Human-Survey Interaction
Usability and Nonresponse in Online Surveys

Lars Kaczmirek

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Abstract: Response rates are a key quality indicator of surveys. The human-survey interaction framework developed in this book provides new insight in what makes respondents leave or complete an online survey. Many respondents suffer from difficulties when trying to answer survey questions. This results in omitted answers and abandoned questionnaires. Lars Kaczmirek explains how applied usability in surveys increases response rates. Here, central aspects addressed in the studies include error tolerance and useful feedback. Recommendations are drawn from seven studies and experiments. The results report on more than 33,000 respondents sampled from many different populations such as students, people above forty, visually impaired and blind people, and survey panel members. The results show that improved usability significantly boosts response rates and accessibility. This work clearly demonstrates that human-survey interaction is a cost-effective approach in the overall context of survey methodology.

Zusammenfassung: Die Teilnahmequote ist eines der zentralen Qualitätsmerkmale bei Umfragen. Deren Erhöhung ist der zentrale Ausgangspunkt des hier entwickelten Modells der Mensch-Umfrage Interaktion bei Online-Befragungen. Der Teilnahmeprozess ist von zahlreichen Schwierigkeiten begleitet, was zu unvollständigen Antworten und Abbrüchen führt. Im vorliegenden Buch verdeutlicht Lars Kaczmirek, wie die praktische Umsetzung von Prinzipien der Gebrauchstauglichkeit Teilnahmequoten erhöht. Zentrale Aspekte gelungener Interaktion von Teilnehmern mit Fragebögen beruhen hierbei auf erhöhter Fehlertoleranz und sinnvollen Rückmeldungen. Die Ergebnisse beruhen auf sieben Studien und Experimenten mit mehr als 33.000 Teilnehmern. Die untersuchten Personengruppen waren Studenten, Teilnehmer von Online-Panels, Personen über 40 sowie sehbehinderte und blinde Personen. Die Ergebnisse zeigen deutlich, dass mit gebrauchstauglichen Befragungen signifikant mehr vollständige Teilnahmen erzielt werden. Investitionen zur Verbesserung der Mensch-Umfrage Interaktion zeigen dabei eine hohe Kosteneffektivität im Rahmen aktueller Umfragemethodik.

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Foreword

The Faculty of Social Sciences at the University of Mannheim trains future professionals for leadership and research in the fields of political science, sociology, psychology and educational science. Many master's, and doctoral theses attest to the high academic level of education in Mannheim, which is especially characterized by its focus on empirical-analytical and quantitative methods.

The results and contents of many of these theses are worth publishing. Therefore, the Faculty of Social Sciences provides an opportunity for broader dissemination of the best manuscripts through its series Mannheimer sozialwissenschaftliche Abschlussarbeiten. The goal of this series is to render the scientific results of outstanding work accessible to a broader professional audience. The publication of these research results may serve as a basis for further scientific investigations.

This series publishes only excellent master's and doctoral theses. Both reviewers have graded the work as "very good" and the work was approved for publication.

Prof. Dr. Josef Brüderl
Dean of the Faculty of Social Sciences at the University of Mannheim

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This book provides empirical evidence that applied usability increases response rates in surveys. Results from seven studies are presented which benefitted from many thousand participants. Doubtlessly, this project was only made possible with the collaboration and support of many people.

I would like to especially thank my supervisors Prof. Dr. Michael Bošnjak and Prof. Dr. Werner W. Wittmann. Without Michael Bošnjak I might never have ventured into the depths of survey methodology. My research has always profited from his strong focus on quality and coherent argumentation. Werner W. Wittmann's teaching fundamentally shaped my methodological thinking. His teaching and the insight that methods have a broad applicability encouraged me to concentrate on methodological issues in my own research.

I am very grateful to my colleague Dr. Wolfgang Bandilla and his continued professional and personal support through the years at GESIS. I am also very grateful to my former research fellow Dr. Wolfgang Neubarth. Exchanging ideas with them has greatly enriched my point of view. I am indebted to Prof. Dr. Mick Couper for numerous encouraging as well as enlightening discussions. I am also indebted to Olaf Thiele for our gratifying cooperation over the years.

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Most importantly, I thank Prof. Dr. Sarah Heinz. She helped shaping this work by discussing, proofreading and commenting on my writing. Thanks to her constant loving support I was able to complete this work.

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Lars Kaczmirek — Mannheim, November 2008

Contents

List of Tables

List of Figures

List of Abbreviations and Translations

AAPOR	American Association for Public Opinion Research
ACM	Association for Computing Machinery
ADM	Arbeitskreis Deutscher Markt- und Sozialforschungsinstitute e.V. [German Association for Market and Social Research Agencies]
AGOF	Arbeitsgemeinschaft Online-Forschung e.V. [Consortium for Online Research]
ALLBUS	Allgemeine Bevölkerungsumfrage der Sozialwissenschaften [General Social Science Survey of German Speaking People in Germany]
ASI	Arbeitsgemeinschaft Sozialwissenschaftlicher Institute e.V. [Consortium of Institutes in the Social Sciences]
BVM	Berufsverband Deutscher Markt- und Sozialforscher e.V. [Professional Association for German Market and Social Researchers]
CAPI	Computer-Assisted Personal Interviewing
CASI	Computer-Assisted Self-Interviewing
CATI	Computer-Assisted Telephone Interviewing
CHI	Computer-Human Interaction
DGOF	Deutsche Gesellschaft für Online Forschung e.V. [German Society for Online Research]
GESIS	GESIS - Leibniz-Institut für Sozialwissenschaften [GESIS - Leibniz Institute for the Social Sciences]
Statistisches Bundesamt	[Federal Office for Statistics in Germany]
GOR	General Online Research Conference
GSA	U. S. General Services Administration
HCI	Human-Computer Interaction
HHS	U. S. Department of Health and Human Services
ICPSR	Inter-University Consortium for Political and Social Research
ISO	International Organization for Standardization
ISSP	International Social Survey Programme
ZA	Zentralarchiv für Empirische Sozialforschung (now GESIS) [Central Archive for Empirical Social Research]
ZUMA	Zentrum für Umfragen, Methoden und Analysen (now GESIS) [Center for Survey Research and Methodology]

1. Introduction

1.1. The Emerging Relevance of Online Surveys

In recent years online surveys have been accepted in the canon of possible survey modes: Web-based surveys have received unique entries in encyclopediae (Alvarez & VanBeselaere, 2005). At conferences online surveys have moved from being discussed in separate sessions to being subsumed under the various topics of surveys and survey methodology (cf., changes in the AAPOR proceedings during the last years). The question of whether online surveys are to be considered as an alternative to traditional survey modes has moved to questions as under which circumstances the mode is able to play its strengths or when to consider other survey modes (Evans & Mathur, 2005). Compared to these traditional survey modes, online surveys are a growing business sector (ADM, 2004). Several organizations have written guidelines for good online survey practice (ADM, ASI, BVM, & DGOF, 2000) or included the mode into an overall framework for the handling of case codes and response rate calculations (AAPOR, 2006). Even in population samples online surveys have taken their role as cost-cutting instruments in mixed mode approaches. The US (Schneider et al., 2005) and Canada (Arora & Gilmour, 2005) both had implemented online versions of the census.

Online surveys have several advantages compared to other modes as they are easier and more effective to conduct with respect to the aspects of the global availability of surveys, multilingual surveys, the timeliness of data collection, data input, available question types, cost of reminders when using e-mails, filtering or skipping questions, and edit checks during the interview. The disadvantages are a result of the employed technology. Not all people of the general population have Internet access, scientific e-mail invitations compete against spam and advertising e-mails, the computer is more difficult to use than talking to an interviewer, and additional security and data protection measures are necessary (Evans & Mathur, 2005; Welker, Werner, & Scholz, 2005). Online surveys share the problems of self-administration in that there is no interviewer available to motivate the respondent or to clarify questions. Irrespectively of the mode, all surveys share threats to data quality due to different types of survey error.

In the following, I refer to online surveys as Web-based surveys. Respondents start a survey (login) by visiting the first page of the questionnaire with a browser. Respondents then proceed through a series of questions and webpages until the end of the survey. The pages are delivered by a server. This concept is also valid for short surveys which can be delivered as a single page. Because the questionnaire is substantially a series of webpages all techniques in current webpage construction can be used. This allows to use visually rich survey design (Krisch & Lesho, 2006), real-time validations (Peytchev & Crawford, 2005), and video (Fuchs & Funke, 2007; Couper, 2005).

1.2. Outline

The general aim of this research is to improve online surveys with respect to successful human-survey interaction. This success can be assessed on the basis of accepted quality criteria in survey methodology, specifically nonresponse (Groves et al., 2004). The theory applied in this work combines survey methodology and human-computer interaction. The focus on the usability of surveys leads to several suggestions for survey design. These suggestions are tested and compared to current design practice.

The theoretical part combines different approaches of usability, the answer process, and response burden with the criteria of nonresponse (chapter 2). Usability principles are reviewed and extended to the context of online survey methodology. The resulting framework is termed human-survey interaction in an allusion to human-computer interaction. The human aspect mainly models the answer process, while the survey aspect includes survey design and response burden. The interaction is concerned with the communication between respondents and a survey. The literature review on usability principles shows that the main focus resides on self-descriptiveness, that is feedback and information about the system status, and error tolerance. Different feedback techniques and error tolerance will therefore be the central focus of the later chapters.

Chapter 3 and study 1 demonstrate the usefulness of the proposed framework by developing specific design guidelines and conducting a survey for visually impaired and blind people in a mixed mode setting of self-administered interviews.

The second part is concerned with further development of instruments in survey methodology. Chapter 4 identifies a lack in the conceptualization of process data, known as paradata. As there is no coherent and conclusive model of paradata, a taxonomy of paradata is developed. As part of this taxonomy a new instrument for the collection of paradata is put forward. This universal approach to paradata collection makes it possible to observe behavior which was hitherto unaccessible such as a respondent's mouse clicks which miss answer controls. This instrument is then used in study 2 which shows that the current implementation of answer buttons in online surveys is far more error-prone than expected. A solution is proposed which is tested as part of study 5.

A very common type of paradata are response times. Study 3 uses the paradata model to define different measures for response times. The developed taxonomy of paradata makes clear that researchers must choose from these different definitions which differ in terms of the time and financial investment needed for the implementation. Even more important however are possible differences in data quality between the definitions. This is problematic as researchers usually go for only a single measurement criterium and may be unaware that the others exist. Research has therefore not been able to identify the most advantageous response latency measurement. To fill this gap, study 3 compares three definitions of response latencies and identifies the best one.

Chapter 5 identifies technical features which should be used to turn design principles into practice. Researchers can choose among a variety of technologies such as JavaScript, Java, Flash, and cookies. Several survey methods require at least one of these technologies, for example when controlling multiple participation or using visual analog scales in questions. Unfortunately, due to fast-changing Internet technologies not all users have all possible technical features available in their browsers. The challenge in surveys is to use features which have a very high coverage among the respondents while maintaining high survey quality standards. This is necessary to minimize nonresponse due to technical inaccessibility. Study 4 assesses the availability of different technology in respondents' browsers. The results show that JavaScript is widely available and allows for the implementation of both the universal client-side paradata instrument and design principles without increasing nonresponse. Later chapters test different survey designs which were implemented with this technology to reduce nonresponse.

The third part beginning with chapter 6 applies the design suggestions from the framework and the previous chapters to online surveys and tests their effects on nonresponse and other quality criteria. Studies 2 and 5 apply concepts of usability to reduce items missing which are an aspect of nonresponse. The design suggestions addressed enhance feedback in survey questions. This is done using interactive color cues which highlight the item that a respondent is about to answer and the items that have already been answered. The results show that good interface design reduces item nonresponse.

Chapter 7 with studies 6 and 7 aims to reduce dropout by means of enhancing self-descriptiveness, and feedback. This is achieved by utilizing progress indicators. The use of filter questions commonly results in wrong feedback that becomes visible as 'jumping' progress indicators as soon as a major part of a questionnaire was omitted because it was not applicable for the respondent at hand. An algorithm is developed to overcome problems in the calculation of progress in all kinds of surveys with filter questions, irrespective of survey software. Study 6 shows a positive effect of the algorithm on completion rates, expected time till completion, perceived burden, and perceived time flow. The algorithm allows for two different calculations: a 'conservative, accelerated' and a 'progressive, decelerated' feedback. Thus, study 7 compares the effects of both approaches and recommends the usage of a progressive, decelerated feedback algorithm that overestimates rather than underestimates the progress at the beginning of a survey to maximize response rates.

Concluding, this work consists of three parts. The first part develops the theory around the framework of human-survey interaction. The second part develops instruments for research within the framework. Finally, the third part uses the framework to develop survey design strategies which are expected to enhance usability and reduce nonresponse. The instruments are employed to test these survey design strategies against current design practice. The next section explains how this work fits into the broader area of survey methodology.

1.3. Sources of Error in the Life Cycle of Online Surveys

This section positions the content of this work into the broader picture of survey methodology by examining the different sources of error in the life cycle of online surveys. Sources of error are the most prominent problems online surveys face and share with other surveys. The life cycle approach ascribes the types of error to the different steps of a survey and thereby allows a better understanding of the process of conducting a survey. Here, the focus of this work is step three, types of nonresponse error where respondents are interacting with questionnaires.

The concept of total survey error is composed of several error types which occur during the different life cycle stages of a survey project.[1] According to Groves et al. (2004, p. 49), "the job of a survey designer is to minimize the gap between two successive stages of the

[1] This section approaches the different stages from an error perspective. Nevertheless, the survey life cycle approach has been used in other contexts as well: ICPSR (2005) uses the data life cycle as a framework to explain the necessary data documentation during a project. Kaczmirek (2008) discusses the many decisions involved in survey design from a software tools perspective. The life cycle model of online surveys integrates other views such as the phases of empirical research (Diekmann, 2007) and research process (Schnell, Hill, & Esser, 2004).

survey process. This framework is sometimes labeled the 'total survey error' framework or 'total survey error' paradigm."

The most prominent types of error are (Groves et al., 2004, p. 48):

1. Coverage error: Identify target population and define sampling frame, for example students and list of e-mails of first year students.

2. Sampling error: Draw sample from sampling frame, for example n*th* visitor sampling on a website.

3. Nonresponse error: Contact respondents, for example refusals.

4. Measurement error: Respondents response, for example acquiescence.

5. Processing error: Postsurvey data editing, for example imputation of missing data.

6. Adjustment error: Postsurvey adjustments, for example weighting.

Each error type marks an important step towards the next phase in the life cycle of a survey. Survey costs are weighted against the quality features to design the best possible survey under the given circumstances and constraints of a project (Groves & Heeringa, 2006).

Although the different concepts of error have been discussed extensively (Groves et al., 2004; Biemer & Lyberg, 2003), a summary of the relevant work explains how my research fits into the life cycle of a survey and the overarching survey error paradigm. Figure 1.1 shows the typical tasks for conducting a survey concerning the data. Each task is associated with a possible source of error which will be discussed in the next sections with respect to online surveys.

1.3.1. Coverage Error

In order to study a target population the researcher needs to define a sampling frame, from which to draw a sample. In online surveys the sampling frame would usually be a list of e-mail addresses of the members of the target population or their postal addresses. Coverage error is the difference between this sampling frame and the target population. Coverage error consists of undercoverage and ineligible units (Couper, Kapteyn, Schonlau, & Winter, 2007). Undercoverage describes the problem that people who have a zero-chance of being selected although they are part of the target population differ in the variables of research interest. Undercoverage is the main threat to online surveys

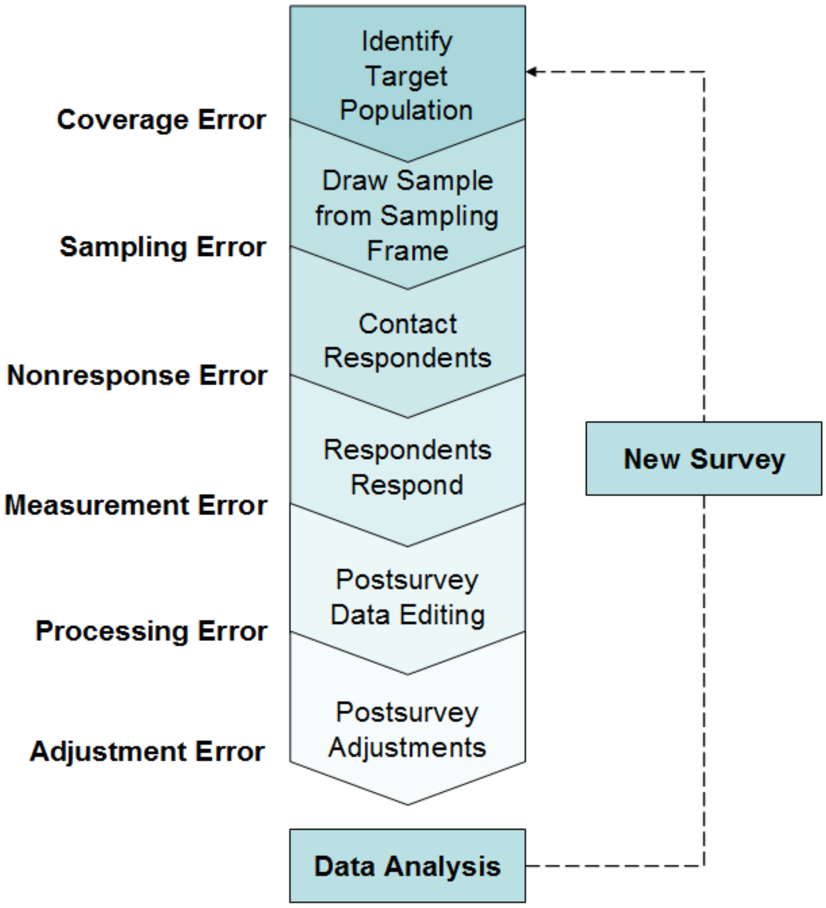


Figure 1.1. The life cycle of online surveys in the total survey error framework.

since there are many eligible people who have no Internet access and no complete list of e-mail addresses exists for the general population. A recent study reported that 63% of all Germans who are at least 14 years old use the Internet (Van Eimeren & Frees, 2007, p. 363f.). For people up to 30 years Internet undercoverage does not seem to be a problem (e.g., at the University of Mannheim all students need to submit their applications online for attending the university, Kaczmirek & Thiele, 2006). However, elderly people and people with a lower education are hard to reach (Bandilla, Kaczmirek, Blohm, & Neubarth, 2009). In the US Health and Retirement Study (HRS) which used a panel of elderly people (50+) only 30% reported that they use the Internet (Couper, Kapteyn, et al., 2007). The problem of ineligible units is a minor one, where researchers need to make sure in the questionnaire that they can be identified and excluded from the analysis. This situation makes online surveys feasible in mixed mode surveys (Christian, 2007; De Leeuw, 2005) and for special target populations with high Internet coverage, such as establishments (Auno, 2004), students (Heerwegh, 2005), and employees (Borg & Faulbaum, 2004).

1.3.2. Sampling Error

In most surveys not all units in the sampling frame are contacted for a response to minimize costs. An exception is a census which aims at questioning everyone in the sampling frame. A sample represents one possible realization of all theoretically possible surveys in the sampling frame. In the case of probability-based methods the error and its effect on the different statistic variables is known to warrant the extent to which interference to the target population is possible. "In nonprobability surveys, members of the target population do not have known nonzero probabilities of selection. Hence, inference or generalizations to that population are based on leaps of faith rather than established statistical principles." (Couper, 2000b, p. 477). With the distinction between nonprobability and probability-based methods in online surveys made by Couper it is possible to evaluate the value of a survey relative to its intended goal. For example polls for entertainment on a website add no or at least questionable value to public opinion research but may be perceived as adding value for the visitors of the website. On the contrary, a well-drawn sample within the customers of a large company can reduce costs while keeping accurate track of the customers' opinions. Despite the fact that online surveys have fostered a profitable industry with many survey software tools (Kaczmirek, 2008) they have a bad reputation among more traditional survey researchers. Vehovar, Batagelj, Manfreda, and Zaletel (2002, p. 239) stress the importance not to blame the online mode for bad sampling habits:

> The threat to validity thus arises only from nonresponse and noncoverage problems, particularly in nonprobability Web surveys, which are, unfortunately, quite common. As a consequence, Web surveys are often automatically associated with the validation issues in nonprobability Web surveys, although this is nothing but the usual problem of statistical inference without scientific/probability sampling.

1.3.3. Nonresponse Error

After having drawn the sample the prospective participants are contacted. Usually, not all sample members answer to such a request. Nonresponse error is the difference between the respondents and the entire sample. It is a problem in so far as nonrespondents indeed differ in their answers from respondents and their answers. When the reasons for nonresponse are linked to the research questions, nonresponse error increases with a declining response. In online surveys the response rates tend to be lower when compared to other modes. In a meta-analysis examining 45 published and unpublished experimental comparisons between Web and other survey modes Lozar Manfreda, Bosnjak, Berzelak, Haas, and Vehovar (2008) on average found an 11% lower response rate compared to other modes. The main factors affecting response rates were the sampling frame, the solicitation mode, and the number of contacts. Here, it is noteworthy that no significant influence of incentives was found. This contrasts meta-analytical findings from traditional mail surveys were incentives have proven to be effective in increasing response (Yammarino, Skinner, & Childers, 1991). Effects on solicitation are also reported in a comparison of online and mail survey response rates by Kaplowitz, Hadlock, and Levine (2004). They found a non-significant difference between mail invitations (RR[2]=.315) and 'postcard followed by-e-mail invitations' (RR=.297). However, there was a significant difference between mail and e-mail only (RR=.207) invitations (Kaplowitz et al., 2004, p. 98f.). Even more importantly, the cost differences between the mail and 'postcard e-mail condition' are substantial \$10.97 vs. \$1.13 per response, stating online surveys as highly cost-effective. In a meta-analysis of 68 online surveys in 49 studies Cook, Heath, and Thompson (2000) reported an average response rate of 39.6% (SD=19.6%): "The number of contacts, personalized contacts, and precontacts were the dominant factors affecting response rates for our study." (p. 829).

In this overview of the different types of survey error in the life cycle of a survey it must be stressed that nonresponse in online surveys plays an important role in research (Bosnjak, 2002; Heerwegh, 2005; Peytchev, 2007). The comparative research reported here provides examples that good, that is evidence-based online survey methodology can keep up with nonresponse rates in other survey modes. My work focuses on nonresponse as a quality criteria to experimentally assess the usefulness of design decisions which were derived from the theoretical framework.

1.3.4. Measurement Error

Measurement error is the deviation of the response to the true answer value. There are two types of measurement errors. The unsystematic error (of classical test theory) does not negatively affect survey estimates. The main problem in survey research are

[2] This response rate is RR6 as defined by the American Association for Public Opinion Research (AAPOR, 2006).

systematic errors (cf., Biemer, 2004; O'Muircheartaigh, 1997, for a historical perspective). These errors arise because survey design can cause systematic bias (Biemer, Groves, Lyberg, Mathiowetz, & Sudman, 2004). It is for example well known that undesirable behavior is underreported by respondents. This ranges from self-reported health risk behavior (Brener et al., 2006) such as drug use (Biemer & Brown, 2005) over the amount of watching television and blood donation to overall satisfaction with life (Stocké & Hunkler, 2004). The survey mode can also happen to affect the response: "Web surveys may have some advantages over telephone surveys in terms of observation errors, or errors arising from the measurement process." (Fricker, Galesic, Tourangeau, & Yan, 2005, p. 374). Defining survey procedures can help to reduce measurement error (Conrad, 1999).

In online surveys most research activity centers around the visual design of the questionnaire and the answer formats. The bottomline is that respondents interpret the available answer options in the context of the presented visual design. This conforms to findings on question wording and order effects (N. Schwarz, 1999; Bishop & Smith, 2001). Respondents will use available pictures to understand what the questions are about: Estimation of 'eating out' results in higher frequencies for questions accompanied by a picture of a drive-through than by a picture of people in a restaurant (Couper, Tourangeau, & Kenyon, 2004). Similarly, "when exposed to a picture of a fit woman, respondents consistently rate their own health lower than when exposed to a picture of a sick woman." (Couper, Conrad, & Tourangeau, 2007, p. 623). These results can be explained in the light of offline research showing that the range of answer frequencies functions as a clue to what is seen as 'normal' behavior and thus affects the respondents' estimates (N. Schwarz & Scheuring, 1992). Likewise, color and labels affect the response in scales (Tourangeau, Couper, & Conrad, 2006).

The use of 'no opinion' options results in a higher amount of such non-substantive answers than the mere possibility to leave the question unanswered (De Rouvray & Couper, 2002). Similarly, using yes–no grids compared to 'check all that apply' yielded higher endorsement rates (Thomas & Klein, 2006; Smyth, Dillman, Christian, & Stern, 2006). The broader perspective is that respondents are more likely to check answers with a higher visibility (Tourangeau, Couper, & Conrad, 2004) than more hidden answers, for example radio buttons vs. drop-down boxes (Healey, 2007; Couper, Tourangeau, Conrad, & Crawford, 2004) and top vs. bottom answers (Couper, Tourangeau, Conrad, & Crawford, 2004).

Another case of the potential of visual design to minimize measurement error is the problem of date answers. Used wisely, visual clues can "improve the likelihood that web respondents report date answers in a particular format desired by the researcher, thus reducing possible deleterious effects of error messages or requests for corrections." (Christian, Dillman, & Smyth, 2007, p. 113). Visual guidance is key to help respondents provide complex answers (Dillman, Gertseva, & Mahon-Haft, 2005), and to help walk through the branching of paper-questionnaires (Redline & Dillman, 2002). To help researchers in design decisions, design guidelines have been proposed (Baker, Crawford, & Swinehart, 2004; Crawford, McCabe, & Pope, 2005; Dillman, Tortora, & Bowker, 1999; Kaczmirek, 2005).

A unique problem in online surveys is the fact that researchers do not have total control over the layout of the questionnaire. The reason is that webpages are written in HTML, that is Hypertext Markup Language. This means that text and questions are marked by their function but that they are not readily formatted like in a paper questionnaire. This is ideal when considering the many different computers and screens Internet users have, allowing for example word wrapping to be adjusted to the actual screen width encountered. It is the task of the browsers to layout the text according to the intended function. Dillman (2007) warns that different screen sizes can have a negative impact on the layout of response scales. It is therefore necessary to include additional measures in the questionnaire to avoid a bias associated with such technicalities. Figure 1.2 demonstrates the problem that the same HTML-code can produce different response scales in different browsers.[3] In the lower scale the middle answer values are pronounced because of unevenly set spaces. This leads to more selections of the middle categories in the lower scale compared to the upper scale (Dillman & Bowker, 2001). Chapter 5 will therefore present research on techniques that can be used to improve survey methodology.

1.3.5. Processing Error

After data collection postsurvey processing aims at improving the measurement. Correcting outliers is such a measure. Outliers are a common problem in the analysis of response times because response times follow a skew distribution and the mean is sensible to outliers (Yan & Tourangeau, 2008). Especially in online surveys people are known to interrupt participation thus making automatic response time collection difficult. Postsurvey processing aims at detecting these cases. Among available corrections Ratcliff (1993) suggests changing the upper and lower one percentile values with the value of the upper and lower percentile respectively. Generally, in open question formats

[3] The problem depicted in figure 1.2 occurred in 2006. At the end of 2007 it was no longer present for the software Surveymonkey using the browsers Internet Explorer and Firefox.

