

Handle with Care: The Impact of Using Java Applets in Web-Based Studies on Dropout and Sample Composition

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Abstract

In web-based studies, web browsers are used to display online questionnaires. If an online questionnaire relies on non-standard technologies (e.g., Java applets), it is often necessary to install a particular browser plug-in. This can lead to technically induced dropout because some participants lack the technological know-how or the willingness to install the plug-in. In two thematically identical online studies conducted across two time points in two different participant pools ($N = 1,527$ and 805), we analyzed whether using a Java applet produces dropout and distortion of demographics in the final sample. Dropout was significantly higher on the Java applet questionnaire page than on the preceding and subsequent questionnaire pages. Age-specific effects were found only in one sample (i.e., dropouts were older), whereas sex-specific effects were found in both samples (i.e., women dropped out more frequently than men on the Java applet page). These results additionally support the recommendation that using additional technologies (e.g., Java applets) can be dangerous in producing a sample that is biased toward both younger and male respondents.

Introduction

USING THE INTERNET FOR DATA COLLECTION is now well established. Many preconceptions, such as "Samples of Internet users are maladjusted, socially isolated, or depressed"¹ were not confirmed and are now regarded as myths.² Although Internet samples can be particular in some respects, such as diversity in demographics (e.g., geographical region, race, religion), data quality has been shown to be comparable to more traditional modes of data collection.² Nevertheless, there are some precautions that have to be taken when planning to collect data online.³ One of these precautions is to use web technologies other than HTML sparingly because this can cause technologically induced error.³⁻⁸

Web browsers are programs that interpret HTML. If technologies other than HTML are used such as JavaScript, Java applets, or audio/video players, the installation of additional software or plug-ins is often necessary. Most web browsers come with these technologies preinstalled, but this does not guarantee that these technologies function properly. Consequently, making use of these technologies in web-based studies can induce dropout because of the additional hurdle of installing the plug-in. There are two possible reasons for not installing the plug-in: participants' unwillingness to invest extra time, and/or their missing technological know-how. Variability in the collected data attributable to technology has

been termed "technical variance" by Reips.^{3,4} This technology-related variance may be due to different technology-related aspects, such as bandwidth, computer monitors (size, color), and other factors. Furthermore, any programming error in an online questionnaire can lead to systematic exclusion of participants and as such can impact data quality.⁵ Although technology-related variance can potentially influence the outcome of the study, little research has been done on the impact of technology-related variance on dropout and sample composition.

What is known is that using JavaScript increases dropout⁶ and skews demographics. With regard to sample composition, Buchanan and Reips⁷ found that respondents who had JavaScript enabled were less educated than those who had JavaScript disabled because more educated participants know how to turn off JavaScript and Java in their web browsers. Thus, although JavaScript is probably the most widely implemented technology in most web browsers, it seems to lead to distortions of participant demographics, which in turn can affect study outcomes. Although this is a severe problem for any discipline that collects data via the web, there is almost no empirical evidence that elucidates this matter further.

Java is another commonly used web technology. Java programs that run in web browsers are called Java applets. In academic research, Java applets are commonly used for

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reaction-time measurements on the web (e.g., the Implicit Association Test).⁹ To date, no study is available on the influence of Java applets on dropout and demographics. To address this gap, we conducted and analyzed two thematically identical studies across two time points using two different samples.

Method

Participants and procedure

Individuals from two different subject pools (UNET: students of the University of Vienna; WiSo-Panel:¹⁰ German-speaking volunteers from all walks of life) were invited to participate in an online study via e-mail. As we providing invitees with a personal key enabling automatic login to the questionnaire, we were able to cull multiple submissions, as well as participants who entered implausible data on their age and sex (validated through demographics known from the panel registration and the pool of UNET users).¹¹ A retest took place 5 months after the initial test.

Of the 8,083 invitations that were sent out successfully for the initial test, 2,362 unique visitors called up the first page (yielding a response rate of 29%), and 2,332 data sets (UNET: $n = 1,527$; WiSo: $n = 805$) remained for analysis after data cleaning (i.e., we excluded data of people who simply clicked through the questionnaire or failed a test of face validity, for example, because they provided implausible answers). For the retest, only those participants were invited who had taken the Java-based implicit measures in the initial test ($n = 2,106$). The first page of the retest was loaded by 1,540 unique participants (yielding a response rate of 73%). After data cleaning, 1,526 datasets remained for further analysis (UNET: $n = 903$; WiSo: $n = 623$). The sample from the initial test did not differ in age ($M = 29$ years, $SD = 9$) and sex (45% women) from the retest sample indicating that there was no self-selection bias—at least with regard to age and sex—between the two time points.

