musch, J., & Reips, U.-D. (2000). A brief history of web experimenting. In M. H. Birnbaum (Ed.), *Psychological experiments on the Internet* (pp. 61-85). San Diego, CA: Academic Press.

O'Neil, K. M., & Penrod, S. D. (2001). Methodological variables in web-based research that may affect results: Sample type, monetary incentives, and personal information. *Behavior Research Methods, Instruments, and Computers*, *33*, 226-233.

Reips, U.-D. (1995). *The web experiment method*. Retrieved January 6, 2002, from `http://www.genpsy.unizh.ch/Ulf/Lab/WWWExpMethod.html`

Reips, U.-D. (1996, April). Experimentieren im World Wide Web [Experimenting in the World Wide Web]. *Experimentelle Psychologie: Tagung experimentell arbeitender Psychologen*, *38*, 256-257.

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. (2001a). 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. (2001b). Web-Experimente: Eckpfeiler der Online-Forschung [Web experiments: Cornerstone of online research]. In A. Theobald, M. Dreyer, & T. Starsetzki (Eds.), *Online-Marktforschung: Theoretische Grundlagen und praktische Erfahrungen* (pp. 97-112). Wiesbaden, Germany: Gabler.

Reips, U.-D. (in press-a). Context effects in web surveys. In B. Batinic, U.-D. Reips, & M. Bosnjak (Eds.), *Online social sciences*. Seattle, WA: Hogrefe & Huber.

Reips, U.-D. (in press-b). Theory and techniques of web experimenting. In B. Batinic, U.-D. Reips, & M. Bosnjak (Eds.), *Online social sciences*. Seattle, WA: Hogrefe & Huber.

Reips, U.-D., & Neuhaus, C. (2000). *WEXTOR, the interactive web experiment creator.* Retrieved from `http://www.genpsylab.unizh.ch/wextor/index.html`

Reips, U.-D., & Neuhaus, C. (in press). WEXTOR: A Web-based tool for generating and visualizing experimental designs and procedures. *Behavior Research Methods, Instruments, and Computers*.

Schmidt, W. C. (1997). World Wide Web survey research: Benefits, potential problems, and solutions. *Behavior Research Methods, Instruments, and Computers*, *29*, 274-279.

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.

Securityfocus.com. (n.d.). *BUGTRAQ vulnerability database statistics*. Retrieved February 28, 2002, from `http://online.securityfocus.com/images/vdb/vperos2.gif`

Smith, M., & Leigh, B. (1997). Virtual subjects: Using the Internet as an alternative source of subjects and research environment. *Behavior Research Methods, Instruments, and Computers*, *29*, 496-505.

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