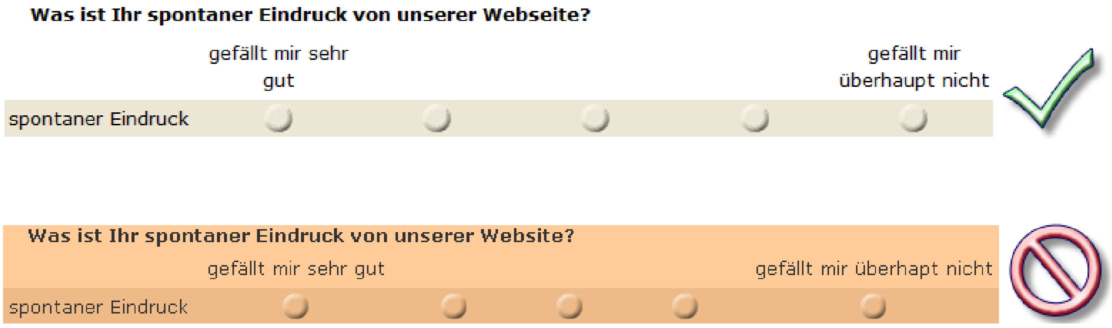


Figure 1.2. Example of possible scale inconsistencies due to the interaction between browsers and HTML code. Screenshots printed with permission from SurveyMonkey.com, Copyright ©1999-2008. All Rights Reserved.

the data need to be scanned for outliers and inconsistencies or contradictions with other answers. An example from the demographical standards (Statistisches Bundesamt, 2004) is the year of birth that should be asked in an open question format instead of a series of ranges. When asking the year of birth in an open question format, answers like '90' can be validated during data collection whereas '1990' may seem valid. Combining the answer of '1990' with an answer to the question of the number of children '4' postsurvey correction and recontacts would be necessary. To allow analysis of open ended questions the answers need to be categorized. This is usually done in a step called coding. A coding scheme defines which concepts should be assigned with which number (Weber, 1990). Poor coding instructions and coder training leads to poor interrater reliability (Krippendorff, 2003) which is a form of processing error. For example the final question in a survey 'Do you have any other remarks?' could be coded into 'positive remark', 'negative remark', and 'other'. Sometimes respondents would provide a mixed comment: 'Overall good, questions seem somehow random though'. If the coding instructions do not explicitly state what to do in such a case, some coders might mark this as positive, while others would think that the negative remark is more substantial and thus code it as negative. Still, others might be undecided and go for the 'other'-category. A clear coding instruction to mark such cases as 'other' helps to reduce processing error. Depending on the research question an even better solution in this example would be to use three variables and code each appearance separately, increasing the costs for coding though. Summarizing, processing effects are the difference between the edited response and the response provided. If the response is closer to the true value than the edited response, the processing adds error instead of improving the measurement. Postsurvey processing error can be reduced by applying online validation (Peytchev & Crawford, 2005), providing clear instructions about the desired formats (Dillman et al., 2005; Christian et al., 2007) and professional coders (Krippendorff, 2003).

1.3.6. Adjustment Error

In a last step following data collection and editing, the data can be adjusted to correct nonresponse, sampling and coverage errors. Adjustment uses information about the target population, sample frame or response rates in the sample to determine the amount of necessary correction. For example the response patterns might show that there is an underrepresentation of older people in the data set compared to the target frame. In online surveys this is a common problem because the Internet coverage is lower for older people and people with higher education are more likely to participate (Bandilla et al., 2009). The introduction of weights to different subgroups in the data can improve survey estimates (Groves et al., 2004). However, it must be understood that weighting is an inadequate approach if the reasons for non-participation are related to the research question. For example weighting does not solve the problem that Internet users and non-Internet users may differ substantially in some of their attitudes (Schonlau et al., 2004; Bandilla, Bosnjak, & Altdorf, 2003). Regarding weighting, specific sampling procedures need special adjustments to make up for this systematic but known error. This is for example the case in the general social survey in Germany (ALLBUS) where oversampling in East Germany allows for more specific subanalyses in these regions. For a nationwide analysis the weighting successfully corrects the otherwise overrepresentated subsample.

Another form of postsurvey adjustment is imputation. With imputation missing data is replaced with estimated responses. Here, the same considerations apply as above: Unsystematic missing data (missing completely at random, MCAR) is less problematic than missing data which correlate with known variables (missing at random, MAR). Missing data which correlate with substantive variables without one being able to predict the correlation is non-ignorable (NI) and thus imputation or weighting would not be adequate. With respect to this notation from Little and Rubin (2002) the findings of Schonlau et al. (2004) and Bandilla et al. (2003) suggest that much of the missing data is non-ignorable and thus weighting does a poor job in correcting this for online surveys. Despite these problems, a weighting procedure which would statistically allow to generalize to the whole population (including those without Internet access) would be a major breakthrough and so the attempts to apply and research various weighting procedures in online surveys continue (cf., Terhanian & Bremer, 2005; Lee, 2006; Couper, Kapteyn, et al., 2007).

Summarizing, postsurvey adjustments are employed to correct several errors. However, if badly applied they increase total survey error.

The introduction of the survey life cycle approach has shown that the focus of this work is at the center of conducting a survey, where respondents interact with the questionnaire. Much of the earlier steps are under the researchers control. However, once a survey is online and respondents were invited, the questionnaire must speak for itself. It is the interaction between the survey and the respondents that is responsible for the success of a survey project. Bad implementations and design will inevitably result in higher nonresponse, while a usable design will motivate respondents to complete a survey. The next chapter describes how human-computer interaction can be applied to online survey methodology and proposes a framework for human-survey interaction which will then be used in the later chapters.

Concepts and Approaches

2. Usability in Online Surveys

The interaction between respondents and online surveys is the basis for applying knowledge from human-computer interaction research to survey methodology. Chapter 2 therefore reviews major frameworks from both fields and proposes an integrated framework termed human-survey interaction which is then used to derive research maxims for improved instruments and applied survey design.

2.1. Applying Human-Computer Interaction to Online Surveys

With the increasing use of new technology the need for standards arise. Several researchers have developed a set of usability principles with a broad applicability in different contexts. They have proposed heuristics[1] to fit this need for 'the design of everyday things' (Norman, 1988), user interface design (Shneiderman, 1998), website design (Nielsen, 1993, 2005) and also for the design of computer-assisted data collection systems (Couper, 1994). In the context of (paper-based) surveys Dillman et al. (2005) apply concepts from cognitive design, emotional design and visual design to form questionnaire usability. They draw especially on the seven principles proposed by Norman (1988). Research on design issues in online surveys have focused on specific design issues, for example paging vs. scrolling (Peytchev, Couper, McCabe, & Crawford, 2006), radio buttons vs. drop-down boxes (Heerwegh & Loosveldt, 2002), and guidelines (Crawford et al., 2005; Reips, 2002).

My main thesis in the following is that all heuristics mentioned here are compatible with each other and can be incorporated in the dialogue principles of the ISO 9241-110. What all these heuristics have in common is that they guide design decisions. They all emerged from the field of human-computer interaction. Moreover, I show that the general principles can be applied to online surveys, leading to recommendations and guidelines in online survey design. This is possible because online surveys rely on the interaction

[1] A remark on the terminology: Heuristics and principles use the most abstract definitions. They can be used to derive more specific recommendations, or even concrete guidelines. Heuristics have the advantage of broad applicability, whereas guidelines provide design rules. For example the design rule "Do not require respondents to provide an answer to each question before being allowed to answer any subsequent ones." (Dillman et al., 1999, p. 11) in online surveys would be supported by the more general heuristic "user control and freedom" (Nielsen, 2005, principle 3).

between questionnaires and respondents in the same way that webpages and computer programs rely on the interaction between computers and humans. Furthermore, the principles are a valuable source for generating new design ideas (or support existing ones) which can be empirically tested. Firstly, the ISO 9241-110 and the heuristics of Norman, Shneiderman, Nielsen, and Couper are summarized. Secondly, I expand on the principles of the ISO 9241-110 standard by applying it on online surveys and the relation to the heuristics is made clear. Table 2.1 on page 33 finally summarizes the fit between the heuristics and the standard. I take a close look at each heuristic separately and provide examples of survey design to scrutinize the existing overlap between the proposals. Consequently, some repetitiveness in the examples and heuristics cannot be avoided. As a result I arrive at a set of heuristics to guide the design of online surveys which is exhaustive and interdisciplinary.

2.1.1. The Applicability of the ISO 9241-110

In 2006 the International Organization for Standardization (ISO) issued a revision of the dialogue principles for ergonomic human-system interaction which were first published in 1996. This ISO 9241-110:2006 is the result of a documented decision process. Drafts were adopted by a technical committee, made available to the public to comment, reworked and finally circulated among member bodies for a vote of acceptance. Although such a process will naturally result in a compromise, the fact that experts from various fields are included in the production process makes it suitable for broad application. Indeed the applicability of the ISO 9241-110 in the context of online surveys is derivable from the introduction and scope of the standard:

> This part of ISO 9241 deals with the ergonomic design of interactive systems and describes dialogue principles which are generally independent of any specific dialogue technique and which are applicable in the analysis, design and evaluation of interactive systems. (p. vi).

and

> This part of ISO 9241 sets forth ergonomic design principles formulated in general terms (i.e., presented without reference to situations of use, application, environment or technology) and provides a framework for applying those principles to the analysis, design and evaluation of interactive systems. (p. 1).

Online surveys are a type of interactive systems because they receive input from and produce output to a human respondent in order to support the task of participating in the survey. Seven principles were identified which serve as rules for the design and evaluation of interactive systems and dialogues (ISO, 2006, p. 3):

1. suitability for the task,
2. self-descriptiveness,
3. conformity with user expectations,
4. suitability for learning,
5. controllability,
6. error tolerance, and
7. suitability for individualization.

When comparing ISO 9241-110 with the heuristics of Norman, Shneiderman, Nielsen, and Couper the importance of visibility, feedback, and error tolerance in interactive systems comes to mind: Self-descriptiveness (ISO) is matched by 'make things visible' (Norman), 'offer informative feedback' (Shneiderman), 'visibility of system status' (Nielsen), and 'informative feedback' (Couper). Even more obvious are the similarities to the demand of 'error tolerance': Norman asks to 'design for error', Shneiderman writes about 'offer error prevention and simple error handling', Nielsen would like to see 'error prevention' incorporated, and Couper terms it 'tolerance'. Not only do the heuristics of the authors overlap, but it also might be necessary to weight dialogue principles against each other in order to optimize usability.

2.1.2. Everyday Design: Norman's Seven

In *The Design of Everyday Things*, Norman (1988, p. 188f.) argues for seven principles. In the following they are described with examples from online surveys:

1. **Use both knowledge in the world and knowledge in the head**. When constructing a questionnaire it is important to understand what respondents need to know to fill out the survey and what additional information should be provided.
2. **Simplify the structure of tasks**. Limitations of short term memory should be considered when writing instructions and questions. To reduce memory load instructions should be placed at the position of the concerned questions, not in the beginning.

3. **Make things visible: bridge the gulfs of Execution and Evaluation**. Required action and feedback of action need to be obvious to respondents. Especially since most questionnaires will only be filled out once per respondent there is little or no time to learn special knowledge about the dialogues.

4. **Get the mappings right**. Answer controls such as radio buttons and check boxes should be in close proximity to the related answer texts. When providing both 'next' and 'back'-buttons the 'back'-button should be on the left followed by the 'next'-button on the right to map the common settings in Internet browsers.

5. **Exploit the power of constraints, both natural and artificial**. Limiting the number of possible user actions means to help users to participate properly. For example leaving out 'back'-buttons helps users to proceed through the survey and stresses that they do not need to bother about their earlier answers. Similarly, additional help links in proximity to the questions should only be available if they are substantial to the questions at hand.

6. **Design for error**. If respondents think that an answer was wrong they should be able to provide a different answer while the survey software avoids inconsistent data. In the case of text answers in the form of "please specify" the text entered should not be saved when respondents change their answer and go for a category instead. Similarly, edit checks help respondents to enter their answers in the desired formats.

7. **When all else fails, standardize**. In some circumstances the principles might not allow to defer a convincing recommendation. In such arbitrary decisions it is important to standardize the design decision throughout the survey and preferably for future designs as well. Although it is clear that a "next"-button should be placed at the bottom of a page after the last answer it is unknown how to align the button. Whether it should be placed on the left, middle or right might not have a big enough impact on user performance to undergo extensive user testing. Still, different survey organizations have decided differently on this issue but keep their own surveys consistent within their own rules. This is especially beneficial in the case of panel members who participate in several surveys of the same organization.

2.1.3. User Interface Design: Shneiderman's Eight

In his book *Designing the User Interface* which is one of the basic class-books in instructing human-computer interaction Shneiderman (1998) puts forth the three principles "recognize the diversity", "use the eight golden rules of interface design", and "prevent errors" (p. 67ff.). Shneiderman stresses the importance of considering and dealing with potential errors by declaring it a principle of its own. In his first principle Shneiderman elaborates how different contexts, users, and tasks all shape the requirements for the interactive system. It is therefore a prerequisite or starting point for all interaction designers. Similarly, it is important in survey research to know the target population and the method of data collection to successfully test wordings and field the survey. The second principle consisting of eight rules of interface design hold the following heuristics for survey design (Shneiderman, 1998, p. 74f.):[2]

1. **Strive for consistency**. Consistency has many forms. Layout, font sizes and emphasis (bold type), color, labels on rating scales, etc. are just some things to consider. Often the question text is formatted in bold type. It is then necessary that this applies to all questions. Validation messages are often in red color. When for example using rating scales they should use the same labels while changes between different number of scale points – for example a five-point and a seven-point scale – should be avoided.

2. **Enable frequent users to use shortcuts**. If respondents are going to fill in a survey repeatedly shortcuts to speed up data entry should be available in addition to the normal interaction behavior of mouse control. This can be the case for diaries when a respondent is questioned several times per day. A different application with the same need is a telephone interview which uses an online interface for the interviewer. Here, the support of number keys for the answer options is a standard procedure.

3. **Offer informative feedback**. "For every user action, there should be system feedback." (Shneiderman, 1998, p. 74). This rule concerns such basic things as a radio button being marked with a dot when it has been clicked. Other forms of feedback are progress indicators, validation messages, and a final thank-you-page indicating that the survey was successfully finished.

[2] Shneiderman uses the term rules. But in line with the argument in footnote 1 I refer to them as heuristics because they still need to be applied to specific contexts of use.

4. **Design dialogs to yield closure**. "Sequence of actions should be organized into groups with a beginning, middle, and end." (Shneiderman, 1998, p. 75). For online surveys this seems to be straightforward as respondents only need to follow the sequence of questions to yield closure. Nevertheless, the structure is often enhanced by grouping several questions into a logical block. Introductory sentences are used to mark the beginning of a new block, for example 'Finally, we would like to ask you a few questions about yourself.' for demographic variables.

5. **Offer error prevention and simple error handling**. "As much as possible, design the system such that users cannot make a serious error" (Shneiderman, 1998, p. 75). Visual clues on desired formatting (e.g., YYYY for a four digit year) and validation of data entry during data collection serve this purpose. Furthermore, the use of filter questions prevent respondents from answering inapplicable questions such as the amount of cigarettes per day when they are non-smokers.

6. **Permit easy reversal of actions**. Allowing respondents to change answers encourages responses and reduces anxiety because respondents know they are allowed to change their mind in the answer process. In correspondence with this heuristic software systems can allow respondents to 'unclick' a rating scale, thus deleting their answer, an action which is not possible with standard HTML radio buttons.

7. **Support internal locus of control**. Respondents should be in charge at any time during a survey. This means that respondents can decide which questions to answer and which not, when to proceed and even to change their mind and discontinue participation. This is truly in accordance with the codes of conduct which state that participation should always be voluntary (ADM et al., 2000).

8. **Reduce short-term memory load**. Starting an online survey with a list of instructions and definitions to be remembered for later questions should be avoided. Instead it is good practice to place them together with the associated questions where they are needed. Complex questions should be redesigned so that the information can be collected with several questions, reducing the memory load in question understanding and answering.

2.1.4. Usability Design: Nielsen's Ten

Nielsen developed ten usability principles on the basis of a factor analysis of 249 usability problems which he presents in his book *Usability Engineering Methods* (Nielsen, 1993).

The following list is a more recent rewording of the ten heuristic usability guidelines (Nielsen, 2005):

1. **Visibility of system status**. "The system should always keep users informed about what is going on, through appropriate feedback within reasonable time." (Nielsen, 2005). This is of paramount importance when respondents are not able to provide an answer although a question has been presented. It can occur in designs which reload partial information during the interview to reduce the overall bandwith needed. For long lists the interview is split into categories and subcategories which can then be loaded and presented on-the-fly, usually without notice of delay. Because a complete list of all places where a respondent could have applied as a student is very long, the question could be divided into the city and the available institutes at that place. With a slow Internet connection the time needed to load the institutes after the respondent chose the place might be remarkable. In such a case an animated picture indicating some sort of progress or loading is a standard practice at least in non-survey settings as can be seen in every browser animation for loading pages.

2. **Match between system and the real world**. "The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms." (Nielsen, 2005). Technical language should be avoided in surveys so that respondents are able to understand the questions. The next-button is often placed on the right side, sometimes with a symbolic '»' added, whereas a '« back' would be placed on the left. This matches the concept of new pages in a book which are on the right and the reading habits from left to right. Nevertheless, the match between the system and the real world must take cultural differences into account as for example reading from right to left in Asian countries would demand alternative button placement.

3. **User control and freedom**. "Users often choose system functions by mistake and will need a clearly marked 'emergency exit' to leave the unwanted state without having to go through an extended dialogue. Support undo and redo." (Nielsen, 2005). Respondents might close a survey window by accident. When reentering the interview the survey should continue where the respondent left off, having saved all earlier answers. Similar to earlier heuristics respondents should be able to choose which questions to leave unanswered and to discontinue a survey.

4. **Consistency and standards**. "Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions." (Nielsen, 2005). In HTML the circled radio buttons are used for 'choose one among many' forms, whereas the checkboxes are used for 'choose all that apply' forms. Hence, online surveys should follow these visual distinguishing clues and not override them with a single set of boxes known from paper-based surveys.

5. **Error prevention**. "Even better than good error messages is a careful design which prevents a problem from occurring in the first place." (Nielsen, 2005). Here, Nielsen stresses that a design that prevents items missing in the first place would be better than a design that sends a validation message to respondents to fill in missing questions. Chapter 6.2 follows this idea by reducing item-nonresponse.

6. **Recognition rather than recall**. "Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue [survey] to another. Instructions for use of the system [questionnaire] should be visible or easily retrievable whenever appropriate." (Nielsen, 2005). This heuristic states clearly that instructions and definitions needed for question understanding should be placed together with the question. Lists of possible answers should not be hidden in hard to access drop-down-fields, especially not when the answers are to be related to each other (e.g., major, minor field of study).

7. **Flexibility and efficiency of use**. "Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users." (Nielsen, 2005). This is very similar to Shneiderman's "enable frequent users to use shortcuts". When online surveys are used for coding or data entry, shortcuts and key input can speed up the process and save costs.

8. **Aesthetic and minimalist design**. "Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility." (Nielsen, 2005). Although definitions need to be placed at the associated questions circumstances exist where they may be reached via a link, requesting more information or a definition. This can for example be useful in an establishment survey with many definitions.

9. **Help users recognize, diagnose, and recover from errors**. "Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution." (Nielsen, 2005). Apart from the questionnaire itself this heuristic also applies to system messages generated by the software. They appear for example when a survey is unavailable. This can happen because a survey is closed or because the server limits the amount of simultaneous respondents. Simple messages like 'the quota is filled', 'the survey is out of the time frame', or 'the survey is closed' might be understandable to survey researchers, but they might leave most respondents without a clue what to do. A good system message thanks the respondent for his/her willingness to participate, explains the situation (e.g., 'The survey has been finished and participation is no longer possible.'), and suggests what to do next (e.g., leave the window or return the next day).

10. **Help and documentation**. "Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large." (Nielsen, 2005). Surveys ideally are self-explanatory. However, this was and is not always the case. Dillman et al. (1999, p. 10) mention several aspects in online surveys which might need explanation for less experienced Internet users. Two aspects probably also apply today: "It may not be clear to some respondents what a drop-down menu is, and how to access the hidden categories." and "It may not be clear how open-ended answers are to be entered, or that in some cases there is far more space than shows on the screen." Moreover, in e-mail invitations explicit instructions on how to start participating are very common.

2.1.5. Computer-Assisted Interview Design: Couper's Ten

Couper (1994) examined the literature on human-computer interaction and derived 10 heuristics for computer-assisted data collection systems. Although Couper probably had computer-assisted telephone interviewing (CATI) and computer-assisted personal-interviewing (CAPI) systems in mind when developing this set these systems share some similarities with online surveys. As with online surveys the interviewer follows the questions and is automatically led through this process. The difference to a usability perspective is mainly that the interviewer is able to compensate for shortcomings of the system. Therefore, these heuristics are even more advisable for self-administered interviews where respondents have to understand and interact with the online survey system on their own. This is supported by the trend of survey software development to merge different modes into a single survey system allowing computer-assisted telephone interviewers, personal interviewers, and respondents to use the same online survey.

The previous heuristics have already been shown to apply to online surveys with added examples in online survey methodology. Couper's set of heuristics is closest to online surveys and directly fits with the ISO 9241-110:2006. I therefore highlight the conforming principles of the standard instead of providing additional examples. Couper (1994, p. 367ff.) argues for the following ten heuristics:

1. **Functionality**. "The system should meet the needs and requirements of users when carrying out the tasks." (p. 367). This means that the functionality and the dialogue should be based on the task characteristics which are part of the definition on *suitability for the task* (ISO, 2006, p. 4).

2. **Consistency**. "This refers to the look and feel of the system. At its simplest level, consistency refers to the placement of items on screens, including the use of fonts, upper or lower case, color, highlighting, etc." (p. 368). "Another component of consistency is predictability." (p. 369). This refers to the *conformity of user expectations* which state that "dialogue behavior and appearance within an interactive system should be consistent within tasks and across similar tasks." (ISO, 2006, p. 7).

3. **Informative feedback**. "For every user action there should be some feedback (Shneiderman, 1992: 73)." (p. 369). This relates to *conformity*: "Immediate and suitable feedback on user actions should be given, where appropriate to user expectations.“ (ISO, 2006, p. 7), and *self-descriptiveness*: "Dialogues should be designed so that the interaction with the interactive system is apparent to the user" (ISO, 2006, p. 6).

4. **Transparency**. "The system should permit the user's attention to be focused entirely on the task being performed, without concern for the mechanics of the system (see Galitz, 1993). The computer is ideally suited for automating routine functions, and these should not detract from those activities requiring human attention." (p. 369). This means that an online survey should not distract a respondent from providing answers by automating for example range and consistency checks. It thus affects *suitability for the task*: "The dialogue should avoid presenting information

not needed for the successful completion of relevant tasks.“ (ISO, 2006, p. 5) and *error tolerance*: “The interactive system should assist the user in detecting and avoiding errors in input.” (ISO, 2006, p. 10).

5. **Explicitness**. “The steps that the user needs to take should be obvious.” (p. 369f.). This relates directly to self-descriptiveness: “it is obvious to the users [...] which actions can be taken and how they can be performed” (ISO, 2006, p. 6).

6. **Comprehensibility**. “The system should be understandable to users. Jargon, idiosyncratic language and abbreviations should be avoided.” (p. 370). A general rule would imply to “use the vocabulary which is familiar to the user” (*conformity of user expectations*, ISO, 2006, p. 7).

7. **Tolerance**. “The system should be tolerant of human capacity to make errors.” This is equivalent to *error tolerance*.

8. **Efficiency**. “The system should be designed to minimize effort and maximize efficiency on the part of the user.” (p. 371). Applying the dialogue principles “supports usability in terms of effectiveness, efficiency and satisfaction” (ISO, 2006, p. 16). Common operations are also covered by suitability for the task. However, specific user demands relate to *suitability for individualization* “when users can modify interaction and presentation of information to suit their individual capabilities and needs.” (ISO, 2006, p. 11). Experienced users might increasingly find operations common and would benefit from available shortcuts.

9. **Supportiveness**. “This is closely related to the principles of explicitness and comprehensibility. Tolerance of errors and facilities for easy recovery from errors is another characteristic of a supportive system. The limited cognitive capacities of users should be recognized and accomodated. [...] Reliance on recognition rather than recall will help reduce cognitive burden for the user.” (p.371). This is closely related to *suitability for learning*: “If infrequent use or user characteristics require relearning of the dialogue, then appropriate support should be provided. [...] Appropriate support should be provided to assist the user in becoming familiar with the dialogue.” (ISO, 2006, p. 8).

10. **Optimal complexity**. “The early dictums on design (on both screen and paper) called for keeping things simple and maximizing the use of blank space. [...] Users both prefer and perform better with a moderate amount of complexity, rather than

too simple or too complex." (p. 371). In other words the dialogue should be appropriate for the task, unnecessary information should not be presented, necessary steps to completion should be included and unnecessary steps avoided (*suitability for the task*, ISO, 2006, p. 5).

2.1.6. Extending the ISO 9241-110 to the Context of Online Surveys

This section examines the recommendations in the norm. Each subsection begins with the definition of the principle, followed by a summary of the recommendations provided with each principle. The heuristics from the previous sections are fit into the set of the dialogue principles. In some cases a heuristic relates to several dialogue principles. The heuristic is then displayed only at one central principle to keep this overview readable. For more specific heuristics it was possible to identify corresponding specific recommendations, indicated by the number in parentheses. Finally, examples in the context of online surveys are presented. The main goal is to explain how the norm can be extended to the context of online surveys. Therefore, the examples should not be understood as being exhaustive.

The most likely argument against the applicability of the norm in the context of online surveys arises from an explanation of the recommendation 4.3.4 (ISO, 2006, p. 5):

> If typical input values are required, they should be available automatically as defaults.
>
> EXAMPLE 1 In a ticket machine at a railway station, where it has been determined that railway travellers typically buy railway tickets from the station they start their journey from, the station of departure is preselected at the start of the dialogue.
>
> EXAMPLE 2 Within a business application, once the user has identified him or herself to the system based on user name and password, the system automatically makes the e-mail address of the user available for processing wherever required in the dialogue.

The word "typical" was carefully chosen in the wording of this recommendation. It is not to be confused with 'probable' or 'most used'. Answers in online surveys are not typical in the sense conveyed by this recommendation because the whole range of answers should be collected without biasing the response. Example 2 raises the issue that when the survey asks for the year of birth in the beginning, it could insert the age on later pages automatically. Similarly, in panel surveys, gender and age could be taken from the panel database and be provided in the survey to prevent possible errors by less caring respondents. In panel surveys these values might already be set as defaults because respondents have provided these answers earlier. The norm itself contains words of caution:

> Not every recommendation within this part of ISO 9241 is applicable in every context of use. If the context of use does not imply user needs that correspond to one or more recommendations of this part of ISO 9241, then those recommendations do not apply within this particular context of use. (ISO, 2006, p. 4)

Suitability for the Task

> An interactive system is suitable for the task when it supports the user in the completion of the task, i.e. when the functionality and the dialogue are based on the task characteristics (rather than the technology chosen to perform the task). (ISO, 2006, p. 4)

All design elements should be targeted towards data quality and survey completion. The survey should present information related to the successful completion of the survey and avoid unnecessary information. Also unnecessary steps for participation should be avoided. If respondents draw the answers for a survey from external source documents the survey should match the units and layout to these documents. The online survey should support appropriate input channels, that is mouse and keyboard input.

The related heuristics of Norman, Shneiderman, Nielsen and Couper are: Norman's "simplify the structure of tasks" which corresponds to the recommendations 4.3.2 and 4.3.5 of the ISO, Shneiderman's "design dialogs to yield closure" which corresponds to the recommendation 4.3.5 of the ISO, Shneiderman's "reduce short-term memory load", 4.3.2 of the ISO, Nielsen's "aesthetic and minimalist design", 4.3.2 of the ISO, and Couper's "functionality" and "optimal complexity" which corresponds to the overall aspect of "suitability for the task". In the following sections the correspondence between the heuristics and specific ISO recommendations are pointed out in parentheses.

Guidelines referring to this heuristics would include but are not limited to the following examples: A list of answers should be exhaustive. 'Check all that apply' instructions should be used. The introduction of a survey on the first page should be kept short. Establishment surveys should ask for units which are already available so that respondents do not need to do recalculations to fit the answer format requirements. Online questionnaires should be organized like their offline counterparts when they are designed for data entry. Filter questions should be used so that unapplicable questions are not shown to the respondent (chapter 7). Taylor the design to meet the requirements of special subgroups, like visually impaired respondents (chapter 3).