In the present two studies, to maintain the highest possible compatibility with different Java versions, we compiled our Java applet with the oldest Java compiler with which our applet was able to run (i.e., Java Development Kit JDK 1.1.8). Furthermore, if the plug-in was not installed on a participant's browser, an automatic download was initiated by the web browser. In cases where the automatic installation failed, we provided participants with detailed instructions on a separate HTML page on how to install and to enable Java applets on the web browser in question. To speed up the downloading of these installation files, we preloaded the most common versions of Java on our server.

Materials

Beside the topic of the study, participants were explicitly informed that Java needed to be enabled to view the association test properly (i.e., Java had to be enabled in the browser, with a short instruction of how to achieve this; browser window should be maximized; the currently most used web browsers should be given preference [At the time of data collection, these were Internet Explorer and Netscape Navigator]). Afterwards, demographic data were queried, that is, sex, age, and field of study (the latter was only asked in the UNET sample because the WiSo-Panel holds many non-student panelists). Furthermore, in a between-subject design, participants were asked to take part in one of two randomly assigned implicit association tests (i.e., either an Implicit Association Test [IAT] on anxiety^{12,13} or two shorter Single Category Implicit Association Tests [SC-IAT] on anxiety and calmness¹⁴). All of these tests were implemented as a Java applet. In addition, all participants were presented with the trait subtest of the State-Trait Anxiety Inventory (STAI)¹⁵ as an explicit (i.e., questionnaire-based) measure of anxiety. Toward the end, participants could make open-ended comments before being thanked and debriefed. The entire questionnaire was presented in a one-item, one-screen fashion. Therefore, it was possible to determine on exactly which question participants dropped out of the questionnaire. To avoid any confounds deriving from the concurrent use of other web technologies (e.g., JavaScript), in these questionnaires, we exclusively relied on Java.

Results

Dropout

To disentangle dropout due to motivational reasons and dropout due to technological reasons, we compared the dropout before and after the Java applet page where only HTML was used (i.e., mainly motivationally induced dropout) with the Java applet page itself (i.e., motivationally and technologically induced dropout). The dropout on the Java applet page was 2.7 (UNET) and 4.3 (WiSo) times higher than on the four pages before the Java applet, which asked about demographics and contained instructions (see Table 1). Moreover, on the Java applet page, dropout was 25.8 (UNET) and 23.9 (WiSo) times higher than on the next three pages, which included the STAI and several open-ended questions (see Table 1).

In the retest, dropout was 5.5 (UNET) and 1.8 (WiSo) times higher on the Java applet page than on the first four pages, and 6.0 (UNET) and 5.4 (WiSo) times higher than on the subsequent three pages (see Table 1).

TABLE 1. DROPOUT BEFORE, ON, AND AFTER THE ONLINE QUESTIONNAIRE PAGE WHERE THE JAVA APPLET WAS USED

Subject pool		Before the Java applet page (mean %)	On the Java applet page (%)	After the Java applet page (mean %)	χ^2 before vs. on	χ^2 on vs. after
#1 (UNET students)	Initial test	9.4	25.8	1.0	116.2***	348.5***
	Retest	2.5	13.7	2.3	69.4***	73.2***
#2 (WiSo-Panel)	Initial test	5.0	21.5	0.9	83.0***	153.1***
	Retest	7.9	14.6	2.7	12.6***	50.7***

*** $p < 0.001$.

Demographics

In the homogeneous UNET student sample, participants who dropped out on the Java applet page did not differ in age from those who did not drop out ($t[1370] = 0.76$, $p = 0.45$, Cohen's $d = 0.05$), whereas in the heterogeneous WiSo-Panel, participants who dropped out on the Java applet page were 2.3 years older than those who were retained ($t[762] = 2.50$, $p = 0.01$, $d = 0.21$). In both samples, dropout was related to participants' sex (UNET: Odds Ratio $OR = 1.33$, $p = 0.03$, 95% $CI [1.05, 1.69]$; WiSo: $OR = 1.49$, $p = 0.02$, 95% $CI [1.06, 2.10]$). Women were more likely than men to drop out on the Java applet page. In the retest, in both samples, dropouts and retainees did not significantly differ in age (UNET: $t[176.1] = -1.66$, $p = 0.10$, $d = 0.16$; WiSo: $t[620] = -1.35$, $p = 0.18$, $d = 0.13$) and sex (UNET: $OR = 1.42$, $p = 0.07$, 95% $CI [0.99, 2.03]$; WiSo: $OR = 0.97$, $p = 0.92$, 95% $CI [0.66, 1.41]$).