Self-Descriptiveness

> A dialogue is self-descriptive to the extent that, at any time, it is obvious to the users which dialogue they are in, where they are within the dialogue, which actions can be taken and how they can be performed. (ISO, 2006, p. 6)

Information such as feedback and status information at any step of the questionnaire should guide the respondent in completing the survey. During participation, the need to consult help or other external information should be minimized. The respondent should be kept informed about the status of the survey, for example by providing an overview of upcoming steps and by making clear when input is expected. The survey should provide information about the type and format of expected input. The interaction with the survey should be apparent to the respondent.

The related heuristics are: Norman's "make things visible" (4.4.1 and 4.4.5 in the ISO), Shneiderman's "offer informative feedback" (4.4.1, 4.5.9, 4.5.2), Nielsen's "visibility of system status" (4.4.3), "recognition rather than recall" (4.4.4, 4.4.6), and Couper's "informative feedback" (4.4.1, 4.4.5), as well as "explicitness" which covers self-descriptiveness as a whole.

Examples: The button to proceed with the next page is clearly labelled, (e.g., 'next'). When a four digit year is desired, a 'YYYY' below the answer field should indicate this. When asking for the amount of fruit eaten today, the survey could indicate that one unit is the amount of one adult's handful of fruit. Questionnaires should use transitions to notice the respondents when the content of the questions switches to a different topic. Respondents should easily see which answer they provided after having clicked on an option (chapter 6). To give feedback about the progress of participation visual or textual progress indicators can be used (chapter 7).

Conformity with User Expectations

> A dialogue conforms with user expectations if it corresponds to predictable contextual needs of the user and to commonly accepted conventions. (ISO, 2006, p. 6)

The survey should use the vocabulary which is familiar to the respondent. Surveys should use answer structures and forms of organization which are perceived as natural. They should follow appropriate cultural and linguistic conventions. Survey behavior and appearance should be consistent within a question and across a survey. Immediate and suitable feedback should be given where appropriate to respondents expectations. The respondent should be informed if the system response time takes considerably longer than he/she would normally expect. Feedback and messages should be formulated and presented in an objective and constructive style. They should be based on respondents' needs. If a location of input is predictable, it should be ready for input.

The related heuristics are: Norman's "when all else fails, standardize" (4.5), "use knowledge in the head and knowledge in the world" (4.5.1), "get the mappings right" (4.5.4), Shneiderman's "strive for consistency" (4.5.7), Nielsen's "consistency and standards" (4.5.7), "match between system and the real world" (4.5.4), and Couper's "consistency" (4.5.7), and "comprehensibility" (4.5.1).

Examples: Rating scales should use labels indicating the continuum. When the delivery of questions to the respondent takes more than the usual time due to heavy server load, an additional animation can be shown to indicate progress. Having entered a non-valid year a concise message could be reading 'Please enter a year between 1890 and 2007.' Respondents not able to use the mouse may rely on the Tab-key and arrow keys to move within the questionnaire (cf., blind respondents, chapter 3). Clicking on the labels instead of the action button should also be considered a valid response (cf., errors in interaction, section 4.5).

Suitability for Learning

> A dialogue is suitable for learning when it supports and guides the user in learning to use the system. (ISO, 2006, p. 8)

Respondents should have access to rules and underlying concepts which are useful for learning how to participate. The information should assist respondents in becoming familiar with online surveys. Information should be available that support infrequent users of the Internet to participate and start the survey. Feedback and explanations should help in building a conceptual understanding of online questionnaires. Feedback should inform respondents about successfully accomplished activities. Online surveys should allow respondents to explore the interface without negative consequences. Especially new or complicated question types should be answerable for test purposes before real answers are provided. Participation should be possible with minimal learning requirements.

The related heuristics are: Norman's "exploit the power of constraints", Nielsen's "help and documentation", which both cover suitability for learning as a whole, and Couper's "supportiveness" (4.6.2).

Examples: E-mail invitations should always include instructions on how to start a survey, considering infrequent Internet users. Respondents can begin participating by clicking on a link. Instructions about anonymity, research goals and sampling help to build a conceptual model about survey research. Instructions to 'check all that apply' and to 'choose a single answer' help to build an understanding of the different visual answer pictures employed for these two types of questions (resp. check boxes and radio buttons). Unusual question types like interactive drag&drop ranking, direct picture selection, or enhanced matrix questions allow respondents to start with test answers, and then change their answers (chapter 6). Extended information about how to fill out and return a braille questionnaire enables blind people to participate in this mode without external help (chapter 3).

Controllability

> A dialogue is controllable when the user is able to initiate and control the direction and pace of the interaction until the point at which the goal has been met. (ISO, 2006, p. 9)

A respondent should be able to decide when to proceed through the questionnaire. If the participation has been interrupted, the survey should allow the respondent to continue where he left the survey. It should be possible to undo at least the last answer step. The survey should allow different input and output devices to function with the survey. The related heuristics are: Shneiderman's "support internal locus of control" (4.7.1, 4.7.2), "permit easy reversal of actions" (4.7.4), and Nielsen's "user control and freedom" (4.7.1, 4.7.2).

Examples: Next-, Previous-, and Save&Exit-Buttons allow respondents to navigate through a survey without loosing earlier answers while allowing to correct answers. A save&continue function allows respondents to continue a survey where they left off without loosing earlier answers. When respondents again click on a link in the e-mail invitation, they continue where they left off. The survey should allow keyboard and mouse input. It should allow the use of software which converts the questionnaire onto a braille line so that it can be read with the help of fingers (chapter 3).

Error Tolerance

> A dialogue is error-tolerant if, despite evident errors in input, the intended result may be achieved with either no, or minimal, corrective action by the user. Error tolerance is achieved by means of

> error control (damage control), error correction, or error management, to cope with the errors that occur. (ISO, 2006, p. 10)

The survey should assist respondents in detecting and avoiding errors. Explanations should be issued to help correct errors. When a correction can be done automatically, the respondent should be given notice and be able to change the correction. The steps needed for correction should be minimized. Validation and verification should be accomplished before data analysis. A respondent should be able to leave an error uncorrected unless absolutely necessary. If severe consequences would result from an action, they should be explained together with a request for confirmation. Respondents should not be able to cause survey software failures or reach undefined states in the survey system.

The related heuristics are: Norman's "design for error", Shneiderman's "offer error prevention and simple error handling" (4.8.8, 4.8.1), Nielsen's "error prevention" (4.8.8), and his "help users recognize, diagnose, and recover from errors" (4.8.1), and Couper's "tolerance", and "transparency" (4.8.8). Both Norman and Couper again cover error tolerance as a whole with their heuristics.

Examples: The last page of a survey should not include a 'next'-button. If a button is required it should be labelled 'Done' or 'Finish'. Questions which require an answer (e.g., filter questions) could be marked with an asterisk ('*') to highlight required questions. If an incorrectly formatted answer in a field for e-mail addresses requires a correction the survey should be specific about the type of format required, the question should be highlighted, and the cursor could be placed in the corresponding input field. However, if a respondent then chooses not to provide a valid e-mail address this should be possible instead of having the respondent enter a fake e-mail. If provided answers on the actual page would be lost when using the 'previous'-page button the survey should give a notice to the respondent and request confirmation. Complications can arise when several survey features are combined. Usually, answers are only saved when proceeding but not when moving back. This can be changed in some survey software systems. However, when used together with mandatory questions this could require respondents to first answer a question which runs counter to their goal of viewing an earlier page. Obviously, such system behavior contradicts the demand for 'controllability' because the question is not really required for viewing an early page. For the important aspect of real-time validations in online surveys Peytchev and Crawford (2005) provide a typology and discussion.

Suitability for Individualization

> A dialogue is capable of individualization when users can modify interaction and presentation of information to suit their individual capabilities and needs. (ISO, 2006, p. 11)

Respondents should be able to modify characteristics of the survey to adjust the questionnaire to specific needs. Whenever possible the following forms of individualization should be allowed or implemented: alternative forms of representation, different dialogue techniques, different methods of interaction with a survey, amount of explanation provided. All individualization should be reversible so a respondent can return to the original settings.

The related heuristics are: Shneiderman's "enable frequent users to use shortcuts" (4.9.6), Nielsen's "flexibility and efficiency of use" (4.9.1, 4.9.6), and Couper's overarching concept of "efficiency".

Examples: A survey is available in different languages. Formats are localized, for example dates in Germany are presented as '01. Jan 2008', whereas English speaking countries use 'Jan 01 2008'. Input values in the currency of the respondent are accepted. The survey system can save an additional variable with a converted currency needed in the analysis. The survey supports the use of screen readers. When using drop-down lists, respondents are able to choose an entry with the help of the mouse or by typing in the answer. A survey can be started by clicking on the link in an e-mail or by copying the URL into the browsers address bar. The layout of a survey still works with enlarged font sizes. If all definitions are visible by default, establishment surveys may allow to hide them behind a link.

2.1.7. Summary of Usability Heuristics and Their Relation to Each Other

The previous section has reviewed the applicability of various authors' set of heuristics to online surveys and finally extended the usability heuristics to the area of online surveys. Table 2.1 summarizes the comparison of the five sets of heuristics. Similarities in the wording among authors describing the same concept indicate a strong agreement in importance on these topics. These heuristics also have a longer tradition and a stronger basis than other heuristics. This is the case for feedback, error tolerance, and consistency. Consistency was described as to conform with user expectations. When online surveys behave unexpectedly, respondents are irritated. Both survey researchers and respondents benefit from consistent design which can be partly achieved by following existing survey design standards or recommendations (Crawford et al., 2005). Although there is no

Table 2.1. Summary of usability heuristics and their relation to the ISO 9241-110

	ISO 9241-110	Norman 1988	Shneiderman 1998	Nielsen 1993, 2005	Couper 1994
4.3	Suitability for the task	Simplify the structure of tasks 4.3.2, 4.3.5	Design dialogs to yield closure 4.3.5; Reduce short-term memory load 4.3.2	Aesthetic and minimalist design 4.3.2	Functionality; Optimal complexity; Transparency 4.3.2
4.4	Self-Descriptiveness	Make things visible 4.4.1, 4.4.5;	Offer informative feedback 4.4.1, 4.5.9, 4.5.2	Visibility of system status 4.4.3; Recognition rather than recall 4.4.4, 4.4.6	Informative feedback 4.4.1, 4.4.5; Explicitness
4.5	Conformity with User Expectations	When all else fails, standardize 4.5; Use knowledge in the head and knowledge in the world 4.5.1; Get the mappings right 4.5.4	Strive for consistency 4.5.7	Consistency and standards 4.5.7; Match between system and the real world 4.5.4	Consistency 4.5.7; Comprehensibility 4.5.1
4.6	Suitability for Learning	Exploit the power of constraints	—	Help and documentation	Supportiveness 4.6.2
4.7	Controllability	—	Support internal locus of control 4.7.1, 4.7.2; Permit easy reversal of actions 4.7.4	User control and freedom 4.7.1, 4.7.2	—
4.8	Error Tolerance	Design for error	Offer error prevention and simple error handling 4.8.8, 4.8.1	Error prevention 4.8.8; Help users recognize, diagnose, and recover from errors 4.8.1	Tolerance
4.9	Suitability for Individualization	—	Enable frequent users to use shortcuts 4.9.6	Flexibility and efficiency of use 4.9.1, 4.9.6	Efficiency

Note. The heuristics are fit into the dialogue principles of the ISO 9241-110 according to the original numbering from 4.3 to 4.9. When a heuristic relates to several dialogue principles, the heuristic is displayed only at one central principle to keep this overview readable. When a heuristic was very specific it was possible to identify related specific subprinciples in the ISO 9241-110, indicated by the assigned number.

doubt that consistency is of major importance, it is not central to the current work which examines new research strategies and focus on methodological improvements. Therefore, I focus on the other two principles, feedback and error tolerance. Both are central to a successful interaction between respondents and surveys. The next section integrates these considerations into the proposed framework.

2.2. A Proposed Framework for Human-Survey Interaction

While the previous sections focused on online surveys from a human-computer interaction perspective, the next sections integrate the disciplines into a proposed framework for human-survey interaction.

The process of respondents participating in a survey can be described as an interaction between humans and a survey. For an understanding about what constitutes a successful interactivity it is useful to view online surveys as a type of self-administered questionnaire where respondents participate by use of a browser. Usually, only a few questions at a time are presented to the respondent. The respondent answers by clicking on answer options and/or by typing text. Answers are submitted by clicking on a 'next'-button. Real-time validations of answers, edit messages and other kinds of feedback add to the interactivity of online surveys. This short depiction outlines only some of the possible interactivity between respondents and the survey. The main aspects of interaction for this work, feedback and error tolerance, were derived from the review of usability heuristics.

The survey aspect of the framework is concerned with visual survey design and how it affects response burden.

The human aspect of the framework contains models about the answering process, for example the satisficing theory as proposed by Krosnick (1991). It distinguishes between respondents who satisfice and those who optimize in answering survey questions. Survey researchers are concerned about the satisficing respondents because they produce answers of poorer data quality (e.g., less accurate) than optimizing respondents. The relevance of the three aspects of human-survey interaction for this work is considered in detail in the following sections.

2.2.1. Interaction: Feedback and Error Tolerance

The main focus of this work resides in the interaction between respondents and the survey. Many features in an online survey increase interaction, for example visual analog or slider scales (Couper, Tourangeau, & Conrad, 2006; Funke & Reips, 2006). As respondents

Figure 2.1. Proposed framework for human-survey interaction.

move and click with the mouse or enter answers with their keyboard an online survey can change the appearance of the questionnaire. Usually, only the answer controls change to show that a response was successfully placed. Useful approaches provide additional information as for example with tally questions where several items must add up to a certain amount. Here, a sum can be shown which is updated with each new entry of the respondent so that distributions in time estimates add up to 100% (Conrad, Couper, Tourangeau, & Galesic, 2005). Clarification features can aid respondents with additional definitions of the terms used in the question (Conrad, Couper, Tourangeau, & Peytchev, 2006). Response can be validated so that respondents are prompted for missing or inaccurate answers (Peytchev & Crawford, 2005). A usability goal is to reduce the probability of errors and misinterpretations in online surveys. Reducing errors in the interaction therefore improves survey quality. The feedback techniques and methods employed in this work improve the interactive experience of respondents with the survey.

2.2.2. Human: A Model of the Response Process

The human aspect in the framework considers the cognitive capabilities and processes in humans. The focus in online surveys is the response process. Tourangeau, Rips, and Rasinski (2000) proposed a cognitive toolbox approach to describe the different components of the response process. Table 2.2 shows an idealized list of components with the specific mental processes that they include.

The response process begins with question comprehension: reading the question, instructions, and assigning a meaning to the words and form of it. Survey researchers know that more complicated questions take more time to respond to (Yan & Tourangeau, 2008). This fact will later be used in study 3 to identify suitable response time indicators. The second component of the cognitive toolbox concerns retrieval of relevant information from memory. Several characteristics of the information affects the accuracy of the response, such as the degree of fit between the question wording and the information in memory. After retrieval a judgement is made to summarize the information. Finally, the response is mapped onto the available response categories or response format requested. For example when asked for the birthday, the response format could suggest four digits, so that respondents would leave out the day and month.

Table 2.2. Components of the response process (Tourangeau et al., 2000, p. 8)

Component	Specific Processes
Comprehension	Attend to questions and instructions
	Represent logical form of question
	Identify question focus (information sought)
	Link key terms to relevant concepts
Retrieval	Generate retrieval strategy and cues
	Retrieve specific, generic memories
	Fill in missing details
Judgment	Assess completeness and relevance of memories
	Draw inferences based on accessibility
	Integrate material retrieved
	Make estimate based on partial retrieval
Response	Map judgment onto response category
	Edit response

The four components of the response process are overlapping, for example it is likely that the retrieval commences with the reading of key words before a question is fully comprehended. To arrive at a response, respondents do not need to employ all these response strategies. Having understood that they do not know an answer, they may skip retrieval and judgment altogether and look for an appropriate response category or refuse to answer when no 'don't-know'-category is offered.

When a respondent performs all of these four steps carefully this is called 'optimizing' (Krosnick, 1991). The opposite behavior, that is skipping steps, taking cognitive short-cuts, or generally participating more sloppy is called 'satisficing'. Higher task difficulty, lower respondent ability, and lower respondent motivation increase the probability of satisficing behavior which is associated with poorer data quality. Forms of satisficing include higher selection rate of 'don't know'-answers and quicker answers. The demand on the respondent in terms of comprehension, judgment, and response mapping increase dropout (Peytchev, 2007). Also the number of items missing may increase as respondents with lower motivation proceed through a questionnaire (Heerwegh, 2005). Accordingly, indicators of satisficing behavior will be used in this work to show that an achieved increase in response rates are not burdened with poorer data quality.

2.2.3. Survey: Response Burden

The survey aspect in the framework is mainly concerned with response burden. Usability heuristics have benefited from concepts in psychology and other areas. Here, response burden conceptually comes so close to usability and survey research that it is examined in more detail.

Response burden is an important issue for business organizations due to the time and costs mandatory governmental questionnaires enforce on them. Considerable effort was invested to assess this type of response burden (Hedlin, Dale, Haraldsen, & Jones, 2005). Response burden is also known to impede data quality (Haraldsen, 2004) and to account for dropout (Galesic, 2006). According to Bradburn (1978) response burden consists of four aspects:

1. **Length**. The longer participation takes, the higher the burden imposed on the respondent.

2. **Respondent effort**. In addition to the length, different types of questions and surveys may require different efforts from respondents. For example simple questions about known facts such as year of birth are easier to answer than detailed information about finances. Open ended questions require more effort to answer than rating scales.

3. **Respondent stress**. The amount of personal discomfort a respondent undergoes during the interview. For example topics that are anxiety-provoking are more stressful than others.

4. **Frequency of being interviewed**. The amount of invitations received and the amount of participations adds to the overall burden of the respondent.

Regarding the length it is important to note that online surveys often look longer than paper-based surveys because the questions are spread over more pages. It is evident that this does not increase the length as such. As Abraham, Steiger, and Sullivan (1998, p. 839) noted in their study: "Our concern that the proliferation of 'pages' in the Web questionnaire, from 31 pages in the paper version to 67 (screen) pages in the Web, might increase response burden did not prove to be an issue". Besides the factual length recorded by the system response burden can also be measured as self-reported time or perceived time (Abraham et al., 1998; Galesic, 2006). Bradburn points out that the subjective perception of the respondent is important. Also the expected time as an aspect of burden can have an influence on survey response rates (Walston, Lissitz, & Rudner, 2006). Trouteaud (2004, p. 388) varied the information about how long the survey would last in the invitation (3–5 minutes vs. 10–15 minutes), yielding a 4% higher response rate in the shorter condition. Similarly, a review of the literature on the effects of questionnaire length on response rates by Bogen (1996) found a positive relationship between interview length and nonresponse, "but it is surprisingly weak and inconsistent." (p. 1024). The length can also be considered in terms of questions asked or the number of answer decisions a respondent has to make. For example a matrix question with one question but consisting of five answer items should be counted as similar to five single questions.

More difficult questions increase response burden and have a negative effect on data quality, that is the number of nonsubstantial answers in the form of 'don't know' (Knäuper, Belli, Hill, & Herzog, 2006). The effect of required effort on data quality and nonresponse is especially visible with ranking tasks. Neubarth (2008) reports higher dropout rates for a set of pair comparison tasks compared to rating tasks on the same items. In developing a ranking tool that uses drag&drop techniques several tests were performed to improve the usability and reduce the burden of the measurement tool. The revisions enabled most respondents to use the tool without external help (Neubarth, 2008). The respondent effort can also be measured by analyzing the amount of interaction errors within a survey or by asking respondents. The belief in the usefulness of surveys and "denial of the privacy-invading character of survey questions were strongly associated with low burden perceptions." (Sharp & Frankel, 1983, p. 36).

Respondent's stress reduces the accuracy of the answers as discomfort increases. A common notion is that answers to sensitive questions are subject to underreporting of undesirable behavior. Respondent stress is thus associated with the social desirability bias which accounts for nonresponse and underreporting (Biemer & Brown, 2005; Couper, Singer, & Tourangeau, 2004).

The frequency of being interviewed also directly affects nonresponse. It is common sense that a respondent who receives several invitations a day is unlikely to participate in all surveys as the available spare time must be divided between work and private life. Studies using subsequent invitations to new surveys after an initial contact phase show decreasing response rates (cf., Bosnjak, Neubarth, Couper, Bandilla, & Kaczmirek, 2008). Similarly, when respondents are invited to another survey at the end of a questionnaire the response rate is diminishing (cf., Kjellström & Bälter, 2003; Bandilla et al., 2009). Here, more respondents would not agree to be reinterviewed when the survey they had just participated in was longer (27 percent vs. 13 percent in the group with a shorter survey, Sharp & Frankel, 1983, p. 43). However, there seems to be an optimal amount of acceptable invitations which can be issued regularly. For example CentERdata in the Netherlands employs a panel with invitations on a weekly basis (CentERdata, 2008).

In an attempt to assess and reduce overall response burden (Hedlin et al., 2005) in establishment surveys, Hedlin and Jones (2005) propose the following guidelines for survey design which are similarly important for personal online surveys:

1. **Perceived importance of the survey**. The importance of a survey should be stated in the invitation or introduction of a survey (cf., Sharp & Frankel, 1983; Stocké & Becker, 2004).

2. **Personalising survey communication**. Surveys should be addressed to specific persons (whenever possible).

3. **Respondent-friendly instrument**. A survey should be well designed and consistent. This corresponds directly to the heuristic 'conformity with user expectations'.

4. **Survey notes and guidance**. Notes and instructions should be placed were they are needed. This corresponds directly to the heuristic 'Suitability for the task'.

5. **Cognitive burden of questions**. Questions should pass cognitive testing with respondents (cf., Converse & Presser, 1986).

Summarizing, response burden negatively affects nonresponse rates and overlaps with concepts from usability. Studies reported in this work will assess the response burden of different survey methodologies to support survey design decisions.

Other concepts subsumed under the survey aspect in the framework are questionnaire design issues. Dillman et al. (2005) approach visual survey design by applying principles of gestalt psychology and Norman (1988). They show how the principles can be applied to redesign survey questionnaires, resulting in a higher usability. Several studies have shown that visual design affects the response process. Some of these effects were already discussed in the survey life cycle in the introduction. Smyth, Dillman, Christian, and Stern (2004) provide several examples how visual grouping influences the answers.

Summarizing, the research on questionnaire design fits into the proposed framework of human-survey interaction as examples on how the survey interacts with the human aspect (the response process).

2.2.4. Nonresponse and Successful Human-Survey Interaction

The experiments described in this work draw on nonresponse rates as the main criteria to measure the success of different survey designs. To allow later analyses, this section therefore defines the different aspects of nonresponse.

The basic categories of nonresponse consist of unit nonresponse, partial response and complete response. People in the sampling frame who did not start taking the survey belong to unit nonresponse. People who started the survey but did not finish it belong to partial response. Items which were not answered are labelled as item nonresponse or items missing. Respondents who finish a survey belong to complete response. In online surveys there are additional categories which must be considered. An advantage of online surveys is that respondents can be traced while they step through the questionnaire. It is known whether respondents started the survey, whether they completed the survey and whether they stopped participating. In the latter case it is possible to track the question number where the dropout occurred (partial response). A new aspect in online surveys are potential respondents who proceed through the survey but do not provide any answers. They may be viewed as partials, completes with missing data (AAPOR, 2006), or lurkers (Bosnjak & Tuten, 2001) a term which derives from mailing lists where lurkers denote people who follow the list without providing input. The taxonomy proposed by Bosnjak and Tuten (2001) extends the basic categorization of complete participation, unit nonresponse, and item nonresponse to include lurkers and variants of these categories (figure 2.2).

To compare response rates across online surveys it is suitable to distinguish three measures. They enable researchers to evaluate the success of a survey in terms of response for several steps in the survey participation process. They are described as:

1. **Login rate**. Respondents who started the survey compared to the number of eligible contacted units. This is the number of respondents who have clicked on a link in the e-mail and viewed at least the first page of the survey. The login rate is a measure of the success of contacting and convincing respondents to participate.

2. **Dropout rate / completion rate**. Respondents who proceeded past the first page but did not finish the survey compared to the number of respondents who

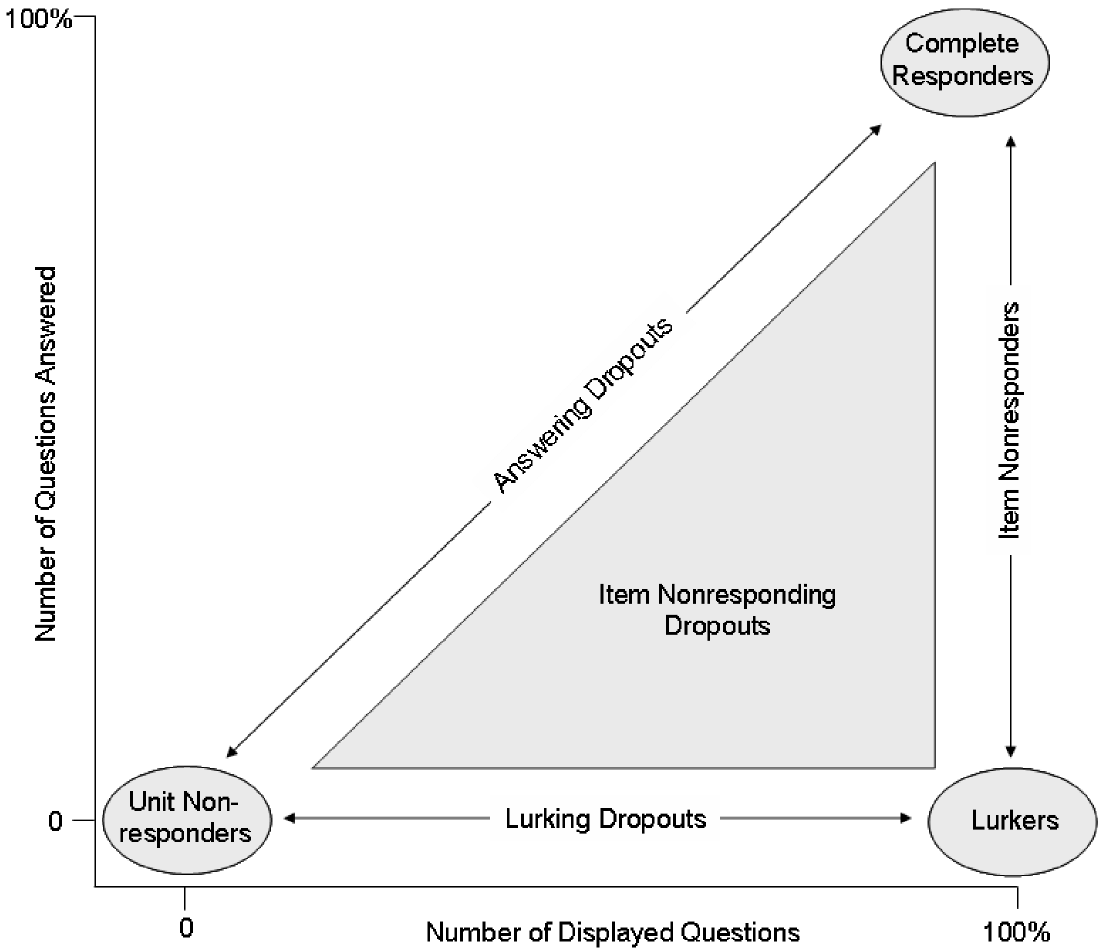


Figure 2.2. Response types in online surveys. Adapted with permission from Bosnjak and Tuten (2001).

started the survey. The dropout rate is a measure of the failure of the questionnaire to catch and maintain the respondents attention and interest. The opposite is the completion rate, comparing respondents who finished the survey with respondents who started the survey.

3. **Response rate**. Respondents who completed the survey compared to the number of eligible contacted units. The response rate is an overall measure of the success of the survey in terms of nonresponse.

Heerwegh (2005) provides the definitions for calculating response rates (table 2.3) and how they correspond to AAPOR's standard definitions. Depending on the research question there are different ways to define what completing a survey really means. The

Table 2.3. Definition of main response rates (Heerwegh, 2005, p. 42)

Rate	Definition
Login rate	Number of sample units starting the web survey divided by the number of sample units minus the known non-contacts and known ineligibles. This is equivalent to AAPOR's cooperation rate, definition 2.
(Complete) response rate	Number of sample units completing the final web survey page (excluding lurkers) divided by the number of sample units minus the known non-contacts and known ineligibles. This is equivalent to AAPOR's cooperation rate, definition 1.
Completion rate	Number of sample units completing the final web survey page (excluding lurkers) divided by the number of units that logged in.
Dropout rate	Number of sample units not completing the final web survey page divided by the number of units that logged in.

standard definitions of AAPOR (2006) include a discussion on how to distinguish between break-offs (dropout), partials and completes. One standard procedure is to count as follows: "Less than 50% of all applicable questions answered (with other than a refusal or no answer) equals break-off, 50%–80% equals partial, and more that 80% equals complete" (p. 23). Using a break-point for completes below 100% usually means that the calculated response rates increase together with an increase of missing data. Such procedures allow to save costs on interviews and are justifiable when the amount of missing data is minimized. In the current work however such procedures would blur the response rates and make them harder to compare. Furthermore, in online surveys specific information on the amount of missing data and page of dropout is available. To fully take advantage of this information, a complete is defined as having viewed the last survey page. All break-offs that happen before are termed partials, dropouts, or break-offs. The pages on which dropout occurs and the number of items missing then provide a deeper understanding of the effects in the conducted experiments. Because lurkers are one end of a continuum of partial responders with different amount of item nonresponse they are not excluded from the calculations in this work. This decision was also made because it is nearly impossible to identify the difference between a lurker who provides no answers at all and a similar person who does not provide a true answer but just answers one question 'for the fun of it' or by accidently clicking a radio button. In practice these two types of break-offs would not make it into the final data set. In this research however all data is maintained so that the variance in items missing is not arbitrarily reduced in the analysis.

2.3. Connecting Research Goals, Studies, Survey Methodology, and Usability

Research Goals

This work combines concepts from survey methodology, human-computer interaction, cognitive psychology, and usability to improve data quality in online surveys. Based on a literature review several approaches were integrated and a theoretical framework of human-survey interaction was proposed. Mapping the literature and terminology into the framework illuminated areas of major interest and worthwhile further research. In this context, researchers have been pursuing several methodological approaches to understand and tackle sources of survey error. In the following I identify areas with a lack of methodological conceptualization, namely paradata and develop instruments to support further research. After preparing the framework and instruments for research in the area of human-survey interaction several experiments apply the concepts to compare strategies in survey design.

This work argues that usability in online surveys can improve the respondents' experience and reduce nonresponse error. The specific research questions are as follows:

Chapter 1. How is this work related to the broader area of survey methodology? What is its role within the total survey error framework and the survey life cycle approach?

Chapter 2. What constitutes a research framework for human-survey interaction? How do sources of error and survey design fit into this framework? How do dialogue principles –namely the ISO 9241-110– concern survey design? How do the heuristics proposed by various authors relate to survey design and how do they fit into the proposed framework?

Chapter 3. How can the framework be applied to survey research?

Chapter 4. What instruments are needed to measure and improve the quality of online surveys? How can paradata be conceptualized? How can errors in the interaction between respondents and the questionnaire be reduced? What is the best measure for response times?

Chapter 5. What technologies are available in survey design? What is the amount of coverage of these technologies among respondents? How much would nonresponse increase when specific technologies are used in survey design? Which technology can be used to improve surveys without increasing nonresponse?

Chapter 6. How can feedback, visibility of answer options and interactive design increase usability and reduce nonresponse?

Chapter 7. What are current design flaws when providing feedback on survey progress to respondents? What are necessary aspects of useful progress feedback and how should it be designed to increase usability and reduce nonresponse?

Outline of Studies

This section shortly outlines the studies addressing the research questions. Overall, seven studies are reported, including several experiments to examine how questionnaire design, feedback, error tolerance, and interactivity relate to survey error and shape the usability of an online survey. The studies target a wide range of people: students, people above forty, visually impaired and blind people, and survey panel members. Overall, data from 33,821 individuals is analyzed. A first set of studies aimed to improve and assess the available instruments (paradata, response time measurements, technical availability of survey design features) which were then used in the second set of studies. The goal of the second set was to apply human-survey interaction to the design of online surveys to increase item completions (decrease item nonresponse) and survey completions (decrease the number of dropouts). The following studies were conducted:

Using the framework in survey design in study 1. In an attempt to make surveys accessible for visually impaired and blind people, guidelines based on the framework of human-survey interaction were developed for the three modes online, paper and braille. Pretesting of the questionnaires helped in refining the guidelines. A self-administered survey was conducted among the members of the association for the blind and visually impaired people of Baden in Germany. The application of the guidelines were successful for the different modes both in terms of response rates and respondents evaluation of the questionnaire.

Reducing interaction errors and improving response time measurement in studies 2 and 3. The term paradata has been accepted to refer to process data in surveys. Nevertheless, as the concept is still young a typology of paradata was developed, outlining new areas for research. A corresponding technical approach was then developed to collect all kinds of paradata. The two experiments illustrate how the typology and the instrument can foster new insights in the process of human-survey interaction. Study 2 illustrates how the typology and the instrument can help to identify and reduce errors in the interaction between respondents and answer buttons. The most widely used type of paradata are time stamps for response latency measurement. Among the different possible measures study 3 determines which of these are best-suited for online research.

Estimating nonresponse as a result of unavailable client-side survey design features in study 4, spanning three data collection periods. For the implementation of online surveys, design decisions about technologies must be made, for example whether JavaScript should be employed. On the one hand, respondents are expected to benefit from additional interactive features which could result in an increased data quality. On the other hand, the technology could lead to an increase of nonresponse canceling positive effects, because not all respondents might have the necessary equipment. This could result in technical problems and unaccessible surveys. Firstly, the technologies are discussed with respect to the usefulness in survey methodology. Secondly, censuses among student applicants clarify the amount by which unit nonresponse would be increased when specific technologies were to be used in an online survey. More importantly, they support design decisions about which technologies can be used to the methodological benefit of survey design.

Increasing item completion rates in studies 2 and 5. The use of matrix questions which combine several question items into a single question layout is associated with a higher dropout rate compared to single questions alone. The experiments show that the use of visual aids and visual feedback suceed in reducing item nonresponse. Moreover, the increase in responses has no negative effect on the data quality.

Increasing survey completion rates in studies 6 and 7. Feedback on progress is a common implementation in online surveys. When a questionnaire includes filter questions, a skip of questions usually leads to an unexpected jump in the progress indicator which may cause confusion and feelings of unreliability towards the feedback mechanism. Studies have shown that a poor implementation of progress indicators increase dropout instead of reducing it. Therefore, a method for dynamic progress calculation is developed which solves the problems filter questions impose. The experiments on progress feedback show that the new method is superior compared to other implementations in terms of response burden and nonresponse.

Connection between Research Goals, Survey Methodology, Usability, and Conducted Studies

This work is divided into three parts. They focus on theory, instruments and applications. Table 2.4 illustrates how the research goals are approached in terms of survey methodology and usability. The table shows a mapping of the main concepts of human-survey interaction framework onto goals, studies, and chapters. The next chapter will continue with developing and applying specific guidelines for visually impaired and blind people in a mixed mode setting.

Table 2.4. Overview of research goals, terminology, and conducted studies

	Goals	**Survey Methodology**	**Usability**	**Study Number**
Theory	Combine approaches into theoretical framework	Nonresponse, Response process, Response burden, Survey design	Dialogue principles, Usability heuristics, Feedback, Error tolerance	—, chap. 2
(propose framework on human-survey interaction)	Show usefulness of framework for mixed mode approach and in development of design guidelines	Cognitive psychology, Response burden, Nonresponse	Accessible survey design	1, chap. 3
Instruments	Derive a non-intrusive method to evaluate survey design. Reduce errors in interaction. Identify best time measurement criterium	Paradata, Attempts to respond, Response latency	Observing the user, Error tolerance, Click failures, Time on task	2, 3, chap. 4
(develop instruments and improve methodology)	Identify nonresponse associated with technology	Unit nonresponse, Item nonresponse, Dropout	Error tolerance, Accessible survey design	4, chap. 5
Applications	Apply usability to reduce items missing	Item nonresponse, Dropout, Response process	Feedback, Self-descriptiveness	2, 5, chap. 6
(apply theory and instruments to survey design practice)	Apply usability to reduce dropout	Dropout, Response burden	Feedback, Self-descriptiveness	6, 7, chap. 7

3. Using the Framework in Survey Design: A Mixed Mode Example (Study 1)

3.1. Deriving Guidelines for Different Modes

Good theories should be fruitful for research in that they foster new ideas, prove themself useful in practice and have a broad applicability.[1] The demands for conducting a survey for visually impaired and blind people are ideal to check on these criteria. Firstly, self-administered surveys with visually impaired and blind people are a worthwile undertaking when trying to understand cognitive processes with respect to questionnaire design. Constraints in the visual field reduce the possibilities of overcoming bad design in survey questions. Consequently, all effort must be made to avoid design pitfalls which in this context can easily result in inaccessible surveys. Secondly, the special demands of the target population make it necessary to derive practical guidelines and to reasses traditional survey design standards. Thirdly, the target population makes it necessary to design the questionnaire in several different modes. Although, I focus on the online mode, the theory will benefit from demonstrating its broader applicability to other modes as well.

The following sections illustrate how theory can be transformed into concrete guidelines for the design of self-administered surveys for visually impaired and blind people within a mixed mode approach.

3.2. Survey Design for Visually Impaired and Blind People

This chapter is concerned with the questionnaire design and the conducting of surveys for visually impaired and blind people. These people are challenged by the readability and

[1] **Acknowledgements**. Parts of this chapter are adapted with permission from Kaczmirek and Wolff (2007). I thank the Badischer Blinden- und Sehbehindertenverein (BBSV) [Association for the Blind and Visually Impaired People of Baden], all unnamed visually impaired and blind pretesters, and especially Karlheinz Schneider and Brigitte Schick for supporting this study. Dr. Harald Weber from the Institut für Technologie und Arbeit (ITA) [Institute for Technology and Labour, http://www.ita-kl.de/] in Kaiserslautern, Germany supported the online version by providing an accessible prototype for online surveys. The online survey was pretested by the initiative LOB: Land ohne Barrieren [country without barriers, http://www.land-ohne-barrieren.de/], Kathrin Kaschura.

usability of traditional paper-based text. Associations for visually impaired and blind people cope with the special requirements by providing various possibilities to obtain textual material. The text corpus may be printed in a bigger font, text may be converted to braille[2] paper or be read aloud to provide audio material. Additionally, text may be obtained electronically and listened to with the help of a screen reader or read by means of a braille display. Special devices can be used (enlargers) which magnify text while allowing for an increase in contrast and changes in color (e.g., yellow on black instead of black on white text). All these aids have in common that they enhance the focus of a specific piece of text and sometimes just a single word. This advantage turns into a disadvantage in terms of a clear overview and arrangement of the text elements on a page. Therefore, text needs to be designed with cognitive processes and accessibility standards in mind. This is especially true for a survey questionnaire because each question and answer item must be self-explanatory.

Several design guidelines for a large font paper-based version, a braille version and an online version of the same questionnaire were developed. These guidelines for the different modes support the various ways in which the target population is used to read and respond to written material.

3.3. Method: Mixed Mode with Paper and Pencil, Braille and Web

This work originates from a survey conducted among the members of the Association for the visually impaired and blind people of Baden in Germany. Prerequisites were a low budget which ruled out the possibility of a telephone survey.

3.3.1. Procedure

To ensure that each member is able to receive information provided by the association it is a standard procedure to develop a number of versions of a text in different modes. The newsletter for example is provided in usual font-size, as a braille version, and as e-mail. Thus, it was a requirement to develop a braille version, a paper-based text version and an online version of the questionnaire. All members of the association received either a large font version or a braille version of the questionnaire identical to the mode in which they receive information material from the association. About three quarters of the members

[2] Braille is a system of printing textual material with raised dots that can be read by touching them. Letters and numbers are represented by a specific combination of dots.

have subscribed to receive textual material. The invitation included an envelope with post stamps for free return. The survey was conducted in German.

3.3.2. Participants

The target population were members of the Association for the visually impaired and blind people of Baden in Germany. All members of the association were invited to participate in the survey (n=518). No incentive was provided. Of the 235 respondents 46% were males and 54% were females, resulting in a total response rate of 45%. The mean age was 67 with a standard deviation of 14 years. Respondents were either blind (55.6%) or visually impaired (42.7%). Only four participants (1.8%) reported to have good eyesight. Table 3.1 shows the number of responses for the different survey modes. The response rates for the different survey modes were estimated on the basis of how many respondents receive the newsletter in this mode. For the online mode 20 people receive the e-mail newsletter. Because these people are expected to participate online, the response rate for the online mode was 55%. Accordingly, the response rate for the paper version was 50%. The braille version had a lower response rate of 30% which is still good given the fact that answering the questionnaire with a braille typewriter is a very time-consuming task which can take more than an hour for only twenty questions.

The answers about Internet usage ("How often do you personally use the Internet at home?") reveals that the majority (81,5%) do not use the Internet or do not have Internet access. Only 15.1% are using the Internet two times per week or more often. In the large font version 70% reported that they needed help from a second person to fill in the questionnaire, whereas in the braille version only 19% and in the Web survey none requested help from others to participate. Overall, participation was perceived as rather easy (17.9%) or easy (77.7%).

Table 3.1. Distribution of responses for each survey mode

Mode	Response	Proportion	Response Rate within mode
Large font paper version	192	81.7%	50%
Braille version	32	13.6%	30%
Web survey	11	4.7%	55%
Total	235	100%	

3.3.3. Questionnaire

The content of the questionnaire was related to demands for supporting equipment, assistance, training, attitudes to social activities and basic demographic data. It consisted of twenty questions and only three basic question types: 'check one that applies', 'check all that apply', and open question formats. Respondents were able to provide additional information for some questions with an answer item which read "Other, please specify:_ _ _". Figure 3.1 shows a design example for the online survey implementation.

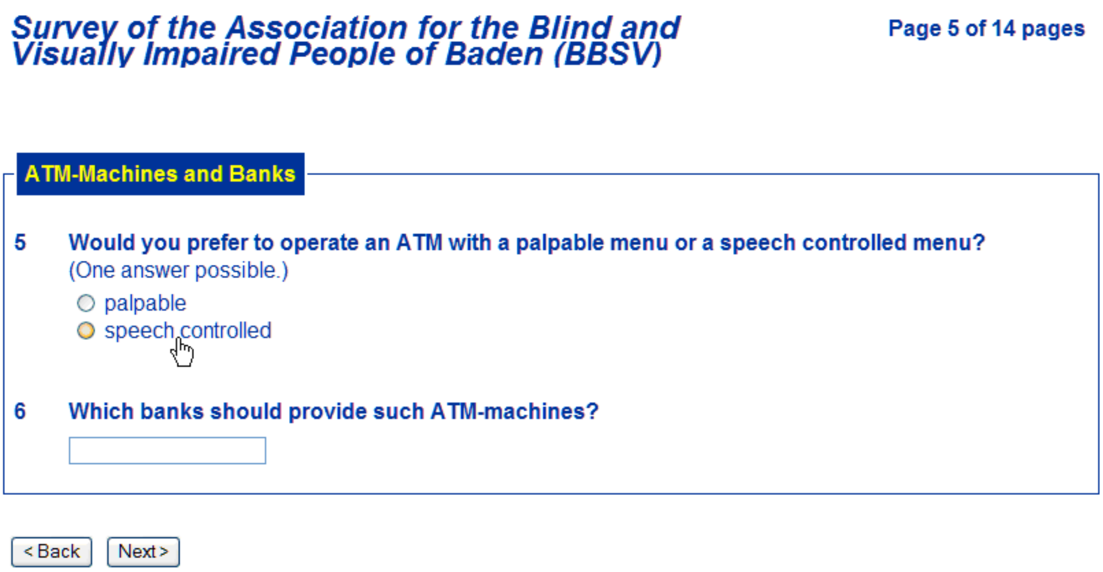


Figure 3.1. Example of survey design in the mixed mode study. The figure shows the screenshot of page five of the online survey version. The original survey was conducted in German. Technical note: The use of label-tags in the HTML-structure make it possible to give an answer by clicking on the answer text and allow screen readers to identify the correspondent radio buttons. Usage of the field-tags results in the grouping of the two questions with a heading and a frame.

3.4. Cognitive Aspects of Survey Design for Visually Impaired and Blind People

Modern approaches in survey research develop questionnaires based on the knowledge from cognitive psychology (Tourangeau et al., 2000). In recent years principles of gestalt theory were adapted to questionnaire design (Dillman et al., 2005) and the usability of a questionnaire (Couper, 2000a; Hansen & Couper, 2004) especially in online surveys

(Crawford et al., 2005) has become an important issue. Despite these new developments, the traditional concept of burden, early defined by Bradburn (1978), still plays an important role in assessing some of the problems involved in survey design. The following subsections explain how cognitive concepts shape the design specifications for surveys for visually impaired and blind people.

Challenges can be categorized into three main aspects: (1) providing overview (e.g., position markers), (2) navigational aids (e.g., clear identifiers for distinguishing between questions and answers), and (3) supporting the sequence of the questionnaire flow (e.g., allowing answer checks at the immediate right end of an answer option in the paper version).

3.4.1. Provide and Support Overview

A questionnaire should provide information about the survey to foster the overview on (a) a general level and (b) at the level of specific questions. People with an impaired visual field, for example a tunnel view find it difficult to get an overview of a page. Several single aspects must first be viewed separately and put together to actively form a whole which is not visible at one glance. Similar problems occur with enlarger devices, braille paper and screen readers. Figure 3.2 shows the traditional layout of a question in a paper-based questionnaire. The corresponding figure 3.3 illustrates the challenges of restricted visual fields. The light rectangle exemplifies the visible part when using an enlarger, the circle can be seen as the result of tunnel vision.

5. What would you prefer in an ATM?
I prefer a palpable menu .... ☐
I prefer a speech controlled menu .... ☐

Figure 3.2. Traditional standard layout in a paper-based questionnaire.

The beginning of a questionnaire should therefore explicitly include information about the length of a survey in terms of number of questions and number of pages (also a footer indicating "page 1 of 6" should be added). As in traditional surveys the topic should be noted. Furthermore, instructions on how to participate need to be stated ("Please fill in the questionnaire and send all pages back to us with the enclosed envelope, which we did address and stamp for your convenience."). In the braille version we included additional instructions for the use of a braille typewriter. Respondents were asked to write the number of the question and their answer in full text: "At the end of the questionnaire you

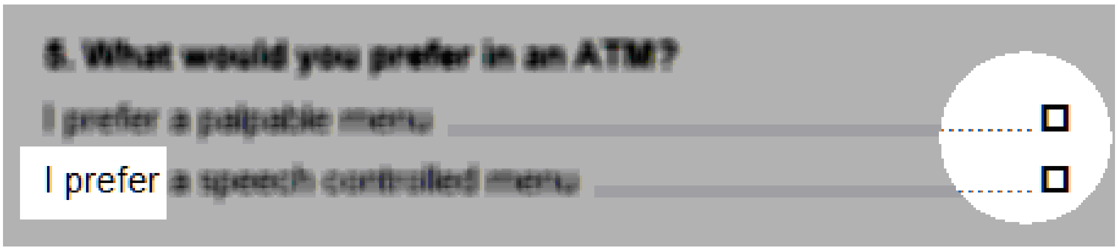


Figure 3.3. Demonstration of possible restrictions in the visual field due to a magnifying device (rectangle) or tunnel vision (circle). The background is blurred and shaded to stress the visible parts.

5. Would you prefer to operate an ATM with a palpable menu or a speech controlled menu? (One answer possible.)
a) palpable □
b) speech controlled □

Figure 3.4. Redesigned survey showing question five of the paper-based survey. This example demonstrates the implementation of the guidelines for an enhanced overview at question level, resulting in improved navigation, orientation and easier cognitive processing.

will find three sheets of paper suitable for your braille typewriter. To answer a question, please write the question number together with your preferred answer. For example to answer question 13 with ‘female’ you would write: ‘question 13 female’. Please start each answer in a new line.” The Web version implemented a textual progress indicator. In the same manner a footer was placed in the large font version.

Besides providing a general overview, extra information is also helpful within each question. Each question has to make clear how a response should look like, that is whether it is a “check one”, “check all that apply” or “write your answer” question type. It is important to note that in contrast to the usual wording mentioned above, the wording in the questionnaire indicated the question type with the first word: “One answer is possible”, “Several answers are possible”.

The braille version provided additional information about the amount of possible answers and instructions to answer the questions. Examples for a set of extra information per question in the braille version are: “Several answers are possible among 5 answers”, “One answer is possible among 3 answers”, “Please write your age on the answer sheet”. If the extra information was redundant for the question, it was not included, so that respondents did not feel fooled: For example “Are you male or female?” was not followed by “(One answer is possible among 2 answers)”.

The guidelines to improve overview are as follows:

1. Reduce the number of question and answer types to as few as possible.
2. Inform about the topic of the survey.
3. Provide instructions on how to fill in and return the questionnaire.
4. Provide information about the length of the survey. Add a footer or header with page numbers and the total amount of pages.
5. For a braille version indicate the amount of available answer options after each question.
6. Indicate the type of answer after the question. For example: "One answer is possible", "Several answers are possible".

3.4.2. Provide Navigation and Orientation Aids

People suffering from restrictions of their visual field find it impossible to benefit from the traditional layout of paper-based questionnaires. One may think that the two answer options in figure 3.2 are easily identified. On the contrary, this is not the case for people using a magnifier or suffering from tunnel vision (figure 3.3). The fact that both answer options start with the same eight letters makes them harder to distinguish from each other. When moving the paper to the left under an enlarger device in order to read and then turning back to the next line with one quick move, respondents might have the impression that they had accidentally positioned the paper on the same line. As a consequence they move further down and skip the second answer alternative. Pretesting revealed that with the fast and often practiced movements involved in the use of enlargers some questions and more often answer categories were easily missed in the case of traditional survey layout. A similar consequence of such restrictions is that identical wording at the end of an answer option (in this example the word "menu") adds an additional hurdle to match the answer field with the distinctive meaning of an answer option. Thus, respondents need to be extra careful and crosscheck their paper or eye movements to avoid unintended line switching.

A restriction of the visual field makes it more difficult to orientate oneself on a sheet of paper and to focus the attention on the desired parts. Loosing orientation or the focus of attention could lead to the following outcomes:

1. A page is skipped and is lost.
2. A question is skipped.
3. Answer categories are skipped and not considered.

An example how a page could be skipped was revealed through pretesting with a braille version of the questionnaire. The participants started by flipping through the pages, reading parts of the top and the bottom which contained the numbering. The paper sheets were turned to also scan the back of the papers for text. Each paper was then laid on the table or kept on the knees. By accident a paper sheet was put on the table aside from the other paper sheets. The remaining pile lead to the impression that the survey consisted of fewer pages resulting in unintentional partial nonresponse.

The derived guidelines draw from the principle that each question and answer option should be distinguishable from each other. Figure 3.4 shows part of the redesigned questionnaire for the large font paper version. The following measures proved to be successful navigation and orientation aids:

7. Start each question with a consecutive number followed by a period, making each new question distinct from the very beginning.
8. Include empty lines (spacers) only before each new question but neither between answer categories, nor between the question and the answers. This visually groups questions and answers together.
9. Start each answer category with a consecutive letter beginning with a) for each question. This helps to distinguish the answer options from each other and differentiates them from the questions which are numbered.
10. Reformulate the answer options towards a maximum of different letters at the beginning and at the end of each item while keeping the meaning. This ensures that each item is easy to distinguish at the start of the line and in the region of the answer options.

3.4.3. Streamline the Answering Process

Usually, the layout of a questionnaire is based on principles of gestalt theory, like proximity and grouping (Dillman et al., 2005). As a result, check boxes are aligned on the right side of a page in paper-based surveys (sometimes with dotted lines to aid eye movement) and the left side in Web surveys. This is only reasonable when a respondent is able to see the whole of the line and can easily connect the answer boxes with the answer categories. Obviously, respondents who only see a few words at a time (some people enlarge only one word at a time) may have difficulties reaching beyond the white gap or following the dotted line between answers and check boxes. What is worse, pretests made it clear that due to the fact that the right side looks like a column of similar boxes only, the correctly corresponding right box is difficult to reach and remains unclear. The intentional effect of such visual grouping does therefore not hold in this case and the linkage between answers and answer fields is broken. As a solution, traditional grouping may be avoided. Nevertheless, the answer fields are placed to the right to allow an immediate response after reading without the need for an errorprone return to the beginning of the answer option.

As a second point, processing all answer options can be time-consuming when a scanning of the lines is not possible. Reaching a valid answer and considering the available options can easily be supported by formulating all answer options into the question. As a positive side effect such wordings also reduce acquiescence (Dillman, 2007). For example instead of asking "What would you prefer in an ATM?" the question reads "Would you prefer to operate an ATM with a palpable menu or a speech controlled menu?"

Accordingly, the guidelines supporting the answer process are as follows:

11. In a paper-version include check boxes directly after the answer text, leaving a ragged right. Instruct respondents to mark either the checkbox at the right end or the character at the beginning of an answer option.

12. Formulate the questions to include all answer categories wherever possible, if only a few answer categories exist. Such a procedure is known to reduce burden for the respondents.

3.5. Summary and Conclusion

This chapter described the development of twelve guidelines for the design of self-administered surveys for visually impaired and blind people within a mixed mode approach. Three modes (paper-based, braille-based, Web-based) were considered to accommodate to the various channels of communication visually impaired and blind people are used to.

Visually impaired people use reading aids to process text. These aids have in common that they enhance the focus of a specific piece of text or single word. This advantage turns into a disadvantage in terms of a clear overview and arrangement of the text elements on a page. Therefore text needs to be designed with cognitive processes and accessibility standards in mind. The guidelines which were derived as a solution for the various design problems are summarized in table 3.2.

The discussed approach is appropriate for projects where a personal or telephone interview is out of scope. Such cases might occur when there is a need to stay within the online medium (e.g., in website evaluation forms), with missing phone numbers or simply under-funded budgets. Considering the expected difficulties with written material and the advanced age of the target population the response rate exceeded expectations. Concepts from cognitive psychology in combination with user tests have shown to be a valuable source for deriving possible solutions and developing the design guidelines for surveys with visually impaired and blind people.

Table 3.2. Guidelines for the survey design for visually impaired and blind people

	Design for Overview
1.	Minimize questions and minimize answer types.
2.	Inform about the topic.
3.	Instruct on how to fill in and return the questionnaire.
4.	Inform about the length; use a progress indicator.
5.	Braille: Indicate the number of available answer options for each question.
6.	Tell the answer type: “One answer is possible”, “Several answers are possible”.
	Design for Navigation
7.	Number consecutively, making each new question distinct from the very beginning.
8.	Visually group questions and answers together.
9.	Number answer categories with consecutive letters.
10.	Reformulate the answer options towards a maximum of different letters in the beginning and at the end of each item, while keeping the meaning.
	Design for Questionnaire Flow
11.	In a paper-version include check boxes directly after the answer text, leaving a ragged right.
12.	Formulate the questions to include all answer categories wherever possible, if only a few answer categories exist.

Instruments

4. Developing the Concept of Paradata

4.1. Background

The term paradata has been accepted to refer to process data in surveys (Heerwegh, 2003).[1] Nevertheless, as the concept is still relatively young this section starts with a short history of the different data concepts, namely data, metadata, and paradata. Then, some of the more common applications of paradata are described. This leads to a typology of paradata, outlining new areas for research. A corresponding technical approach is then developed to collect all kinds of paradata. Finally, two empirical experiments illustrate how the typology and the instrument can foster new insights in the process of human-survey interaction.

Computers have improved data collection and processing. Answers (reactive data) are saved in nearly ready-to-analyze data sets and process data (non-reactive data) can automatically be captured and saved to enrich the information given in the answers (e.g date and time of an interview).

In this context, a common distinction between reactive and non-reactive data is made (Diekmann, 2007; Schnell et al., 2004). Answers in surveys are categorized as reactive data. This reactivity is a possible source of error in surveys because the measuring process itself can influence the answers. In the case of non-reactive data respondents are not conscious of the fact that this data can be used for analysis as non-reactive data are traces of behavioral processes. One example is the duration of an interview. Respondents are informed about this kind of data collection prior to the survey. Nevertheless, they are unlikely to be conscious of the collection and usually will not think about the data being used for data cleaning purposes after the survey. In the Internet non-reactive data emerge from all activities and is often collected, for example as visitation patterns of websites. The corresponding logfiles are of ongoing research interest (Sterne, 2002).