Discussion

Apart from JavaScript and Flash, Java applets are one of the most widely used client-side web technologies. Therefore, we analyzed whether using Java applets had an impact on dropout and sample composition in a test-retest design in two large online samples ($n > 800$) from two different communities (UNET: homogeneous students, who were not self-selected; WiSo: individuals from all walks of life, who volunteered in the panel). We found that although many web browsers come with some preinstalled web technologies, relying on technologies such as Java applets for collecting data online distorts the sample toward younger and male participants.

Despite the fact that we took many measures to prevent or alleviate the potentially biasing effects of using Java, dropout due to using a Java applet was substantial and distortion of demographics significant in two different samples. Even in the retest, which was conducted with individuals who had successfully taken part in the initial test that had contained a Java applet, there still was significant—albeit less than in the initial test—dropout on the page that featured the Java applet. Because the initial test and the retest were 5 months apart, it is likely that, in the meantime, some participants had switched to a newer browser version or to another type of browser with Java not being enabled. Furthermore, since the initial test, some participants might have deliberately switched off Java in their browser for various reasons, such as fear of security breaches, trying to speed up their browser, or weariness of Java's recurrent attempts at downloading upgrades of itself. This suggests that the setting of online questionnaires (i.e., browser version or type, browser security settings) changes rapidly. This is important to bear in mind for researchers: if possible, avoid using non-standard web technologies in retest studies, even more so than in one-shot studies. In retest designs, in addition to the naturally occurring dropout between time points, the non-standard web technology not only causes extra dropout in the initial test but also in the retest.

Limitations

One might object that participants dropped out on the Java applet page not because of the Java applet but because of lack of interest in the topic. We conducted a post hoc analysis on

this question. In one experimental group, the Java-based SC-IAT was presented twice to each participant successively on two different web pages. Dropout after the first of these two SC-IATs can be assumed to be largely due to motivational reasons (e.g., low interest in the topic or the task was perceived as too burdensome) because the first SC-IAT has already shown to have worked from a technology point of view—so should the second. The dropout *after* the first SC-IATs was 8.3%, which is 2.9 times lower than the dropout *at* the first SC-IAT. In contrast to dropout *after* the first SC-IAT, which should be almost purely due to a lack in motivation, dropout *at* the first SC-IAT is likely to have been due to lack in motivation or technological problems with the Java Applet or both. The markedly lower dropout after the first SC-IAT than at the first SC-IAT renders unlikely that participants dropped out on the Java applet page merely on motivational grounds.

To examine this possibility in even more depth, we examined the amount of item-nonresponse as a proxy for participants' motivation to take part. If people had dropped out on the Java applet page merely because of insufficient motivation, they should have been more likely to omit questions prior to reaching the page with the Java applet compared to people who were retained until the end of the questionnaire. Retainees were six times less likely to have answered the question about their sex than people who dropped out on the Java applet page. Moreover, retainees were two times less likely to answer the question on their age and 1.6 times less likely to reply to the question pertaining to their field of study. This suggests that participants who dropped out on the Java applet page were actually somewhat more highly motivated than retained responders. Although we cannot completely rule out that participants also dropped out on the Java applet page for motivational reasons, the above post hoc analyses indicate that dropout on the Java applet page was to a large extent technology driven.

Conclusion

Currently, widely used web technologies in web browsers have a substantial impact on dropout and on the sample's demographic composition, even if reasonable precautions are taken (e.g., maximizing compatibility).³⁻⁸ Whenever the generalizability of results or finding out about differences in demographics (e.g., sex differences) are important goals of a study, we advise using web technologies other than plain HTML for data collection with caution. Although the penetration of preinstalled plug-ins may increase in the future, due to security concerns, as well as rising computer literacy, the share of web users who disable these additional technologies will probably increase as well.¹⁶

Similar sex-specific effects have been found for other design choices of online questionnaires, for example, when using a forced-response design (i.e., participants are forced to answer questions to proceed to the next page).¹⁷ A customary sex difference in dropout (i.e., men drop out more than women) was counterbalanced by the forced-response design. Although online questionnaires offer more possibilities compared to classical pen-and-paper questionnaires in terms of design elements (e.g., forcing answers, including non-standard web technologies, real-time syntactic input validation), researchers and practitioners applying new design features or web technologies should always be aware that

particular design features might significantly affect sample composition. In this regard, we fully agree with Schmidt,⁵ and Buchanan and Reips⁷ who recommend keeping the design as simple as possible by using the lowest common technology for programming, which is still plain HTML.

Disclosure Statement

No competing financial interests exist.

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