This chapter concentrates on non-reactive data in the context of surveys, that is paradata. Paradata are data points which do not require any explicit data entry on the

[1] **Acknowledgements**. This chapter is based on a German publication by Kaczmirek and Neubarth (2007). Wolfgang Neubarth developed and programmed the initial version of the paradata-tracker-script and reviewed the German manuscript.

respondent's side (Heerwegh, 2003; Bosnjak & Tuten, 2001; Couper, 1998). They can be collected automatically and provide additional information about the process of a given interview. Paradata could therefore be referred to as process data as well. I define paradata as containing three aspects:

1. Data which is not consciously provided by respondents.
2. Data which is available on a per person basis.
3. Data which can be abstracted and aggregated to more general and meaningful information.

Metadata should be distinguished from this concept. Metadata describe the survey data and the whole project. Well-known examples for metadata include the codebook and project descriptions. The data documentation initiative provides an extensive classification scheme for metadata (Blank & Rasmussen, 2004). The collected data can only be meaningfully analyzed with the help of metadata. Thus, metadata does always accompany the data. This is not necessarily the case with paradata. Table 4.1 summarizes the three types of data.

Table 4.1. Paradata, metadata and data about respondents in surveys

Paradata	**Metadata**	**Data**
Information about the survey process of single respondents and its aggregations. Often the data is automatically collected.	Information describing the data.	Answers provided by or about respondents.
Examples: duration of each interview, duration for each question and respondent, number of mouse clicks on a page, sequence of presented questions including "flipping to earlier survey questions", the page a dropout occured, screen resolution.	Examples: codebook, additional descriptions of questions, general project descriptions such as the organization conducting the survey, the period of data collection, noteworthy political and social events during the time the survey was fielded.	Examples: self-reported data, data reported by other persons, test data. For example attitudes, gender, income, education, personality, intelligence.

Before the Internet was accepted in the canon of survey modes, paradata was subsumed under the notion of metadata. With online surveys emerging, the need for an independant category for paradata became clear. This was mainly due to the fact that online surveys opened a new research area based on the huge amount of automatically collectable process data. The conceptual extension of the data concept was first presented by Couper (1998) who described additional examples of paradata and its distinction to metadata:

> As discussed elsewhere (Couper, 1998), one of the benefits of computer-assisted data collection is that a great deal of automated data is generated by the process and these data can be used in turn to evaluate the process. I term these sources of information 'paradata' (auxiliary data describing the process) to distinguish them from metadata (describing the data). Sources of paradata include case management information such as response rates, number of calls per case, average interview length, and so on. A most useful type of paradata for usability evaluation is keystroke or trace files (also called audit trails). (Couper, 2000a, p. 393f.).

4.2. Applications of and Approaches to Paradata

Refusals and survey break-offs are the most commonly reported paradata because they are part of each survey and part of the standard documentation practices (AAPOR, 2006). They can be derived from the collected data without the necessity for additional programming or data collection. Bosnjak and Tuten (2001) have used this kind of paradata to develop a typology of response behaviors. A logical next step to collect more information about response behavior is to save the response times per survey page (Fraley, 2004). To collect response times per question, a more detailed approach is needed. Janetzko (1999) has provided scripts, which collect reaction times between different mouse clicks. A more extensive collection of scripts (The CSP Project, Client Side Paradata) is maintained by Heerwegh (2003, n.d.). The CSP-script saves data on reaction times, changes in answers, detected pauses and scrolling. The data can be used to analyze response times.

Draisma and Dijkstra (2004) comprehensively discuss the implications and importance of response times. The authors emphasize that substantially different causes may lead to similar response times. To make things worse, wrong answers are associated with a longer response time. Simultaneously, fast responses lead to a higher degree of wrong answers as well. Answering complex questions takes more time, and the response time increases with the length of the question (Yan & Tourangeau, 2008), whereas strong attitudes shorten the time needed to respond. Similarly, short answer times may be an indicator of correct answers in knowledge-based questions. Summarizing, it is pointless to assume a single cause for any given response time. Instead researchers need to consider the type of the question, the answer options, and the context of the question to arrive at testable assumptions about appropriate response times.

Even more paradata with a nearly incredibly high amount of data points arise with non-standard interface elements which use freely moveable objects on the screen (Neubarth, in press). Applications are visual analog scales (VAS) –often used in medical research (Bälter & Bälter, 2005)– and ranking tasks which are important in market research (e.g., conjoint analysis Welker et al., 2005). Possible data points are, among others position of the first click, movements of objects, and end positions.

In addition, more conceptual kinds of paradata have been described. Haraldsen (2005) used the number of elicited error alerts in a survey to calculate a quality index of a questionnaire. Possible error alerts are all requests that demand to reformulate the answer, for example as a result of automatic data validation procedures.[2] Wrong entries may be invalid numbers or characters in fields where only digits are allowed. The quality of a questionnaire is calculated as one minus the ratio of activated errors to possible errors considering the number of respondents (Formula 4.1).

$$QualityIndex = 1 - \frac{\sum(\frac{activated\ errors}{possible\ errors})}{n} \tag{4.1}$$

According to Haraldsen (2005), this quality index was successfully implemented and improved establishment surveys of Statistics Norway.

Overall, paradata are applicable to many areas of empirical social science research (Couper & Lyberg, 2005). However, the reader should be cautioned that paradata should only be collected as a means to improve or measure the quality of surveys. They should never be misused to spy on respondents (Janetzko, Hildebrandt, & Meyer, 2001). The demand for informed consent also needs special consideration when planning to collect paradata. The guidelines for online surveys which was signed by several organizations state explicitly that whenever data is collected in an unnoticed way respondents need to be informed beforehand and they need to give informed consent (ADM et al., 2000). Moreover, respondents must be able to refuse their consent at any time during participation, in which case the data must immediately be deleted.

After illustrating the various and diverse forms of paradata, the next section develops a typology to integrate and classify the different aspects of paradata.

2 A comprehensive typology of real-time validations of data entries in online surveys is provided by Peytchev and Crawford (2005).

4.3. Conceptualizing Paradata

As outlined above, Couper (2000a, p. 393f.) used the concept of paradata to encompass the process data of single surveys (e.g., the duration of an interview) and their aggregates (e.g., the average time an interview takes). By means of computer-assisted data collection and especially in online surveys, single data points can by now be traced, classified and saved right down to single actions like mouse clicks and keyboard-input. In order to better understand the various aspects of paradata this chapter proposes a hierarchical typology on four levels within the dimension of respondents, variables, and time (table 4.2). Figure 4.1 visualizes the data model and the different levels of aggregation.[3] This typology illustrates that different aspects of paradata are suitable for an analysis of several different research questions.

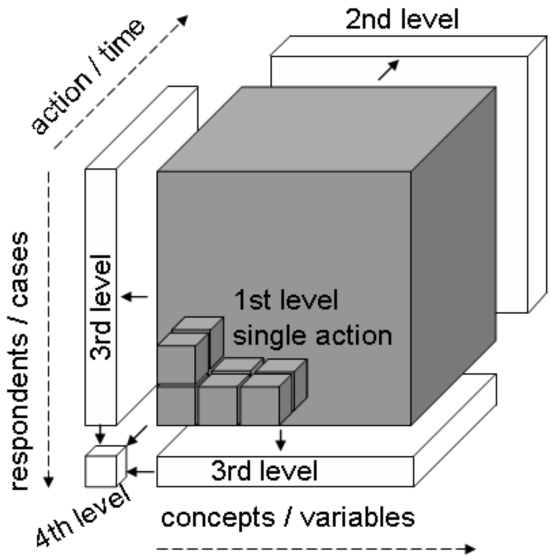


Figure 4.1. Paradata model. See also table 4.2.

On the first level paradata are very basic data points. They include the process data of each person's single actions within an interview such the time of a mouse click or the point onto which a respondent clicked on the survey page. The fact that every single mouse click or keyboard input can be registered can easily lead to a vast amount of data points and variables that cannot be easily analyzed. As the amount of paradata

[3] The data model shows similarities to the data boxes by Wittmann (1990) who demonstrated that researchers can benefit from a systematic view on data both in conceptualization of variables and in analysis.

Table 4.2. Typology and aspects of paradata

Fourth level paradata: Aggregates across variables and persons. They describe the whole survey with a single number. Examples include the response rate, and the average time it takes to complete the survey.
Third level paradata: Aggregates across variables *or* persons. The first summarizes single respondent's behavior over time in a single variable (e.g., duration of each interview, interview date). The latter summarizes all respondents' behavior in a relevant concept (e.g., average time to complete a specific question).
Second level paradata: Aggregates across actions, resulting in content which is conceptually relevant. They describe the behavior of single persons. A concept is formed by several variables each describing a different period of participation. Examples include the view times of single survey pages, the number of mouse clicks per page, and the number of changes in answers per question.
First level paradata: Records of single actions or events emitted in the process of survey participation. They describe individual actions. Therefore, the amount of possible values is not determinable before survey start. They lack meaningful content and are technical in nature. Examples include a mouse click, a mouse movement, a key press, and timestamps and location of the action.

Note. See also figure 4.1. In this typology the amount of data decrease from the first to the fourth level while the level of aggregation increases from the first to the fourth level.

on this basic level cannot be regulated before beginning the survey, this problem is even increased.

It is therefore helpful to decide for which research questions these primarily meaningless data points are intended, before starting the survey. These concepts are paradata on the second level in the sense that such concepts integrate several data points of the first order in a defined time frame into a meaningful unit. Within the second level a number of necessary variables can be assigned beforehand. This makes it possible to set up the data matrix before the survey is conducted.

An often implemented concept of the second level is the response time. It can be measured with different approaches and definitions which will be discussed in detail in study 3. The study shows that the definition of a concept requires a careful procedure as the various concepts can be fraught with different sources of disturbance. Still, second level concepts are the key to a useful analysis of paradata.

Paradata of the third level again condense the variables of the second level by aggregating them into one value per respondent *or* across more than one respondent. They sum up values to include a whole interview. In the case of response times this would correspond to the cumulated response time across all questions per respondent, or to the average response time of all respondents per question.

There are also paradata of the third level that already exist without aggregation. These include for example the dropout page in case of an interview break off, the time and date of the beginning of an interview, the screen resolution used, whether JavaScript can be executed, whether the participant allows Cookies and many more. These paradata can provide information on whether a valid interview has been taken place and its circumstances (Kaczmirek & Thiele, 2006).

The most abstract level is formed by paradata on the fourth level. They condense the complete survey into one value. Such a value can be for example the average duration of the whole survey among all participants or the response rate. On this high level of description the separation between paradata and metadata begins to blur. Metadata as well as paradata on the fourth level provide descriptions of the survey as a whole. Nevertheless, paradata on the fourth level can be traced back to paradata on a lower level and therefore back to individual participants. This is not possible for metadata. For example a project description does not relate to any specific respondent.

Apart from their conceptual meaning and the above proposed hierarchical system paradata can be divided into server-side and client-side paradata. This depends on whether they are collected on a Web-server or on the local computer of the participants (Heerwegh, 2003). Server-side paradata are the most common as most survey software packages regularly collect information like time stamps for delivered pages, dropouts or the status of participation (Kaczmirek, 2008). Client-side instruments are necessary when server-side process data are not enough because information about events within an interview page or on the pages of the participants is needed. This includes information on scrolling or the exact time measurement of single actions. Usually, JavaScript is used for the collection of such information.

The proposed division of paradata into four distinct levels improves the planning, analysis and evaluation of paradata. It provides a structure in which mere technical data points can be identified and meaningful paradata can be conceptualized.

4.4. An Instrument for the Collection of Client-Side Paradata

To collect paradata of the first level and to resolve single actions within a page, it is necessary to employ client-side methods. The proposed approaches so far (cf., Janetzko, 1999; Heerwegh, 2003) have in common that they require the insertion of program code in every element that is of research interest. Therefore, a researcher usually tweaks every answer button to catch the associated clicks on these elements. This task is time-consuming and error-prone in self-programmed questionnaires. Similarly, implementing client-side paradata collection in survey software packages often requires much effort or is even impossible because software is not flexible enough.

Additionally, data collection is restricted to the elements which are prepared beforehand. Therefore, it is impossible to detect clicks which miss an element, which results in the problem that this important measure of erroneous behavior cannot be analyzed. Only successful mouse clicks are captured. Generally, the observation of the interaction between the respondent and the interface is restricted.

To solve this problem of getting closer to the user behavior and collect all client-side actions a new instrument was developed which universally collects client-side paradata (UCSP). Addressing earlier problems, this method is easier to implement than previous methods also when using survey software packages. More important, it allows the collection of all actions within the user interface, that is the survey.

Earlier approaches captured actions concerning elements. In contrast to this, the universal method is based on general events, for example a click, a key press or any other window event in the browser. This approach is more compact in terms of necessary code changes because all mouse clicks can be captured with one function (event handler) instead of having to tweak every element in the survey. Only a single code insertion is necessary. Comparing this to the action-based approach, 25 code insertions would be necessary for a five times five matrix question. The next section uses the UCSP instrument to explore unsuccessful human-survey interaction.[4]

4.5. Clicking the Answer Button and Failures in Survey Interaction (Study 2)

The experiment described in this section uses the universal client-side paradata approach to answer the research question: How accurate do respondents click on the form elements necessary to answer a survey question? Or, how often do they miss the target? This research question can be addressed by looking at paradata. Earlier methods of paradata collection are not sufficient to answer these questions. However, the universal client-side paradata approach is able to collect mouse clicks which missed the usual answer elements

[4] The program code is explained in Kaczmirek and Neubarth (2007) and is available at `http://www.kaczmirek.de/ucsp/`

in an online survey. Failures to produce a valid answer with a single mouse click would show a problematic relationship between the respondents and the survey at hand. Survey designers should always aim to reduce errors in the interaction between the survey and the respondent.

4.5.1. Design Rationale

Practically, there are three possible ways to implement an answer dialog (in this case a radio button) in an online survey. Firstly, the technically simplest way is that respondents need to click the button directly. Secondly, when using HTML-labels a click on the labels 'male' or 'female' would also yield a response. Thirdly, with the help of Java-Script also the table cells can become sensitive and allow correct responses (figure 4.2). The implementation of HTML-labels is part of the Standard HTML specification but is rarely used in online surveys. Nevertheless, its use is generally demanded for accessible websites (Hellbusch, 2004). How many times respondents miss the answer elements is unknown and part of the research question of this study.

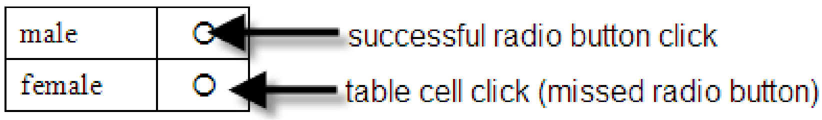


Figure 4.2. Answer radio buttons in table cells with labels. The cell borders are drawn in this example to show the surrounding table.

4.5.2. Questionnaire

The data for answering the research question was obtained from a matrix question within the survey. The full experiment associated with the matrix question is described in chapter 6.2 on page 98. For the current research question it is sufficient to note that there were five experimental conditions and that they differed in visual design aspects. The matrix question consisted of 16 items and a seven-point-scale with an eighth column labelled ´don't know'.

The paradata was collected with the UCSP-script approach described above. Each mouse click was tracked and recorded together with the clicked element. To give a valid answer respondents needed to hit a radio button directly. This is the implementation most often used in online surveys.

4.5.3. Participants

Participants were drawn from a self-selected panel (Sozioland, Respondi AG).[5] 4987 persons received an e-mail invitation about the topic ´Security on the Internet'. 2003 respondents started the survey and 1581 reached the end resulting in an overall response rate of 79%. 54,5% reported being female and 45,5% reported being male. The average age was between 25 and 29 years.

4.5.4. Results

Of all mouse clicks, two types are relevant for the research question. The first type are successful attempts to respond: a click which hit a radio button and elicited a valid response. The second type are clicks which prove an attempt to respond but miss a radio button and thus show no sign of a successful response to the respondents. The second type was defined as a hit on a table cell nearby a radio button (see figure 4.2).

The results in table 4.3 show that on average 38% of respondents click at least once on a table cell. In this study these were click failures because they yielded no valid response. The amount of respondents who clicked more than necessary was between 35% and 46%. This is a substantive effect when compared with an expected distribution of 100% successful hits, $\chi^2(4) = 249$, $p < .001$.[6]

Table 4.3. Distribution of click failures

Group	Zero failures	Failed	Total
1	202 (65%)	111 (35%)	313
2	214 (64%)	120 (36%)	334
3	239 (64%)	132 (36%)	371
4	170 (54%)	147 (46%)	317
5	227 (63%)	136 (37%)	363
Total	1052 (62%)	646 (38%)	1698

Note. Respondents who always clicked successfully on a radio button or failed at least once by hitting a table cell.

[5] I thank Otto Hellwig and Tom Wirth for supporting this study with respondents from the Panel Sozioland.

[6] The degrees of freedom for inferential statistics (e.g., t tests, F tests, chi-square tests) are denoted in brackets, that is a χ^2 with one degree of freedom is written as $\chi^2(1)$.

4.5.5. Discussion

The study demonstrated that a substantive amount of participants encounter troubles with the common interface used in online surveys. The interface in online surveys is not as usable as it could be. However, the problem that radio buttons are not hit with the first click can easily be solved by implementing the additional measures described above, namely with HTML-labels and JavaScript. Additionally, this study exemplifies how a research question can be answered with universal client-side paradata which was not possible with previous methods for collecting client-side paradata.

Although mouse click failures can have several reasons, the solutions proposed in this study target the problems and do not hinder irrelevant reasons. An obvious reason would be that respondents experience difficulty with aiming the mouse at the radio buttons which are indeed rather small. Another reason could be that respondents think that clicking a table cell would also be an appropriate action. Both would be solved with the proposed solution. Also, the second reason is unlikely in the current study because respondents had to hit the buttons correctly throughout the study to provide an answer. A third reason would be that respondents might just play around with the mouse to see what happens. The proposed solution does not pose additional problems to such a behavior. On the contrary, respondents might even learn that answering is easier surveys which implement the proposed solutions.

Summarizing, respondents face difficulties when using mouse clicks to answer online survey questions. The proposed implementations for survey questions can solve the issue of nearby missed clicks. These failures would then be turned into successful human-survey interaction.

4.6. Data Quality of Paradata: Different Response Time Measures (Study 3)

4.6.1. Introduction and Definitions

Response time measures are commonly used to indicate response latencies and have a long tradition in survey research (for an overview see Yan & Tourangeau, 2008). Traditionally, response latency is defined as the time span beginning with an interviewer having read the question to a respondent and ending with the respondent giving his final answer (Draisma & Dijkstra, 2004). In online surveys the time span starts with the presentation of the survey to a respondent on the screen and thus includes the reading time. The ending can be defined in several ways as was demonstrated in the paradata model.

A researcher who is interested in online response latency measurement would usually decide on one definition and stick to it throughout data collection and analysis. However, because different definitions are possible, if a researcher chose unwisely, the data may be of poorer quality than necessary. This work therefore compares three common approaches of defining and catching the end of the time span to help guide future research. They are:

1. $t_a :=$ answer time or click time: the time from presenting the survey page to clicking the final answer. This approach uses client-side measurement.

2. $t_p :=$ page time or submit time: the time from presenting the survey page to submitting the page. This usually means clicking on a next-button. This approach uses client-side measurement.

3. $t_s :=$ server time: the time from delivering the survey page to receiving an answer from the client. This approach does not need client-side measurement.

In addition, the several time spans are important when collecting data via the Internet. Figure 4.3 depicts how the three measures of response times relate to various time elements which can be distinguished when visiting survey webpages. The following additional time elements are important:
$t_t :=$ additional thinking, for example for reconsidering a given answer.
$t_m :=$ motor activity for mouse movement.
$t_d :=$ deliver question. Time span for sending the page from the server to the client (Internet lag I).
$t_r :=$ receive answer. Time span for sending the answer from the client to the server (Internet lag II).
The formalized relation between the three response time measures (see figure 4.3) are summed up in the formulas 4.2 and 4.3.

$$t_a < t_p < t_s (answertime < pagetime < servertime) \tag{4.2}$$

$$\begin{aligned} t_p &= t_a + t_t + t_m \\ &and \\ t_s &= t_p \qquad\qquad\quad + t_d + t_r \\ &= t_a + t_t + t_m \quad + t_d + t_r \end{aligned} \tag{4.3}$$

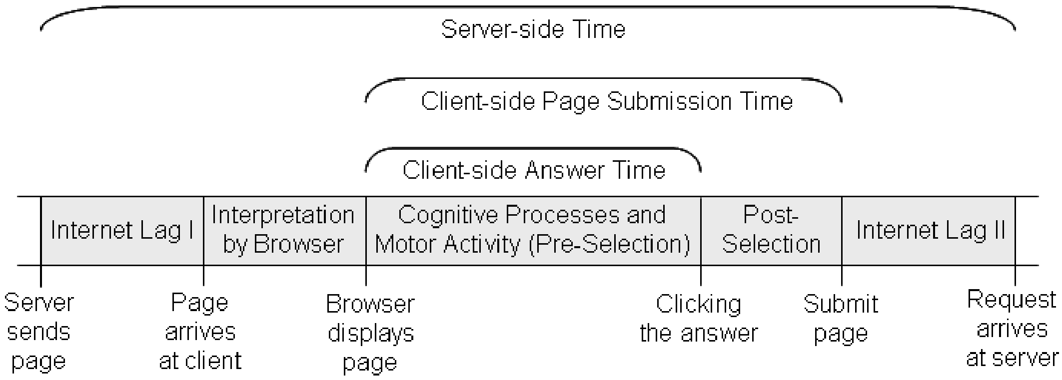


Figure 4.3. Different elements in time measurement via the Internet for a one-question-per-page design. When several questions are asked per page, several answer times can be recorded before the page is submitted.

In other words, the page time includes motor acitivity and additional cognitive processes after an answer was given. The server time includes the transmission times for receiving and sending the information over the Internet. The answer time is the strictest definition of response latency used in this research. These measures were tested in terms of data quality and accuracy in response latency analysis in an online experiment.

The research questions were:

1. How suitable are the three measures for detecting different response time latencies in experimental designs?

2. Is there a difference in data quality between the three measures?

Because both t_s and t_p add time variables to the strict definition of response latency as given by t_a it is assumed that they add noise to the measurement process. Therefore, the hypotheses are that the answer time should be superior compared to the other two measures and that page time should be better than the server time.

4.6.2. Method

To check our hypotheses we used an online experiment.[7] One group of participants received well-formulated survey questions. The other group answered questions which were suboptimal with respect to various psycholinguistic text features (e.g., word frequency,

[7] **Acknowledgements**. The experiment described here which varied question wording was conducted as part of a Magisterarbeit by Timo Faaß (2007) and replicated findings by Graesser, Cai, Louwerse, and Daniel (2006) in an online survey. Faaß' research did not overlap with the research question addressed in this chapter.

syntactic complexity). These text features have been shown to have a considerable impact on comprehension difficulty and the cognitive effort required to process survey questions (Graesser et al., 2006). As a result, participants need more time to respond to badly-formulated questions than to well-formulated ones. The effect was expected to be strong enough to use a between-subjects design, that is participants received either the well- or the badly-formulated questions. Because the condition with well-formulated questions is expected to result in lower response times, this criterion can be used to decide about the quality of the three time measures. The time measure that best replicates the known effects according to theory should be considered in future measurements for response latency.

4.6.3. Questionnaire

The experiment consisted of 28 questions which were constructed to differ in terms of comprehension difficulty due to psycholinguistic text features according to Graesser et al. (2006) and Faaß (2007). These were: word frequency, vague or imprecise term relative term, vague or ambiguous noun-phrase, complex syntax, working memory load, syntactic redundancy and inferences. The sequence of the questions was randomized for each participant. The questionnaire is described by Faaß (2007).

4.6.4. Participants

Participants were recruited by e-mail and a link on the Web site of the Department of English of the University of Mannheim. Survey participation was not restricted and respondents were self-selected. Overall 117 participants started the survey. 34 people were ineligible for analysis because they dropped out (22 people), had technical difficulties (6) or German was not their native language (6). After random assignment the two groups consisted of 15 men and 27 women (badly-formulated questions, n=42) vs. 15 men and 26 women (well-formulated questions, n=41). Respondents were between 15 and 65 years old with a mean age of 28 (SD=8.8). This left 83 respondents in the analysis.

4.6.5. Results

The analysis is threefold. Firstly, I consider the correlations between the three measures to see whether a researcher might accept them as proxies for each other. Secondly, I test how well the measures distinguish between the experimental groups. Thirdly, I visualize the findings to illustrate the differences between the three measures. For each measure the 28 questions were aggregated into a single dependant variable. This was done to increase the reliability of the measures and to analyze the overall effects.

The correlations between the three measures is high and is between .944 and .997 (table 4.4).

To compare time stamps between two groups parametric tests are often used, sometimes after logarithmic transformations of the time measures to reduce skewness (Yan & Tourangeau, 2008). However, to avoid progressive testing the non-parametric Median test is used for analysis. Because there is only one degree of freedom and a strong hypothesis, a one-tailed testing approach can be employed. However, the reader should notice that the same conclusions would be drawn with two-tailed tests in this experiment. The answer times between the two groups differ significantly, $\chi^2(1) = 5.32$, $p = .01$ (one-tailed). There are no significant differences for the measures on page times, $\chi^2(1) = 2.04$, $p = .08$ (one-tailed) or server times, $\chi^2(1) = .98$, $p = .16$ (one-tailed). The results are summarized in table 4.4.

Table 4.4. Quality of different time measures

N=83	answer time	page time	server time
answer time		.950	.944
page time			.997
Mean in seconds	384	446	473
SD	122	145	148
Well-formulated questions			
Mean in seconds	360	421	448
SD	110	134	137
Ill-formulated questions			
Mean in seconds	408	470	498
SD	129	152	156
Median in seconds	371	424	460
$\chi^2(1)$	5.32	2.04	0.98
p	.01	.08	.16

Note. The table shows the correlation between the time measures and corresponding median test statistics for the two experimental groups for one-tailed testing.

Figure 4.4 visualizes the difference and relation between the three measures. Server times are naturally higher than page times which in turn are higher than answer times (cf., figure 4.3).

The width of the area can be interpreted as Internet lag. Without delay due to the Internet connection the area should be nearly invisible as page and server times move closer together. Differences in Internet lag between participants add to measurement noise. The high correlation between page times and server times indicate that they are nearly constant among participants. Nevertheless, Internet lag cannot be expected to be constant for all participants in several surveys, especially if respondents participate from around the world and at various hours. Indeed, the survey questions at the beginning of the questionnaire indicate that some of the participants who were ineligible due to dropout also seem to have experienced a high Internet lag during their participation. This is problematic because researchers are usually not able to detect the Internet lag per participant and are thus unable to delete outliers.

Equally important is the higher noise in page times compared to answer times. The figure shows that the page time adds a seemingly random amount to the answer time while the server time adds another amount of time on top of this. Contrary to the Internet lag as depicted in the grey area, the time needed to submit an answer varies considerably between respondents.

The hypotheses can be answered as follows: Answer time is better suited for the detection of differences in experimental conditions than the other two measures. In addition, page times are still better than server times. In terms of data quality table 4.4 and figure 4.4 show that both page and server time is impaired because of unnecessary noise in the measurement process.

4.6.6. Discussion

Response time measurements are widely used as quality indicators in survey research. An advantage of online surveys is their ability to record time stamps and thus associate response times with every action of respondents. The analysis of the different time elements which compound survey participation showed that several methods exist for collecting response times in online surveys. The research question was to decide which response times measure is most suitable as a dependant variable in experimental designs. To test the performance of the measures a randomized experiment was conducted which varied the question wording of 28 questions. It was known from theory that the two conditions would elicit different response times as a result of well- and bad-formulated

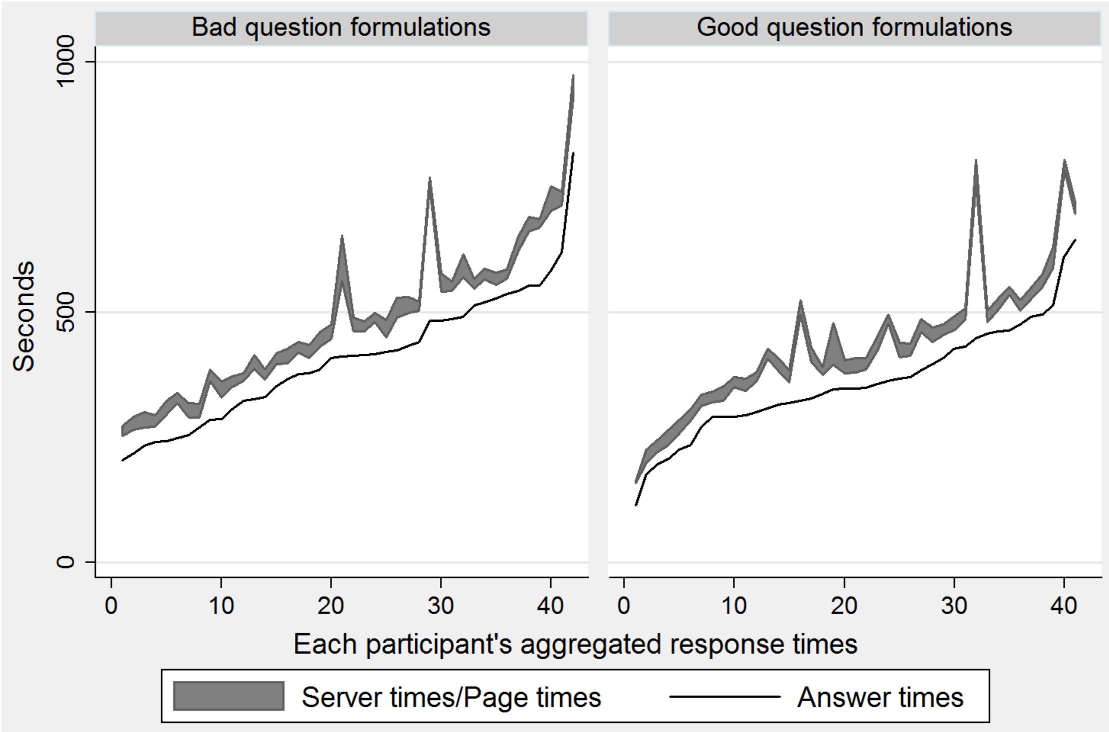


Figure 4.4. Aggregated answer, page and server times in seconds for the 28 questions in the experiment. The lower line is the response time to provide an answer. The difference between the line and the area shows the additional time needed to submit the answers. The area itself corresponds to the technical transmission time or Internet lag.

questions. Three measures for response times were obtained: The time to click on an answer option (answer time), the time to click on the 'next'-button (page time), and the time recorded by the server, the server time. The response time per respondent of all 28 questions was aggregated into a single response time measure. Median tests which compared the response time between the two conditions show significant differences between the good and bad formulations for answer times ($p = .01$) but no significant results for the other two methods (page time, $p = .08$, and server time, $p = .16$).

The results show that a high correlation between different time measures does not guarantee their usefulness in randomized experiments when used as dependant variables. As server side time stamps are widely implemented in survey software it is tempting to use them for analysis related to response times. Despite these readily available data, our results show that server side measurements include more measurement noise and are not sensitive enough to detect differences in response latencies as expected by psycholinguistic theory. The three methods are decreasing in the ease of implementation and increasing in terms of data quality. The results show that ineffective measurement leads to an underestimation of effects. When working with concepts in the realm of response latencies, researchers are advised to ignore server side time stamps and rely on the most accurate client-side measurement, namely answer clicks.

4.7. Summary and Conclusion

In this chapter I developed a data box model for the concept of paradata. Paradata are process data in surveys which can be collected while respondents answer a questionnaire. Paradata provide insight into respondents' behavior such as response times, changes in answers, and mouse clicks. In addition, paradata serve as performance indicators for surveys: Dropout patterns, item nonresponse, and response rates are key measures for the success of a survey. Paradata are already widely used in survey research. Nevertheless, paradata lack a concise conceptualization. The starting point was therefore to define paradata and differentiate it from (survey) data and metadata. Next, a data model for paradata was developed. It distinguishes four levels of paradata within the dimensions of respondents, variables and time. The higher levels are aggregations of lower levels over single or multiple dimensions.

The lowest data level consists of single actions such as mouse clicks. These single actions are easily collected but difficult to analyze because the collected amount of data points is enormous and still lack conceptualization.

The second level aggregates these mere technical data points resulting in content which is conceptually relevant for researchers. Such a concept is for example interaction failure measured as the number of mouse clicks which missed an answer option (this was part of study 2).

The third level aggregates variables to summarize them into concepts such as the overall number of items missing. The third level also includes aggregations over respondents, resulting in concepts such as the average response time on each page.

The fourth level is the most abstract aggregation and summarizes across respondents, variables and time to yield a single measure such as the average time to complete the survey or the response rate.

The model clarified that hitherto available instruments for collecting paradata had blind spots which prevented survey researchers from collecting certain aspects of paradata: Only successful interaction with a survey was collected. Therefore, an instrument was developed (universal client-side paradata approach) which allowed to observe all mouse clicks, whereas earlier methods only captured mouse clicks on answer elements. Study 2 used this instrument to determine a new indicator for the success of human-survey interaction, specifically how many respondents suffer from click failures. Between 35% and 46% percent of the respondents made unsuccessful mouse clicks. They clicked in the vicinity of answer buttons which did not result in a valid answer, making a reclick necessary. This finding shows a huge possibility for improvement in human-interface design. The proposed solution was to enlarge the clickable area to encompass the surrounding of the answer elements. The easiest way to accomplish this is by making the table cells sensitive to mouse clicks. Part of the observed item nonresponse in surveys could be due to these interaction failures. Study 5 which is described in section 6.3 therefore tested whether item nonresponse can be reduced by following this recommendation and tested it against the current standard practice in survey design.

The paradata model also provided a deeper understanding for operationalizations. Seemingly identical concepts of response latencies were shown to differ significantly. Response latencies are part of the second level in the paradata model. Accordingly, the data at the lowest level –the response times– can be collected as different actions. The following three types of response times were already used by other survey researchers and were therefore collected in the study: mouse clicks on answers, page submission times and server times. Usually, survey researchers decide to implement one of these measures and conduct their analyses on this basis. In study 3 however, the goal was to identify the differences between these three types of paradata which are usually summarized under the same concept of response latencies. The study used an experiment with two conditions varying the question wordings which were known to covary with the required time for a response. Well-formulated questions take less time to respond to than badly-formulated questions. The question wording was changed with respect to psycholinguistic features such as the number of words, the syntactic complexity, and others. It was therefore possible to compare the three response time measures in their suitability to detect these differences. The results showed that the client-side paradata of mouse clicks on answers was able to statistically detect the difference in response latencies between the two conditions. However, the other two measures were not significantly different between experimental groups. In conclusion, the paradata model helped in identifying the difference between seemingly identical concepts.

The three measures for response times did also differ in the investment needed to implement them. Server-side time stamps are widely available in software packages and require nearly no effort from the researcher. Submit times require one change per page, whereas response time clicks usually require most programming knowledge and invested time for implementation. The value of the measures for research are reciprocal to the effort needed for their implementation. The study showed that easier available server-side time measures should be avoided because they include a loss of accuracy in the measurement of response times. As a result researchers may be faced with inconclusive findings which would have been less likely with a client-side measurement approach.

Summarizing, this chapter identified a lack in the conceptualization of paradata. Therefore, a paradata model was developed and a new instrument provided to fit the need for indicators of failed human-survey interaction. Two studies applied the paradata model. Study 5 determined the amount of unsuccessful response behavior and provided a solution, while study 3 specified and compared different measures for response latencies, resulting in a recommendation for client-side answer click times.

5. Nonresponse as a Result of Missing Accessibility: Coverage and Usefulness of Technology for Design and Methodology (Study 4)

Until recently, the preparation phase of online surveys usually led to discussions among survey researchers whether technologies such as JavaScript should be employed. On the one hand, respondents were expected to benefit from additional interactive features which could result in an increased data quality. On the other hand, the technology could lead to an increase of nonresponse canceling positive effects, because not all respondents might have the necessary equipment. This could result in technical problems and unaccessible surveys.

This chapter focuses on the technology in online surveys. The technologies are discussed with respect to the usefulness in survey methodology. To address these issues censuses of student applicants at the University of Mannheim from three semester show the amount of coverage and availability of different technology among respondents.[1] The results clarify the amount by which unit nonresponse would be increased when specific technologies were to be used in an online survey. More importantly, they support design decisions about which technologies can be used to the methodological benefit of survey design. Accordingly, studies 2, 5, 6, and 7 in this work take up these results employing these technologies in their methodological experiments to further decrease item nonresponse and dropout.

5.1. Background

Although technology is a central aspect of online surveys (Couper, 2005), a problem is the diversity of the technical equipment among respondents. Respondents use a variety of computer equipment with different system software and different browsers. Moreover, respondents can install a variety of functions via plug-ins (e.g., video support). Worse for survey researchers, they can also disable standard functionality by changing default settings, using security plug-ins or extra software (e.g., that browsers accept cookies).

[1] **Acknowledgements**. Parts of this chapter were presented at conferences (Kaczmirek & Thiele, 2006; Thiele & Kaczmirek, 2005).

Ludwig (2004) found that 21% of unit nonresponse was due to technical problems according to a follow-up survey asking respondents for reasons for their previous nonresponse (missing compliance, 35%, no contact, 40%, other reasons, 4%, 97 persons responded to the follow-up survey, p. 137). This indicates that surveys are not accessible for a considerable number of potential respondents. On the one hand, respondents may experience problems with the Internet connection or their computer which are out of control of researchers. On the other hand, there are many possibilities to program a survey which may all pose different requirements to the respondents' browsers. The implementation of new methods is known to impose problems and to exclude participants. "A gap remains between what is technologically possible and what typical Internet users actually use on their computer" (Heerwegh, 2005, p. 16). The research goal is therefore to estimate the amount of this gap and identify which methods can be used in online survey research. This enables researchers to choose among widely available techniques to further reduce nonresponse without adding to it by choosing technically inappropriate methods.

Important aspects of technology-driven methods are:

- Increase of data quality, for example real-time validations (Peytchev & Crawford, 2005), and immediate feedback and counting in question types which uses the constant sum method (Conrad, Couper, Tourangeau, & Galesic, 2005).
- Simplification of the response process, for example automatic forwarding to next question, preselected answers, and automatic focus of the cursor into open text fields.
- Collection of paradata (Heerwegh, 2003; Kaczmirek & Neubarth, 2007).
- New types of question formats, for example visual ranking (Neubarth, 2008), and visual analog scales (Couper et al., 2006).

All these methods have in common that they rely on technologies which are optional and may be disabled or need to be installed on the respondents' computer. Especially technologies beyond pure HTML, for example Flash impose problems and exclude participants. Nevertheless, each technology has its special advantages which cannot always be substituted by other forms of implementation. Should the researcher therefore avoid new technologies and abandon their advantages to match the technical capabilities of every participant? The most sensible way to deal with this problem is to utilize new technologies which have a high coverage in the target population and to simultaneously provide fall-back procedures for participants which would otherwise be excluded. In the case of the most widely spread browser extension JavaScript, a good procedure is to check for its availability at the beginning of a survey. Respondents may then be prompted to enable JavaScript together with a thorough technical description on how this can be accomplished. Because such actions add to the burden even before the survey has started (which will most likely increase nonresponse) a more sensible approach is to route respondents past question types which they will not be able to respond to or provide alternative question formats (e.g., a traditional rating scale instead of a visual analog scale). Generally, disabled or missing technology should not interfere with the accessibility of the survey. In the case of a constant sum question type this might result in the absence of automatic calculations but respondents would still be able to fill in the form. In contrast to the above illustrated examples where fall-back procedures are possible in case of unavailable technologies, there are situations where no alternative in pure HTML exists. Question types using video material are such an example. The considerations in such a scenario is which video types to support and what can be gained by adding additional video support.

An important goal in online questionnaire design is to gain the maximum advantage of possible client-side technology in terms of reducing the various types of survey error while maintaining a high level of accessibility. This study therefore provides information about the present coverage of different technologies. Survey researchers can then make an informed decision for or against specific methods.

5.2. Method

The study analyzed data from more than 29.000 university applicants during three application periods in 2005 and 2006. All people who apply for a position as a student need to fill in an online application form. The application form is a type of online survey asking many factual questions. The application periods were the periods of data collection. Wave 1 was the application for the winter term 2005/2006 between May and July 2005. Wave 2 was the application for the summer term 2006 between November 2005 and March 2006. Wave 3 was the application for the winter term 2006/2007 between May and July 2006.

5.2.1. Questionnaire

An application form consists of four to five pages with approx. 20 questions on each page. It takes about two hours to complete the questionnaire (see figure 5.1 for an example of the application form). After completing the application form applicants are asked to print it, sign it and send it to the university administration (Studienbüros) together with additional documents supporting their statements. The year 2006 was the fourth year of online application practice. Students could choose from 28 possible subjects of study. We may assume that applicants strive to provide valid and true data because their answers are used to decide about their application.

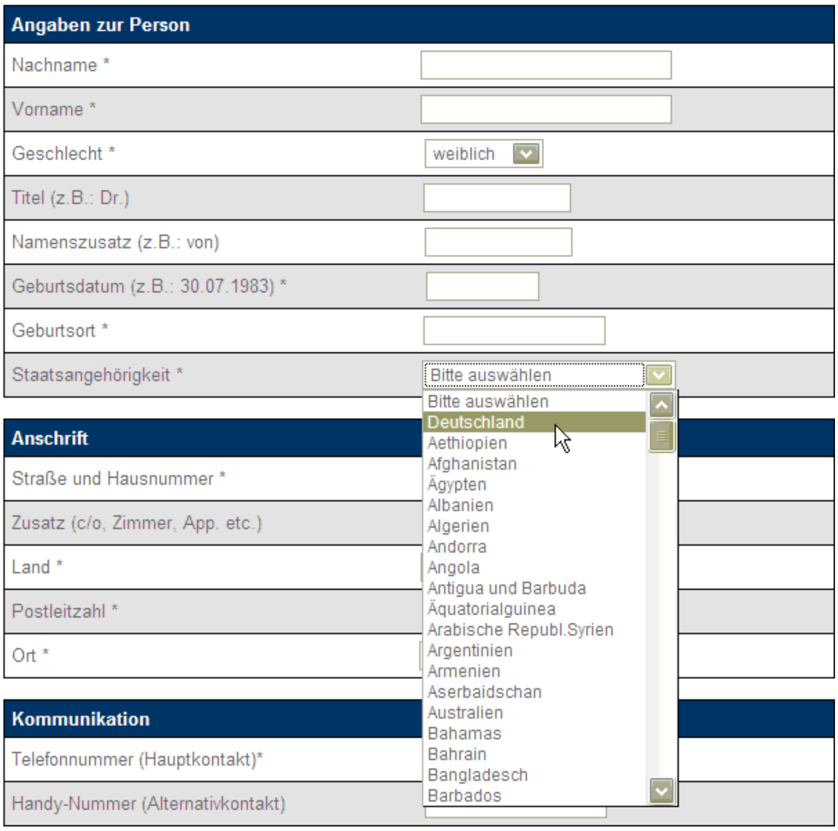


Figure 5.1. Online application form of the University of Mannheim. This design example shows a part of the first page of the online application form. The form consists mainly of open question formats and pull-down menus.

Information about applicants was collected by means of questions in the form. Information about the available technology was collected by means of JavaScript functions.[2] With the help of these scripts the browser collects and provides this kind of information automatically so respondents do not need to answer questions about their technology. As the research is not concerned with the equipment of university computers which are usu-

[2] Open source scripts that collect data about technical equipment and available technologies are available in the logfile analysis program AWStats (Destailleur, 2008).

ally under the control of researchers, applicants using university computers are excluded from the data analysis.

5.2.2. Participants

The data is a full coverage sample or census of student applicants in the sense that every application for a place at the University of Mannheim during that period had to be submitted online with the exception of non-German applicants living abroad during the time of their application. The online application rate amounts to 99.7% of all applications.

University applicants are mainly university freshmen with an average age of 20.6 years. The basic demographic variables are shown in table 5.1. The winter term is the first opportunity to apply after school. It is therefore reasonable that applicants for the summer term are older on average. The proportional shift from 46% males in the winter term, to 55% in the summer term can be explained by the duty of military and civil service for males in Germany. The majority of applicants have the German citizenship (94,5%) and are living within the top level post code areas 6 and 7 (56.9%), that is they are applying from the areas of Baden-Württemberg, Saarland, Hesse and Rhineland-Palatinate. As a general rule there are fewer applicants the higher the distance from Mannheim. Generally, there are five times more applications for the winter terms than for the summer terms because only five courses of study start in the summer.

Table 5.1. Demography of university applicants

	Wave 1 Summer 2005		Wave 2 Winter 2005		Wave 3 Summer 2006	
age						
mean	20.6		21.6		20.4	
SD	2.1		2.6		2.1	
sex						
male	6136	(46.1%)	1185	(55.0%)	5946	(43.9%)
female	7185	(53.9%)	971	(45.0%)	7586	(56.0%)
nationality						
German	12642	(94.9%)	1986	(92.1%)	12798	(94.5%)
abroad	679	(5.1%)	170	(7.9%)	739	(5.5%)
n	13321		2156		13537	

5.3. Results and Discussion for Client-Side Technology

The next sections explain the use of the different technologies in online surveys and draw conclusions for methodology and design. Generally, there is a trend of an increasing availability of technologies and improved technical equipment between 2005 and 2006.

5.3.1. Acceptance and Persistence of Cookies

In survey research cookies are used to monitor a respondent throughout survey participation and to re-identify returning respondents after they have abandoned the survey. Stein and Stewart (2003, paragraph Q10) provide a thorough description in the *W3C World Wide Web Security FAQ* of the advantages of cookies and outline the associated privacy risks:

> A cookie is a small piece of information, often no more than a short session identifier, that the HTTP server sends to the browser when the browser connects for the first time. Thereafter, the browser returns a copy of the cookie to the server each time it connects. [...] However cookies can be used for more controversial purposes. Each access your browser makes to a Web site leaves some information about you behind, creating a gossamer trail across the Internet. Among the tidbits of data left along this trail are the name and IP address of your computer, the brand of browser you're using, the operating system you're running, the URL of the Web page you accessed, and the URL of the page you were last viewing.

From a user perspective cookies may make the Internet experience more convenient in that they help websites to remember useful information. Cookies make it unnecessary to enter one's preferences over and over again. Additionally, cookies are also useful in analyzing browsing behavior of single websites and help improve the websites to the users need. Despite these obvious advantages cookies have gained a bad reputation because they are also used to track the visiting and surfing behavior across different websites for marketing and advertising purposes. As a result, Internet security software and some browsers make it easy to automatically delete or reject cookies from being set. Even worse for researchers, cookies may be accepted during a session but may be automatically deleted after the browser closes. This overestimates the number of new visitors and leads to the wrong conclusion that such a user would never revisit a website. Such a visitor would appear as a new user every time s/he restarts his/her browser. Accordingly, there are consequences to consider in intercept surveys.[3] In intercept surveys cookies are used to detect revisits. It is good practice not to invite visitors twice who either rejected to

[3] Surveys which invite website visitors to participate in a survey by means of a popup, link or banner are called intercept surveys because they ask visitors to delay their website visit and to take the

participate or already completed the survey (Kaczmirek & Neubarth, 2005). In the case of intercept surveys this is usually achieved by means of cookies. More generally, cookies are needed in online surveys which do not allow a personal enumeration of respondents but which start without any possible personal identification. Because the functioning of this mechanism cannot be guaranteed when cookies are deleted intercept surveys should implement pages and questions in the beginning of a survey to filter out refusals and returning visitors.

For survey researchers cookies serve two purposes. Firstly, survey researchers use cookies during one session to identify respondents across different pages and to help distinguish them from other respondents. Secondly and more importantly, cookies are used to identify respondents across time and different visits. To test how much cookies are available, an attempt is made to place a cookie on the respondent's computer at the first visit. If this attempt was successful, cookies are accepted. The results show that nearly all respondents' computers accept cookies. The possibility to set and retrieve cookie information reaches nearly a hundred percent (table 5.2).

Table 5.2. Acceptance of cookies

	Wave 1		Wave 3	
	n	%	n	%
Accepted	13108	98.4	13408	99.0

To gain information about what happens when a visit is abandoned at least one second visit of the respondent and a valid personal tracking method is needed. Fortunately, the online application form meets these requirements. It takes a rather long time to fill in while requiring detailed biographical information. It is thus most likely that applicants interrupt their work to collect all necessary information and continue their submission on a second visit. To measure the persistence of cookies the survey sets a cookie during the first login and tries to read it at the end of the submission process. The proportion for the persistence of cookies is surprisingly low (table 5.3), especially when considering the extremely high acceptance at first. If relying solely on cookies, 31.7% of the respondents would have been misclassified as new visitors. Nevertheless, there are aspects of over- and underreporting to consider when looking at this figure. Overreporting can happen when respondents change computers between their session in which case all client-side

survey. If the frame is narrowly defined as visitors to the site and only every n-th visitor is invited, this survey type may be classified as a probability-based survey (Couper, 2000b).

methods to track a respondent must fail. As this would overreport the deletion of cookies, these respondents would also be re-invited in an intercept survey. Therefore, the cookie persistence is an accurate measurement from a survey methodology perspective. Underreporting happens for respondents who complete the whole application in a single session. Because they do not close the browser to start a new visit these cookies cannot be automatically deleted and are therefore confounded with persistent ones. Thus the proportion of persistent cookies are rather underestimated than overestimated in this sample for the concern of intercept surveys.

Table 5.3. Persistence of cookies (availabe for third wave)

	n	%
Cookies disabled	134	1.0
First cookie deleted	4296	31.7
First cookie persisted	9107	67.3

Concluding, the usage of cookies within one visit is unproblematic. However, because cookies can be manipulated by respondents survey researchers should prefer server-side tracking methods to administer pages in a single visit. If re-identification is corrupted, the status of intercept surveys as a probability-based method (Couper, 2000b) becomes questionable because the bias rises to invite the more frequent visitors. This is especially true for websites with a high revisitation rate which is a goal for many websites. Similarly, intercept surveys with popups which use a high probability for invitation (e.g., every second visitor) and a long fielding time have a higher chance to invite the same person more than once.

The finding that nearly one-third of the website visitors cannot be re-identified poses a threat to the methodology of intercept surveys. To overcome the problem of re-identification, the method of first screen filters is essential in intercept surveys. Here, a first filter question makes it possible to distinguish between non-responders, explicit rejections and revisits of participants (for an example see Stahl, Binder, & Bandilla, 2004, p. 61).

Summarizing, the problem of administering and sending the correct survey pages to respondents while they proceed through the pages is easily solved by a technical solution without cookies. However, in intercept surveys special measures need to be taken to identify respondents who follow a request for survey participation more than once.

5.3.2. Coverage of JavaScript, Java and Flash

The most common and versatile extension for online surveys is JavaScript. JavaScript allows for the collection of paradata (Heerwegh, 2003; Kaczmirek & Neubarth, 2007), dynamic elements (Couper et al., 2006; Neubarth, in press), and implementation of immediate feedback (Peytchev & Crawford, 2005; Conrad et al., 2006) without the need to resend the survey page and wait for the server to respond. To apply visual design principles (Dillman et al., 2005) standard input browser controls such as radio buttons and check boxes can be replaced by images. Nearly all features and question types which make a survey easier to respond to are implemented with the help of JavaScript. For example a ranking question with several items is easily conducted in a personal interview with a card sorting task. The early approaches in online surveys asked to enter numbers to indicate the ranking order of each item. Such a procedure is time-consuming. It is cumbersome to change the rank order and it misses the direct manipulation capabilities of the real cards. Modern approaches draw pictures of cards on the screen and employ direct manipulation techniques such as drag-and-drop mouse movements of the cards to sort them in the desired order (Neubarth, 2006). In the sample of university applicants, JavaScript was the technology with the highest coverage, reaching availability rates between 99.4% and 99.7% (table 5.4). This makes JavaScript the most suitable choice when implementing survey design.

Table 5.4. Coverage of Technical Features for University Applicants

Application for	Winter Term 2005/2006		Summer Term 2006		Winter Term 2006/2007	
Data Collection Period	May05 - Jul05		Nov05 - Mar06		May06 - Jul06	
Technique	n	%	n	%	n	%
JavaScript	13245	99.4	2149	99.7	13471	99.5
Cookies	13108	98.4	n/a	n/a	13408	99.0
Java	12393	93.0	2046	94.9	12940	95.6
Flash	12476	93.7	2024	93.9	12680	93.7
Mediaplayer	12332	92.6	2004	92.9	12531	92.6
Quicktime	6462	48.5	1094	50.7	7643	56.5
Realplayer	5377	40.4	864	40.1	5656	41.8
Scalable vector graphics	3416	25.6	425	19.7	2566	19.0
Number of Applicants	13321	100.0	2156	100.0	13537	100.0

On the downside, JavaScript is restricted in the control and observation capabilities of the survey participation process. Being a scripting language JavaScript is also openly visible to participants who like to have a look at the code. Thus, malicious participants may produce ineligible data or use the code for their own purpose. Java and Flash on the other hand work with a compiled code, which makes the code unreadable for humans and faster in its execution. In addition, they have the control and observation capabilities which JavaScript lack. To use Java or Flash the survey researcher needs access to programming knowledge. It is necessary that respondents have installed these extensions or are willing to install them at the time of survey participation. Contrary to JavaScript, respondents need to take action to use Java or Flash, whereas with JavaScript respondents need to take action to disable its use. The results show that if a special survey interface design is needed, Java and Flash should be considered as alternatives to JavaScript. In the last wave Java reached a coverage of 95.6% and Flash a coverage of 93.7% (table 5.4).

A promising new development is AJAX (**A**synchronous **J**avaScript **a**nd **X**ML). With AJAX and its ability to transfer data without the need to reload the whole page a new scope of interaction capabilities arises. AJAX allows for a much more desktop-like interface design as was previously possible with HTML and JavaScript alone. In the case of the University application form long lists have to be loaded in advance. This includes lists of countries (206 items), universities and colleges in Germany (501 items) and districts of Germany (446). Long lists can considerably lengthen the download time for dial-up connections to several minutes. It has been reasoned in the past that longer download times account for dropout in online surveys (Couper, Traugott, & Lamias, 2001; Heerwegh & Loosveldt, 2002). AJAX solves part of this problem because it is possible to load and suggest possible entries while a respondent types the answer. This might for example be used in the complex issue of coding the personal occupation: Open answers are allowed but suggestions on available terms allow for a pre-coding, thus speeding up the manual coding work after the survey is finished. Breakoffs are probably reduced for slower Internet connections because such an approach shortens the download time of the whole page while providing all necessary terms or a complete dictionary.

Summing up, JavaScript is the first choice when implementing survey design methods. Nevertheless, alternatives without JavaScript need to be maintained for special subgroups, for example when visually impaired and blind people should be able to participate. Solutions based on Java and Flash can be appropriate in circumstances which demand a higher control of a survey than is possible with JavaScript.

The high coverage of JavaScript in the student sample makes it ideal for survey research. However, the question remains whether this is also true for other populations. To answer this question the availability of JavaScript was assessed in two additional studies sampling from the general population with Internet access. The first used an online follow-up survey of a face-to-face survey which employed a probability sample of the general German population. Here, JavaScript was available for 99.7% of the respondents (n=386) with only two respondents who had disabled JavaScript. The study is described in more detail in Bandilla et al. (2009). The second study used a quota sample of a market research panel. One thousand invitations were e-mailed to respondents with a sampling distribution equalling the demographic variables school education, age, and sex in the German general social survey 2004 (ALLBUS). In the quota sample JavaScript was available to 99.1% of the respondents. Only 5 respondents had not enabled JavaScript. Overall, 58.8% of the 1000 invited persons responded to the e-mail invitation. Concluding, these additional studies show that JavaScript is highly available to the general Internet population, not only in market research panels but also in probability-based surveys.

5.3.3. Coverage of Video and Scalable Vector Graphics

The increase in bandwidth among Internet users with cable/DSL makes it feasible to include video material in online surveys. Video material is essential for the online evaluation of cinema trailers or commercials. Survey instructions might also be supported by video and/or audio material (Fuchs & Funke, 2007; Krisch & Lesho, 2006).

Table 5.4 shows that the most widely spread player for video is the Mediaplayer (coverage 92.6%). Thus, video codecs supported by the Mediaplayer are the first to be supported in online surveys. Further analysis shows that in wave three 25.8% of the participants who do not use the Mediaplayer use Quicktime (adding 1.9% to the total video coverage) while 13.5% use the Realplayer (adding 1% to the total video coverage). Supporting all three players in an online survey leaves 4.5% of the applicants without the ability to play video material.

An alternative technology to the standard formats of web graphics (gif, jpg, png) is svg (scalable vector graphics). Vector graphics are supposed to save file space compared to full pictures but the increasing bandwidth and the lack of support in browsers render this technology useless for online surveys. Only 19% of the respondents' computers support svg (table 5.4) making this technology the only diminishing one.

Recent developments in online video applications avoid the problem of competing video players altogether. Instead, online communities which share videos (e.g., YouTube, Google Video) employ Flash technology. The even higher coverage of Flash compared to the Mediaplayer and its platform independence makes it ideal for video and audio transmission in online surveys (Fuchs & Funke, 2007). A recent example is provided by a survey targeting people with physical and mental disabilities using the Internet which employed Flash technology to implement sign language videos and speech to achieve accessible survey design (Deutsche Behindertenhilfe – Aktion Mensch e.V., 2008).

5.3.4. Screen Resolution and Browser Usage

One of the most important design decisions in online surveys is the width of the questionnaire. It is a basic assumption in survey methodology that horizontal answer scales should be fully visible to respondents (Dillman, 2007). Therefore, online surveys are optimized for the smallest screen expected. Hitherto, this threshold was 800 pixels. In 2006 the proportion of applicants who possessed at least a screen width of 1024 pixels reached 94.9% (table 5.5). The emerging and accepted standard in online surveys will therefore become 1024 pixels within a few years and is already acceptable for certain subgroups of the web population. Considering web page design in general, Webtrekk announced similar findings for their long-term study. Only 7% of their panel possess a resolution of 800x600 pixels (Casamento, 2006). Nielsen (2006) also speaks out in favor of a design aiming at a resolution of 1024x768 pixels.

Before fielding time, online surveys should be tested with the most common browsers used in the target sample. During the testing phase oddities of different browser behavior can be identified and visual and technical problems can be removed. Testing for technical bugs and errors is necessary and a standard procedure for computer-assisted surveys (Couper, 2000b). Good testing practice is especially important in self-administered online surveys due to the fact that no trained interviewer is available to compensate for the problems during survey participation:

> By their very nature, Web questionnaires must run in the uncontrolled and largely unpredictable environment of the respondent. PC configuration, Internet connection quality, and browser software all have a significant impact on how the questionnaire is presented and behaves. Ensuring that all respondents experience the survey in a reasonably standard way is a primary goal of Web questionnaire testing. This dynamic nature of Web questionnaires requires that our testing protocols extend beyond the techniques now employed both for paper and other computer-based instruments. (Baker et al., 2004, p. 363)

Table 5.5. Distribution of screen resolutions

x- and y-resolutions	Wave 1		Wave 2		Wave 3	
	n	%	n	%	n	%
800 x 600	1171	8.8	117	5.4	671	5.0
1024 x 768	8443	63.8	1282	59.7	7928	58.8
1152 x 864	696	5.3	94	4.4	693	5.1
1280 x 800	464	3.5	157	7.3	993	7.4
1280 x 960	161	1.2	34	1.6	183	1.4
1280 x 1024	1864	14.1	367	17.1	2403	17.8
1400 x 1050	168	1.3	44	2.0	150	1.1
Other lower than 1024 x 768	25	0.2	3	0.1	15	0.1
Other higher than 1024 x 768	244	1.8	50	2.3	437	3.2
n	13236	100	2148	100	13473	100
n/a	85		8		64	
Total	13321		2156		13537	

From a technical standpoint the challenges associated with layout and different screen sizes arise from the fact that the browsers differ in their behavior of interpreting and visualizing the survey code. Table 5.6 shows that testing should at least encompass the Microsoft Internet Explorer (used by 65.6%) and the Firefox browser (used by 28.4%). Noteworthy is the increase in the usage of the Firefox browser from 17.7% to 28.4% and the simultaneous decrease in the usage of the Microsoft Internet Explorer. In the Webtrekk study (Casamento, 2006) the Firefox browser amounted to 18% of all browsers supporting the necessity to include it into pretesting activities. Other browsers on the whole play a minor role but are important for certain subpopulations, for example the Safari browser for Mac users.

5.3.5. Internet-Related Questions

During the third wave questions about Internet usage, number of available e-mail addresses, and Internet security were included. Answering these additional questions at the end of the application form was completely voluntary which resulted in an item-nonresponse ranging from 8.1% to 9.4%. Respondents claim a high Internet affinity, 77.8% reported using the Internet on a daily basis and 96.6% using the Internet at least once a week (table 5.7). A related question about e-mail usage at home was asked in the Allbus, the German general social survey (ZA & ZUMA, 2004), and resulted in answers

Table 5.6. Distribution of browser usage

Browser	Wave 1		Wave 2		Wave 3	
	n	%	n	%	n	%
MSI Explorer	10059	75.5	1500	69.6	8887	65.6
Firefox	2362	17.7	519	24.1	3848	28.4
Opera	353	2.6	53	2.5	374	2.8
Safari	128	1.0	26	1.2	168	1.2
Mozilla	216	1.6	39	1.8	155	1.1
Netscape	188	1.4	18	0.8	98	0.7
Other	15	0.1	1	0.0	7	0.1
Total	13321	100	2156	100	13537	100

of 68.7% of the respondents with Internet access receiving or sending e-mails at least once a week.

Table 5.7. Responses to the question about Internet usage at home[a]

Answers	n	%	valid %	cum. %
Daily / nearly daily	9678	71.5	77.8	77.8
Approx. 2-3 times per week	1868	13.8	15.0	92.9
Approx. once per week	467	3.4	3.8	96.6
Approx. 2-3 times per month	145	1.1	1.2	97.8
Approx. once per month	47	0.3	0.4	98.2
Less than once a month	33	0.2	0.3	98.4
I do not use the Internet	7	0.1	0.1	98.5
I do not have Internet access	189	1.4	1.5	100
Total	12434	91.9	100	
n/a	1103	8.1		

[a] The question read: "How often do you personally use the Internet at home?"

The second question asked participants about the number of actively used e-mail addresses (table 5.8). This formulation tried to avoid overestimation of available e-mail addresses due to old accounts where the password is lost or accounts which are never checked. Surprisingly, as many as 44.4% of the participants state that they only use one e-mail address actively. From the standpoint of survey methodology and participation control this enables 55.4% of the respondents to easily switch identity when e-mail addresses need to be provided.

Table 5.8. Responses to the question about the number of actively used e-mail addresses[a]

Answers	n	%	valid %	cum. %
0	13	0.1	0.1	0.1
1	5444	40.2	44.4	44.5
2	4554	33.6	37.1	81.6
3	1364	10.1	11.1	92.8
4	320	2.4	2.6	95.4
5	225	1.7	1.8	97.2
6 or more	343	2.5	2.8	100
Total	12263	90.6	100	
n/a	1274	9.4		

[a] The question read: "How many e-mail addresses do you use actively? (Do also count actual e-mail forwarding.)"

The third question asked the applicants whether they or someone else had taken measures to raise the security level for surfing the Internet (table 5.9). Such measures are problematic as they usually disable the above discussed technologies which in turn renders them useless for online surveys. Indeed, 71.3% of the respondents state that such measures were taken at their computer. These answers directly contradict the massive availability of the various technologies discussed so far. This is particularly remarkable for the wide availability of JavaScript (99.5%). JavaScript was not required for the online application form to work and could have been disabled without disadvantage for the application. Probably the easiest first measures for higher security when surfing the Internet would be to disable JavaScript and the use of cookies. In computer journals and articles about security both measures are often mentioned. Thus, the high discrepancy between the results of self reports and the automatic checks of available technologies provide a strong argument in favor of automatically measured availability of technology as conducted in this study.

5.4. Summary and Conclusion

This chapter provided information about the present coverage of different technologies to support decisions for or against the use of technologically driven methods in online surveys. Here, advantages, disadvantages and the applications of technology were dis-

Table 5.9. Responses to the question about security measures[a]

Answers	n	%	valid %	cum. %
Yes, I did it myself	4276	31.6	34.5	34.5
Yes, someone else	4553	33.6	36.8	71.3
No, nobody	1858	13.7	15.0	86.3
Don't know	1696	12.5	13.7	100
Total	12383	91.5	100	
n/a	1154	8.5		

[a] The question read: "Did you or someone else take measures at this computer to raise the security level of surfing the Internet (do not count antivirus programs and firewalls)?"

cussed with respect to online surveys. The results show that some technologies are far more common than hitherto assumed. JavaScript has a coverage of more than 99%, making it the first choice when it comes to implementing interactive survey design features. Two additional studies using a probability sample and a quota sample suggested equally high coverage for the general Internet population. This high availability of several client-side technologies allows for questionnaire designs and implementations which have been avoided so far. The measurement of the persistence of cookies showed that they might be used in single sessions but are not sufficient to control participation in intercept surveys. Java and Flash are widely available extensions to HTML which suit special needs for interface design and control. The main video player is the Mediaplayer, followed by Quicktime and Realplayer. It is advisable to support at least the first two, so that subgroups (e.g., Mac-users) of the Internet population are not excluded. An alternative is to employ Flash technology for video and audio. The standard width for screen design was previously 800 pixels. In 2006 such low resolutions have diminished to a proportion of 5% of all applicants at the University of Mannheim. The most common screen resolution is 1024x768 pixels. As a last aspect, online surveys should always be tested against design flaws in the two most common browsers: Microsoft Internet Explorer and Firefox.

This research did not examine the speed of the Internet connection and the processor speed of the computer. Some authors argue that slow download speed, especially in case of dial-up connections, might negatively influence survey participation (Couper et al., 2001; Crawford et al., 2005). According to a study of AGOF (2006, p. 12) 55.5% of the Internet users have a dial-up connection. Although sensible survey researchers make use of picture compression and caching to avoid long download times, complex material might still take some minutes to download when using a dial-up connection. In line with our argument for using fall-back procedures respondents would benefit from survey instruments which detect the Internet connection speed and route to alternative question types. This is especially true in the case of video material where respondents should be able to skip the questions when they feel videos are not displayed adequately. Similarly, respondents on slow computers may experience a lag in response with questions which include dynamic elements updated in real-time as the mouse moves. Response lags might even counteract the positive effects of immediate feedback. It is still a challenge to automatically and accurately measure these characteristics while avoiding the introduction of long download times or processing load during the measurement process itself.

Summing up, the results show that the least common denominator in available technology on client-side does not necessarily need to be pure HTML-code. For interactive survey design JavaScript is recommended. This contradicts older findings from 2001 where browsers differed substantially in the support of JavaScript (S. Schwarz & Reips, 2001). The coverage of several promising technologies has reached a high level among participants enabling online surveys to use methods and questionnaire formats which are not feasible or impractical to conduct in traditional survey modes. These technologies can be used to design successful human-survey interaction and enhance the data quality of online surveys.

Tests on Applications

6. Increasing Item Completion Rates: Interactivity in Matrix Questions

6.1. Background

In question design survey researchers have to choose among several question and answer formats. The most basic types use categories in the form of 'choose one that apply', 'choose all that apply', and open-ended questions. A matrix question is a type of question where a number of questions are subsumed under a single question heading with the same answer scale for all items. Common examples include questions like 'To what extent do you agree or disagree to the following?' with a series of statements that are to be evaluated. They are convenient to create by researchers and easily readable by respondents. The design is space-saving because the introduction is only presented once. A potentially problematic side effect of such a design is that it elicits a higher inter-item correlation than a series of the same questions on subsequent pages (Tourangeau et al., 2004).

On the whole, it is a common experience for survey researchers that respondents are more likely to abandon a survey when confronted with a matrix question than when having to answer a single item question. This is not surprising because a larger set of visible questions imposes a higher burden on respondents than a single visible question. However, there is no difference in the cumulated dropout between questions presented together or on different pages (Peytchev et al., 2006). Nevertheless, this means that the number of completed items is reduced in matrix questions. The dropout on pages employing matrix questions is a challenge in survey design which is addressed in this chapter.

The review of different authors' principles for design in chapter 2 has shown that all of them emphasized the importance of feedback for a successful human-computer interaction (Couper, 1994; ISO, 2006; Nielsen, 1993; Norman, 1988; Shneiderman, 1998). In the context of the framework for human-survey interaction, feedback corresponds to the interaction part of the framework. There are several aspects in an online survey where feedback can be provided. Already existing feedback in current online surveys is often a result of respondents' interaction with the survey. A subtle but always present example of such feedback is the change in the appearance of an answer button when a respondent clicks on it, indicating a successful response. The radio buttons and check boxes implemented in browsers are small, providing only a small visible change of a few pixels in radio buttons and only a few more in check boxes. Accordingly, the goal of my work is to enhance the visible feedback when interacting with these types of answer controls in an online form. This is supposed to enrich the interactivity of the dialogue, and to strengthen the motivation of respondents. As a result they are expected to answer more questions resulting in lower item nonresponse.

Before establishing different feedback methods I start with analyzing the task: Providing a response can be divided into the time before clicking on an answer (pre-selection phase) and the time after having clicked on an answer (post-selection phase). The post-selection phase naturally overlaps with the next pre-selection phase for the following question. Feedback can be applied in both phases as will be shown in the following two experiments.

6.2. Focusing on Available Answers (Study 2)

This experiment uses feedback techniques to enhance the visibility of available questions and their answer options.

6.2.1. Method

The basic feedback provided by computers in the pre-selection phase is the position of the mouse pointer. It indicates which object a mouse click will affect. A corresponding radio button only provides feedback after it has been clicked. Thus, feedback can be enhanced in the pre-selectio n phase by interactively highlighting the surrounding area of a radio button while the mouse pointer is in the immediate vicinity. This was technically accomplished by colorizing the underlying table cell as a mouse-over effect with a light blue color. The highlighting was spread as a cross to encompass the whole row and column in the matrix question.[1] The blue cross highlights the position of the answer within all possible answers and the item text to be answered.

In the post-selection phase a radio button provides feedback by adding a few pixels in the middle of its circle. This can be enhanced by colorizing the surrounding of the radio button in dark grey. To increase the visibility of the remaining questions the dark

[1] I thank Wolfgang Neubarth for inspiring me with the visual cross using a mouse-over effect and for sharing a technical prototype for the implementation.

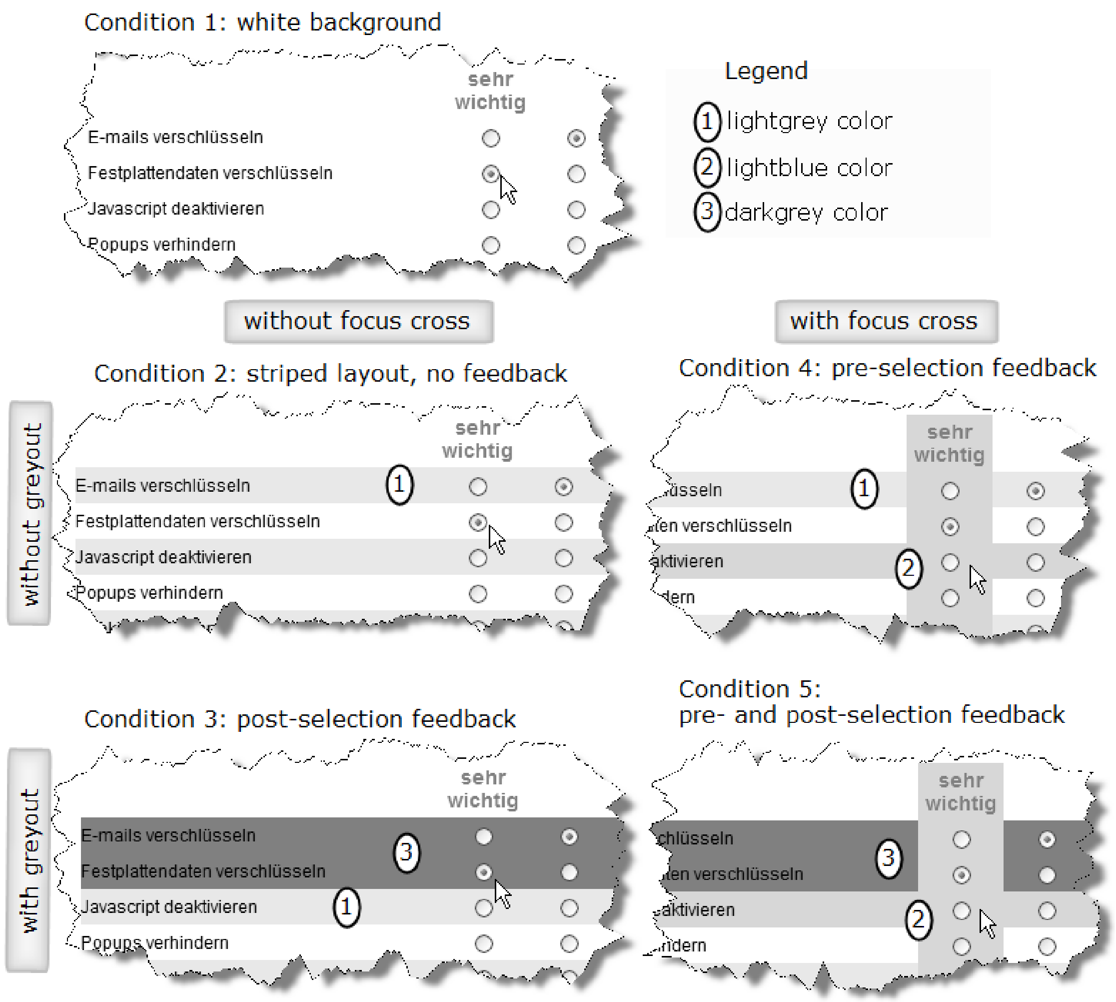


Figure 6.1. Experimental design in study 2. The images show part of the third matrix question.

grey color was spread across the whole row. This emphasized that the item had been answered and which items were still missing.

The experiment consisted of a fully-crossed design of these two feedback techniques. In addition a condition was added as a worst case scenario: The matrix questions even omitted the alternating background stripes which are otherwise common practice and aid in aligning the different item texts to their corresponding answer buttons. Thus, the experiment consisted of five conditions:

1. White: matrix questions without feedback and no alternating background stripes.

2. Striped: standard alternating background color.

3. Greyout: post-selection feedback, after a click the row turns to a dark grey color.
4. Cross: pre-selection feedback, mouseover effect which highlights the row and column in a light blue.
5. Greyout & Cross: both pre- and post-selection feedback activated.

The experiment used three subsequent matrix questions. The visual and experimental design of the survey conditions is depicted in figure 6.1.

The feedback is expected to reduce item nonresponse. The hypotheses are therefore that all feedback conditions supersede the conditions 'white' and 'striped' in terms of completed items. In addition, the condition 'white' should result in fewer item completions than the condition with stripes. Because both feedback techniques employ heavy color changes it is not expected that their effects positively add up. Instead the goal was to explore both techniques in the sense of competing design ideas. No interaction effect was expected.

6.2.2. Questionnaire

The topic of the survey was announced as 'security in the Internet'. The questionnaire asked about security concerns, experience with threats, and security related behavior regarding the Internet. It consisted of 13 pages and requested 47 answers. The experiment used three matrix questions on three pages. The first question in the experiment on page nine asked to rate nine browsers. The second question on page ten asked about the frequency for seven types of Internet communication (e-mail, chat, etc.). The third question on page eleven asked to rate the importance of sixteen possible measures to enhance the security in the Internet (using a firewall, e-mail encryption, etc.). A complete documentation of all three matrix questions and the conditions is included in appendix .

6.2.3. Participants

Participants were invited by e-mail. 4987 invitations were sent to members of the self-recruited panel Sozioland of the Respondi AG. Of the 2003 respondents who started the survey 1581 completed the questionnaire (78.9%). More women (54.5%) than men (45.5%) completed the survey. The average age was between 25 and 29 years, which was collected in categories.

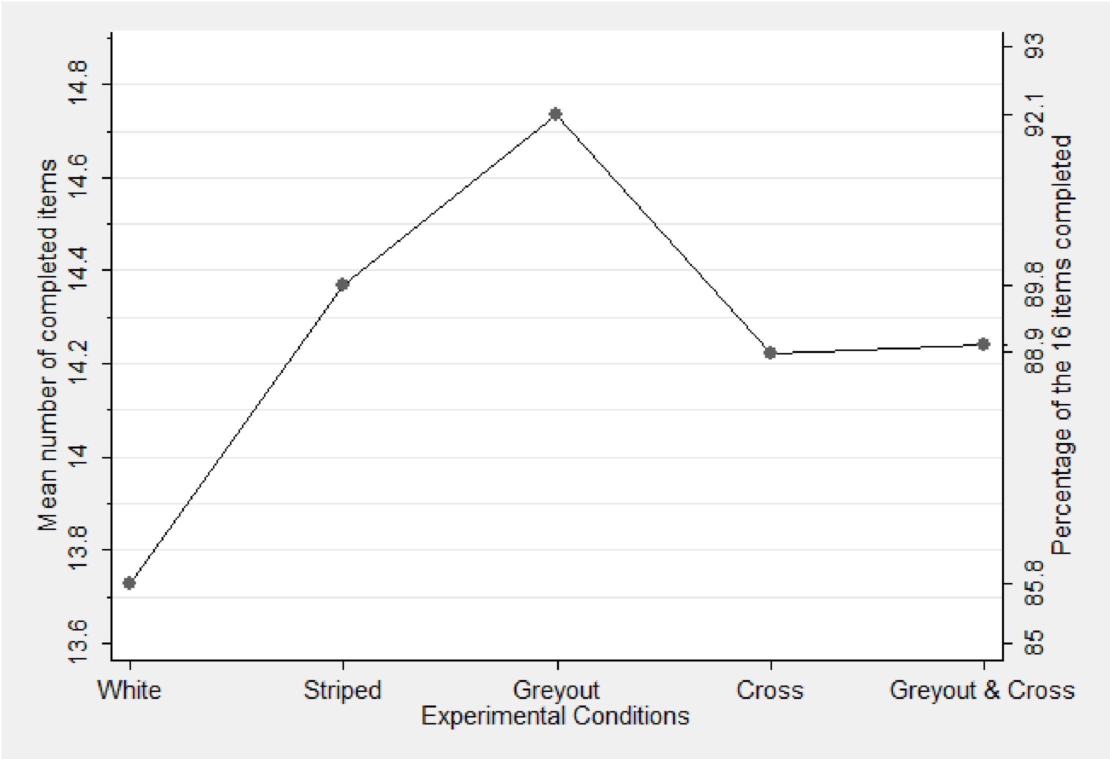


Figure 6.2. Mean number and percentage of items to which respondents answered in the third matrix question in study 2.

6.2.4. Results

The experiment consisted of three subsequent matrix questions. Because the implemented feedback techniques were new to respondents the first two matrix questions were included to allow respondents to become familiar with the survey interaction. The following presentation of results will therefore focus on the third matrix question. Nevertheless, matrix question one and two of the experiment provide similar results which are included in appendix .

To test the hypotheses the number of completed items is counted for each respondent. The mean numbers of completed items are depicted in figure 6.2. A first look at the figure confirms that the condition without alternating striped background results in the lowest number of completed items. The condition which used greyout in the post-selection phase yielded the highest completion rate. The mean difference is one item or a 6.3%[2] higher

[2] All reported percentages in this work when used to compare across conditions are 'raw' percentage differences. The sentences can therefore be understood as having X percentage points higher response rates compared to another condition. They are not increased by recalculating them to the basic

item completion rate compared to the condition 'white' per respondent. Contrary to our expectations, the condition which implemented the blue cross resulted in a lower number of item completions compared to the standard 'striped' condition. A combination of 'greyout' and 'cross' resulted in a negligibly higher completion of items than when the 'cross' alone was presented. The number of completions is even lower than in the standard condition.

Table 6.1. Frequency distribution of the number of completed items

Completed items	Conditions White	Striped	Greyout	Cross	Both G&C	Total
0	49	34	29	31	39	182
1	0	1	1	0	2	4
2	1	0	0	2	0	3
3	0	1	0	0	1	2
4	1	0	0	0	0	1
5	0	1	0	4	1	6
6	0	0	0	0	0	0
7	0	0	0	0	2	2
8	1	0	0	0	0	1
9	0	0	1	1	0	2
10	0	0	0	1	0	1
11	0	0	0	1	0	1
12	0	0	0	0	0	0
13	0	1	0	1	0	2
14	1	2	1	0	2	6
15	9	11	15	26	9	70
16	303	317	351	279	347	1597
Total	365	368	398	346	403	1880

Note. The table can be read as: 303 respondents answered all 16 items in the condition 'white'.

To analyze the data of such experimental designs a much used method is a multivariate analysis of variance with repeated measures for the three pages of measurement. However, as can be seen in table 6.1 the prerequisites for applying such a model or even a simple ANOVA are not present. One of the central requirements is a normal distribution of the error components (Bortz, 1989). A first step is therefore to look at the distributions in the conditions. The number of completed items follows a U-shaped distribution. Most

response rate of the worse condition which in this case would have resulted in 7.3% $= \frac{6.3\%}{85.8\%}$. 1.073 however, is the odds ratio for this effect (Kohler & Kreuter, 2006, p. 271).

respondents answer all items, fewer respondents overlook one or two items. A second peak can be seen at the other end where several respondents answer zero items. An ANOVA is therefore not suitable for the analysis.

Survey researchers have also employed other methods to compare effects on completion rates, among them logistic regression, survival analysis, and χ^2-statistics for cross-tabulations. In this work I focus on χ^2-statistics for three reasons. Firstly, as a parameter-free test no assumptions about the distribution of the data need to be made. Secondly, because this work proposes very strict hypotheses about the direction and relation of treatments across groups they can best be tested in direct comparisons. Thirdly, both survival analysis and logistic regression did not provide a deeper understanding of the effects. To support my third argument, the results for logistic regression and survival analysis are presented in appendix on page 173f. They lead to no or the same conclusions as the results presented in the following. It should be noted that the logistic regression with a single binary predictor simplifies to a χ^2-statistic with one degree of freedom allowing for directed hypothesis testing (Kohler & Kreuter, 2006, p. 270ff.).

Table 6.2. Proportion of respondents who completed all items

	White	Striped	Greyout	Cross	Both G&C	Total
items missing	62	51	47	67	56	283
% within	17.0%	13.9%	11.8%	19.4%	13.9%	15.1%
Completed	303	317	351	279	347	1597
% within	83.0%	86.1%	88.2%	80.6%	86.1%	84.9%
Total	365	368	398	346	403	1880

To analyze the data the χ^2-test-statistic is an appropriate approach. To overcome the problem of less than five counts in many cells in table 6.1, categories should be collapsed. Therefore, respondents who failed to answer the complete set are collapsed into a single category (table 6.2). The conditions differ significantly from each other, $\chi^2(4) = 10.2$, $p = .037$.[3] The hypotheses can now be tested by contrasting the according conditions against each other. Table 6.3 summarizes the results. Contrary to the hypothesis, the condition which provided the feedback of a visual cross resulted in even fewer completed items compared to the standard condition with stripes. Moreover, this negative effect of

[3] The degrees of freedom for inferential statistics (e.g., t tests, F tests, chi-square tests) are denoted in brackets, that is a χ^2 with one degree of freedom is written as $\chi^2(1)$.

a visual cross would have been significant with an undirected hypothesis, $\chi^2(1) = 3.92$, $p = .048$ (two-tailed).

In line with the hypotheses, the completion pattern for the condition 'greyout' with colorized rows after an answer was provided proved to be better than the standard condition. Although the higher completion rate of 2.1% is not significant, the combination of stripes and greyout is significant 5.2% higher compared to no visual aids (condition 'white'). Accordingly, the worst case scenario with no visual aids results in marginally fewer item completions than the standard implementation of matrix questions.

Table 6.3. Significant tests of the hypotheses about completion rates for the data presented in table 6.2

Hypothesis			$\chi^2(1)$	Probability p
White	$<$	Striped	1.37	.121 (one-tailed)
Striped	$<$	Greyout	0.72	.198 (one-tailed)
White	$<$	Greyout	4.17	.021 (one-tailed)
White	$<$	Cross	The effects are in	
Striped	$<$	Cross	the opposite direction	
Striped	$<$	Greyout&Cross	of the hypotheses.	

Summarizing, a visual cross obviously interferes with the task of completing a survey and results in a reduced number of completed items. Visual feedback after an answer was provided via colorized rows leads to a higher number of completed items.

In this context, survey researchers may wonder whether this gain of completion rates comes with a trade-off in terms of poorer data quality. It could be argued that respondents who would normally not answer all items but who are positively motivated by additional visual feedback have a greater tendency to satisfice instead of optimize their response than other respondents (Böhme, 2003; Heerwegh, 2005). This would result in poorer data quality. I use two aspects of paradata (cf., chapter 4) to assess a possible difference in data quality between experimental groups: response times and number of switches in answers. In accordance with Krosnick (2002) I analyze the use of nonsubstantial values as an indicator for satisficing behavior, namely the answer category 'don't know'.

There is no reason to believe that respondents would have different attitudes towards the substantial issues across conditions. Indeed, this was not the case. Differences in substantial answers between groups was tested with an analysis of variance with repeated measures for each item and proved no significant between-subjects effects (matrix question 1, $F(4, 1162) = .558$, $p = .694$, matrix question 2, $F(4, 1524) = .945$, $p = .437$, matrix question 3, $F(4, 947) = 1.196$, $p = .311$).[4]

The first indicator for satisficing is the time a respondent spends on answering the questions. Lower response times could indicate a higher degree of satisficing. To compare the response times across conditions, I look at all respondents who have answered all items. According to recommendations made by Ratcliff (1993), the response times outliers (the upper and lower one percentile) are substituted with the values for the upper (89 seconds) and lower (69 seconds) percentile respectively. As recommended by Yan and Tourangeau (2008), a natural log transformation is applied to the time data to reduce skewness. The largest observed mean difference between conditions was about one second. Compared to an average of 73 seconds response time this would be a negligible effect. Accordingly, the t tests in table 6.4 show no significant time differences between the conditions.[5] On the basis of response times, I conclude that no difference was found between the conditions, indicating no difference in data quality.

Table 6.4. Mean response times

Conditions	Raw M	Raw SD	ln M	ln SD
White	72.6	7.67	4.28	0.098
Striped	73.3	8.26	4.29	0.105
Greyout	72.8	7.83	4.28	0.100
Cross	73.7	8.53	4.29	0.109
Both G&C	73.8	7.86	4.28	0.100
t test	df	t	p	
Greyout vs. Striped	543	-0.839	0.402	
Greyout vs. White	521	0.299	0.765	
Cross vs. Striped	471	0.521	0.603	
Cross vs. White	449	1.554	0.121	

Note. The t tests used the response times of the logarithmic transformation as a dependant variable. No difference was found between conditions.

[4] The differences in the degrees of freedom are due to ‘don’t know’-answers. Because most browsers are unknown to participants the distribution in matrix question 1 was only compared for the two most common browsers Microsoft Internet Explorer and Firefox.

[5] Note: Testing the raw time data without outlier correction and logarithmic transformation results in the same conclusions. This is also the case when including respondents who only partially answered. Using an ANOVA model with response times and the experimental factors does not provide more insight.

A second data quality indicator is the number of switches or corrections respondents make. When a respondent changes his/her answer after having provided a first answer this is an indicator of uncertainty or weak attitudes (Draisma & Dijkstra, 2004). Because respondents were confronted with new visual feedback techniques the feedback may have interfered with the answering process which would result in a higher number of switches. To test whether different feedback affects the stability of answers the number of switches was counted per respondent per item as part of the implemented paradata model. The numbers were accumulated to show how many switches a respondent makes in the matrix question over all 16 items. Items missing were excluded item-wise. The complete distribution of how many switches occurred in each condition is documented in appendix . The hypotheses were tested by comparing respondents without any switches with respondents who changed at least one answer. Switching behavior is significantly different between conditions as shown in table 6.5, $\chi^2(4) = 15.2$, $p = .004$. In the condition 'greyout' only 40% of the respondents switched answers compared to 47% in the standard condition, $\chi^2(1) = 4.23$, $p = .040$. The standard condition did not differ significantly from the condition 'cross' with 41% switches, $\chi^2(1) = 1.88$, $p = .170$. I conclude that no negative impact of feedback on switching answer behavior was found. Moreover, the feedback implementation used in the condition 'greyout' significantly reduces the percentage of respondents who change their answers. The overall pattern in table 6.5 suggests that feedback and visual aids have a positive effect on data quality in terms of changes in answers.

Table 6.5. Proportion of respondents who switched answers

	White	Striped	Greyout	Cross	Both G&C	Total
No Switching	155	176	224	184	225	964
% within	49.5%	52.7%	60.4%	58.0%	62.0%	56.8%
Switched answers	158	158	147	133	138	734
% within	50.5%	47.3%	39.6%	42.0%	38.0%	43.2%
Total	313	334	371	317	363	1698

A third data quality indicator is the number of nonsubstantial values. Satisficing would result in a higher number of 'don't know'-answers. This can be tested in the current design because such a 'no answer' option was presented for each item. The hypotheses would be that the conditions 'greyout' and 'cross' result in a higher number of 'don't know'-answers compared to the standard condition. The hypotheses were tested by comparing respondents who used at least one 'don't know'-answer with respondents who provided only substantial answers. The number of respondents who only provided substantial answers does not differ between conditions, $\chi^2(2) = .629$, $p = .730$. In the condition 'striped' 63% of the respondents provided substantial answers to all items, compared to 64.1% in the condition 'greyout' and 61.3% in the condition 'cross'. The complete distribution of how many 'don't know'-answers were obtained in each condition is documented in appendix . In conclusion, either feedback techniques do not affect whether respondents provide substantial answers or not. Data quality is not affected.

Summarizing all three indicators of data quality, the feedback techniques do not have a negative impact on data quality in terms of response times, changes in answers, or number of substantial answers in this sample. Still, there is a positive effect on item completion rates for the post-selection feedback in the condition 'greyout' and a negative effect on item completions for the pre-selection feedback in the condition 'cross'.

6.2.5. Discussion

The experiment tested different feedback techniques in online survey matrix questions which were supposed to reduce items missing. Feedback was provided both before an answer was selected (condition 'cross') and after an answer was chosen (condition 'greyout'). The experiment used a fully-crossed design plus a fifth condition which was designed as a worst case scenario with no alternating background stripes.

The results show that contrary to expectations a light blue cross which follows the mouse pointer and spans across the whole row and column does not increase the number of completed items. Worse, items missing are significantly increased. The feedback was expected to help respondents focus on the item wording and the corresponding answer column they were going to select. However, the results indicate that the additional interaction and visual animation distract respondents from their task of answering the items. Observations of respondents who were exposed to such a feedback technique with matrix questions in the laboratory support this. The videos of the mouse movements and facial expressions of the respondents show that several respondents start to play with the design and move the cross across the screen. Only after exploring this, they return to the task of answering the questions. Without the additional motivation imposed by the laboratory setting it is likely that these respondents may completely loose interest in the survey questions and thus complete fewer items. The user testing also revealed that not all respondents were able to use the cross for their advantage: The cross often highlighted items and columns which were not in the focus of the attention. This happened when an answer was clicked but the mouse was not moved to the next question. In these situations, the cross detracts the attention to unimportant –because already completed– aspects of the questionnaire. Although two pages with matrix questions were presented before the third matrix question to allow for familiarization to the new interface, the results advice against the use of such a feedback technique in survey questions. This negative finding is important because it demonstrates how much the actual design implementation which is part of the operationalization affects respondents. Although theory clearly advocates feedback, researchers still need to evaluate how it should be designed. As such, the condition 'cross' is an example of how too much animation has a negative impact on task completion in a stage where attention is required to process and answer a question. The next study will address this problem with a much more unobtrusive feedback in the pre-selection phase.

A positive finding in line with the hypotheses was the higher number of completed items in the condition 'greyout' compared to the standard and worst case condition. The results show that the combination of a striped background with colorizing the row after a selection significantly increases the number of completed items compared to a matrix question with no visual aids. According to theory, the feedback enhances the overview in terms of which items have already been answered and which are still to be completed. This makes it easy for respondents to identify items which they accidentally left out.

Finally, the conditions were compared in terms of obtained data quality. The three indicators for data quality were response times, number of changes in answers, and number of nonsubstantial answers. All three provided no evidence for a loss of data quality in the conditions with additional feedback. Moreover, the number of switches in answers in the condition 'greyout' was significantly lower than in the standard condition, indicating an advantage of post-selection feedback for data quality. The next study built on these results and used less obtrusive feedback techniques to optimize the positive effects on completion rates.

6.3. Emphasizing Answer Options in the Pre- and Post-Selection Phase (Study 5)

The previous study 2 has shown that visual feedback after selecting an answer reduces nonresponse. In the pre-selection phase the study tested a graphical cross which moved with the mouse to highlight possible answer options and items. This feedback in the pre-selection phase did not reduce nonresponse. On the contrary, it led to a lower item completion rate compared to the standard condition with a striped background.

Study 5 continues this research. While the previous study 2 employed visually strong feedback techniques with colorizing rows and columns, study 5 tests more subtle feedback techniques, especially in the pre-selection phase. The study also draws on the findings presented in section 4.5, implementing the recommendation to extend the clickable area by making table cells clickable in addition to clickable buttons.

6.3.1. Method

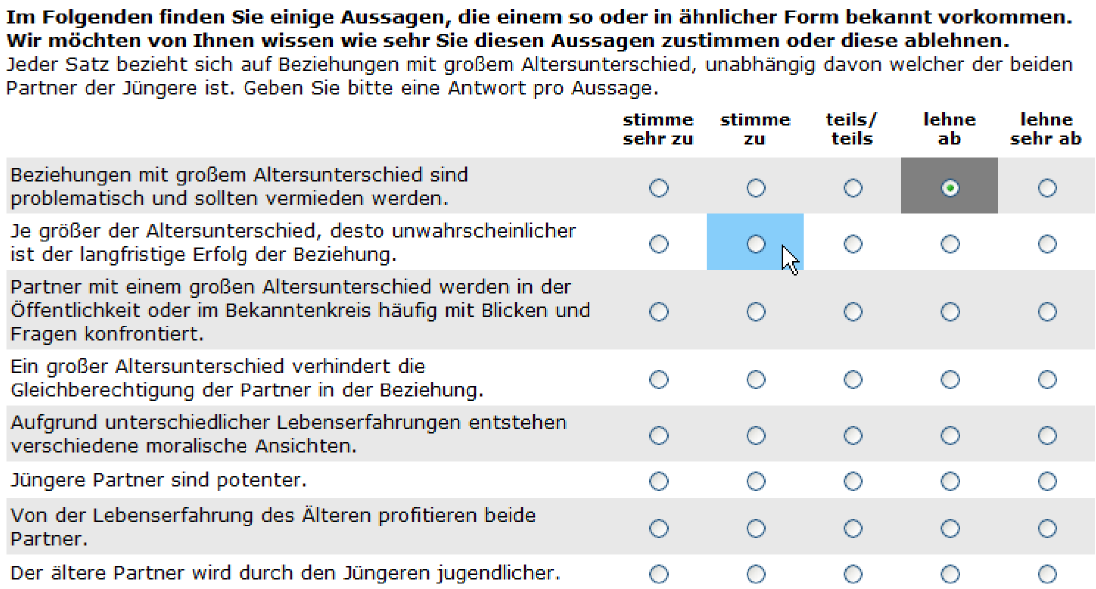


Figure 6.3. Visual design of matrix question 1 in study 5, showing the treatment condition with additional feedback. The first item was already answered and the table cell of the answer is shaded in a dark grey color. An answer is pending at the second item and the table cell is highlighted in a light blue color.

The experiment was designed to contrast feedback and interaction techniques with the current standard in online surveys. Thus, the experiment consisted of two conditions: a treatment group and a baseline group. The treatment condition employed three techniques. Firstly, feedback in the pre-selection phase was provided by highlighting the table cell under the mouse pointer. Secondly, feedback in the post-selection phase was provided by colorizing the corresponding answer cell (figure 6.3). This is different to the previous study where whole columns and rows were colorized. Thirdly, the clickable area was extended so that also clicks on the table cell provided valid answers. Not only was this a recommendation of section 4.5 but figure 6.3 visualizes how highlighting the table cell under the mouse pointer may suggest that this area is indeed clickable. The figure depicts the first matrix question of the experiment with a first answer given and a second one pending at the mouse pointer. The second condition in the experiment used the standard implementation in current survey design without additional feedback and no clickable cell areas. Thus, the second condition can be viewed as a baseline condition.

The experiment consisted of two matrix questions with eight items each and five answer values. The feedback was designed to assure respondents of their pending answer possibilities and to enhance the visibility of possible and given answers. The treatment enhanced the human-survey interaction by including the following three steps of the response process:

1. A light blue rectangle followed mouse movements to possible answer values.

2. Following an answer, the blue rectangle turned to dark grey, indicating that an answer had been placed successfully. The rectangle remained grey at the position of the answer and moved to a new position when the answer was changed.

3. To allow for a valid response when clicking within the blue rectangle the sensitive area for valid mouse clicks was enlarged. This was a recommendation in section 4.5 which should reduce the number of interaction failures shown in study 2.

The matrix questions were positioned in the second half of the survey, respectively page nine and ten. The hypothesis was that the treatment results in a higher completion rate for item response, that is that it reduces item nonresponse compared to the baseline condition.

6.3.2. Questionnaire

The survey was a short unrestricted online poll about “Age Differences in Relationships” by the company Der zweite Frühling [The second spring]. The company offers an online service to connect people above the age of 40. The survey consisted of 20 questions and 17 pages. The mean time to complete the survey was 7 minutes, 30 seconds.

6.3.3. Participants

Invitations were sent to subscribers of the company’s e-mail newsletter and an invitation link was placed on their website. Survey participation was not restricted and respondents were self-selected. No incentive was offered. The first page informed participants about the anonymity of the survey and the collection of additional data such as window size, mouse clicks and times as part of methodological experiments. It was also mentioned that respondents were able to refuse analysis of their data at the end of the survey if they had reconsidered their participation. Only one respondent (0.2%) used this possibility and was deleted from the data set.[6]

Respondents were between 19 and 75 years old with a mean age of 50.8 ($SD = 8.5$). 159 respondents were male (35.4%) and 290 respondents were female (64.6%).

An overall of 708 participants started the survey. 140 participants dropped out on the introduction screen. 459 respondents completed the survey. Taking the amount of participants who viewed the first page as basis, the response rate for completions was 64.8%. Participants were randomly assigned to one of two experimental groups in the beginning of the survey.

6.3.4. Results

The first step in the analysis is to test whether the experimental groups differed in their dropout rates. This was not the case. During the two matrix questions in the experiment, 12 respondents quit the survey in the treatment condition and 13 respondents abandoned the survey in the baseline condition. This is 1.7% and 1.8% respectively of those who had started the survey. There is also no difference in dropout patterns across the whole survey, with 52 and 50 dropouts per condition.

The hypothesis was that in the treatment group there should be less items missing. To test this hypothesis the number of items missing for the two matrix questions was counted. This resulted in a number of items missing per respondent between 0 and 16. Table 6.6 lists the distribution of items missing. Problematic for analysis is the fact that many cells have fewer than 5 cases. Therefore, all categories for items missing were collapsed into a single category (table 6.7). The results support the directed hypothesis: The treatment condition with added feedback and an extended clickable area resulted in a significant 3.5% higher completion rate for items, $\chi^2(1) = 3.0$, $p = .041$ (one-tailed).

[6] He/she was treated as ineligible respondent and was excluded from all following calculations. Although researchers might feel uneasy with adding such a last question, the expectation to loose data was unjustified in this survey. On the contrary, such an approach is in accordance with online survey research guidelines which state that respondents should always have the possibility to withdraw their consent: "During the survey respondents must always have the possibility to withdraw their previous consent. In which case all collected data must be deleted at once." (ADM et al., 2000, p. 2, my translation). The codes of conduct claim that a break-off should always be possible (ADM, ASI, BVM, & DGOF, 2001).

Table 6.6. Number of respondents and items missing in the experimental conditions

	Conditions	
Items missing	Treatment	Baseline
0	279	254
1	3	3
2	3	3
3	1	6
5	0	1
16	6	9
Total	292	276

Table 6.7. Proportion of complete item responses

	Conditions	
Answers	Treatment	Baseline
Complete	279	254
Partial	13	22
Complete	95.5%	92.0%
Partial	4.5%	8.0%
Total	292	276

Note. Two questions with 8 items each were presented within the experimental treatment. The table shows the proportion of respondents who answered all items.

Similar to the previous study, the conditions were tested for differences in data quality. Indicators for satisficing behavior were changes in answers and response time. The results showed clearly no differences between the conditions for either of the two matrix questions. The number of respondents who changed their answer in the first matrix question was 42 (17.4%) in the control condition and 43 (16.9%) in the treatment condition, $\chi^2(1) = .021$, $p = .884$. The mean response time for respondents who completed all items was 73 seconds. The conditions differed only by 0.3 seconds, $t = -.099$, $p = .921$. In the second matrix question 48 (20.3%) respondents changed their answer in the control condition compared to 48 (19.2%) in the treatment condition, $\chi^2(1) = .085$, $p = .770$. The mean response time was 64 seconds. Respondents in the control condition needed 61 seconds on average, whereas the treatment condition took 67 seconds, $t = -.925$,

$p = .355$. Overall, no negative effect on data quality for the treatment was found for the quality indicators response time and changes in answers.

6.3.5. Discussion

This study was designed according to the recommendations presented in earlier sections of this work. The goal was to combine several techniques in a single treatment and compare it with a standard implementation of current online surveys. The treatment provided additional feedback making respondents more aware of the current answer option they pointed at and making a given answer option more visible. This was accomplished by highlighting and colorizing the surrounding of the answer buttons. In addition respondents in the treatment condition had a larger area which they could click to provide a valid answer. Nearby misses of a button click would thus be interpreted as a correct answer, resulting in a more successful human-survey interaction. The results support the hypothesis and show a significantly positive effect for the combination of additional feedback for pre- and post-click behavior and enhanced interactivity, that is enlarged clickable areas. The next section therefore summarizes the presented research of this chapter and embeds the results in the broader are of survey methodology.

6.4. Summary and Conclusion

The research presented in this chapter showed that the use of visual aids and visual feedback in matrix questions is suitable for reducing item nonresponse. The increase in responses did not decrease data quality.

The theoretical background was shaped by the assumption that feedback is a principal part in successful human-survey interaction. To identify possible feedback techniques the task of survey participation was divided into two phases: The phase before clicking, the pre-selection phase and the time after a click, the post-selection phase which then overlaps with the pre-selection phase for the next question. Feedback can be provided in both phases.

The first experiment used a visual cross spanning the row and column to highlight the position of the mouse pointer. This enhanced the focus on the item wording and the answer category. Contrary to expectations, the added visual activity in the pre-selection phase distracted respondents from their task to answer items. Here, the number of respondents with missing items was 5.5 percentage points higher than in the baseline implementation. Another condition in the first experiment colorized the row of the item after an answer was selected. This post-selection feedback successfully increased the number of item completions. This feedback condition had a 2.1 percentage points higher number of respondents who completed all items compared to the standard condition, and a 5.2 percentage points higher number of fully participating respondents compared to the worst-case condition which used a white background. The post-selection feedback also provided evidence for higher data quality in terms of fewer corrections of answers: The condition had 7.7 percentage points fewer respondents who changed an initial answer. Similarly in line with the hypothesis, a matrix question which used only a white background resulted in a higher number of respondents with items missing than the standard practice with an alternating striped background (17% vs. 13.9%). There was no negative impact of either feedback techniques on data quality in terms of response times, changes in answers, or nonsubstantial answers in the form of 'don't know'.

The second experiment combined feedback techniques and an enlarged clickable area in a single treatment condition to test a combined effect of less obtrusive feedback. The enlargement of the clickable area was recommended as a result in chapter 4. The less obtrusive feedback techniques were designed to solve the negative effect of a visual cross while keeping a positive effect in the pre-selection phase. The pre-selection phase implemented a highlighting of the table cell which indicated that the cell was clickable as well. The post-selection phase implemented a color change to dark grey after an answer was provided which indicated a successful answer. The results showed that the combined effects in the treatment group successfully increased item completion rates by 3.5 percentage points. There was no negative effect on data quality in terms of response times and changes in answers.

Overall, the results showed that visual feedback can successfully reduce the number of items missing. This is supported by recent work which also report a positive effect of post-selection color changes on item completions (Galesic, Tourangeau, Couper, & Conrad, 2007). A combination with other measures to enhance human-survey interaction provided a stronger positive effect than single feedback techniques alone. These enhancements in human-survey interaction perform well for three reasons: Firstly, feedback in the pre-selection phase supports the attention of respondents by giving stronger visual cues about the position of the mouse pointer within the questionnaire and by capturing the attention (Pashler, Johnston, & Ruthruff, 2001). By changing the underlying color it visualizes where answer clicks are possible. These subtle unobtrusive visual changes strengthen the connection between the survey and the respondent by constantly reminding him/her what s/he is about to do. Secondly, the enlargement of the clickable area makes is much easier for respondents to provide an answer, reducing the amount of click failures and thus frustration. Thirdly, feedback in the post-selection phase provides a strong assurance that an answer was successfully placed by making the change more visible (Rensink, 2002). Moreover, the grey color supports the focus on the remaining items, making it clearly visible which items are still missing or may have been overlooked.

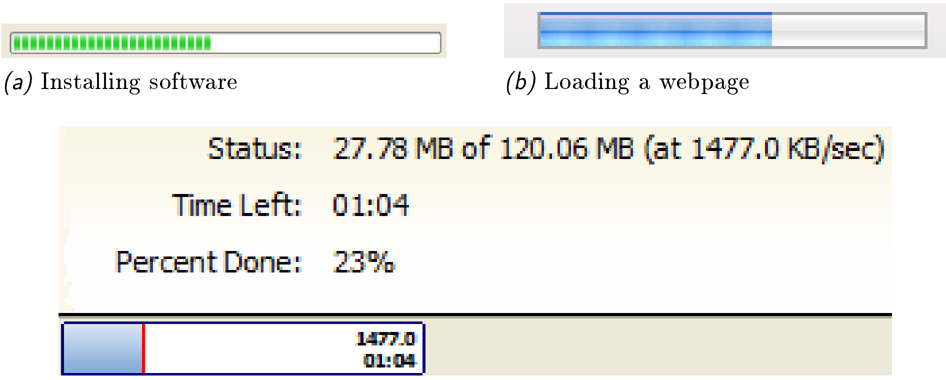
The first experiment included an operationalization of pre-selection feedback ('cross') which actually increased item nonresponse and thus negatively affected the overall survey performance. That design implementations can be problematic and reduce response rates was also found by Dillman, Tortora, Conradt, and Bowker (1998) who compared plain vs. fancy design. Because online survey methodology and Internet technology has changed much in the last ten years the following should be noted: Some of what Dillman et al. termed 'fancy' design is part of today's standards, for example the use of HTML-tables. Similarly, the argumentation of longer transmission times for more complicated HTML-code is no longer applicable. Nevertheless, the work demonstrates that online survey design needs careful implementation and must consider the technical environment of the respondents (cf., availability of technology in chapter 5).

The conclusion is that standard feedback techniques provided in current browsers are too weak. Respondents would benefit from much stronger feedback. An example in the Firefox browser may illustrate how small feedback in current browsers with a standard HTML implementation really is. This can be done by comparing the size and proportion of visual changes. Common standard sizes are: A single line question with five answer options may have the size of 640x20 pixels. A radio button's size is 13x13 pixels. The changing dot's size in the middle is 5x5 pixels. A click results in a change of 14.8% of the radio button's area. This might seem enough, but the five answer buttons only take up 6.6% of the whole question area which is the clickable area for valid clicks. Accordingly, a single click only visibly changes 0.2% of the whole question area. In contrast, the first experiment changed the appearance of the whole item, that is 100% of the item. The second experiment increased the visible feedback for a single answer to an area of 12.5% compared to the standard 0.2%. Moreover, the clickable area was increased from 6.6% to 62.5%. These numbers illustrate why visible feedback helps respondents to understand how they can interact with the survey. As a result, the human-survey interaction is more successful in leading to a higher number of completed items.

The accumulated evidence of a positive effect for the tested feedback techniques make them suitable for implementation in survey software packages where the investment in programming is made up by the huge number of respondents who benefit from these techniques. When an extra investment for a single survey implementation is necessary, survey researchers should compare the potential benefit of an increased item response rate with other possible benefits such as investing in an additional pretest to reduce measurement error. However, when readily available, researchers could benefit from applying these techniques in survey research.

7. Increasing Survey Completion Rates: Feedback on Survey Progress

Several tasks carried out on a computer require a substantial amount of time or steps.[1] In human-computer interaction users are informed about the status of the task via progress indicators. They are used in dialogue 'wizards' or assistants. When for example inserting a diagram in a calculation sheet, the title of the window could point out the current status of the task by stating 'diagram assistant – step 1 of 4'. Graphical progress indicators are commonly employed during software installation (figure 7.1a), when loading webpages (figure 7.1b) and when downloading software (figure 7.1c). These examples show that progress indicators can be textual, graphical or a combination of both.



(a) Installing software

(b) Loading a webpage

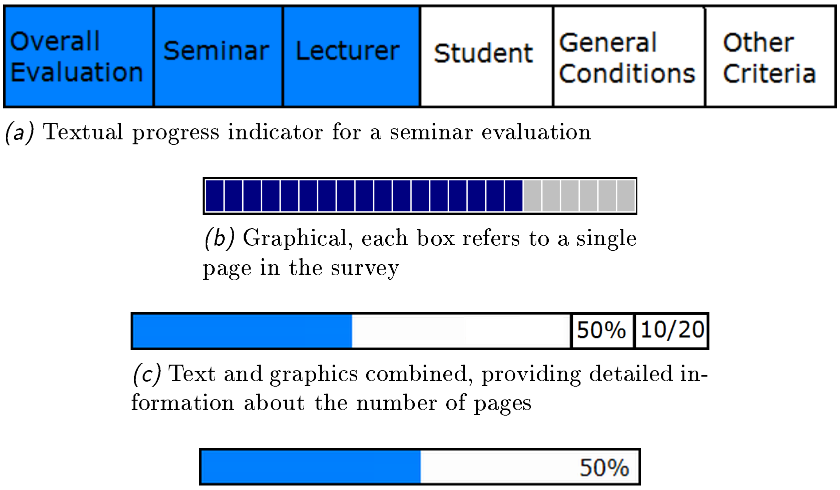
(c) Downloading software

Figure 7.1. Examples of progress indicators in human-computer interaction with Windows XP and the browser Firefox.

In online surveys the task is to complete the questionnaire. The corresponding steps involved are to navigate through its pages. Whereas progress indicators in software commonly display technical information such as download speed, indicators in online surveys focus on survey pages. Feedback can either indicate the section a respondent is currently answering, regardless of how many pages they may contain (figure 7.2a), or provide information about the amount of pages completed. The latter can be graphical

[1] **Acknowledgements**. The first experiment reported in this section was presented at two conferences (Kaczmirek, Neubarth, Bosnjak, & Bandilla, 2004, 2005).

with each slot indicating one page (figure 7.2b), or employ additional text with the number of pages or a percentage (figure 7.2c, 7.2d). In addition progress indicators can be plain text such as '50% of the survey completed' or ´Page X of Y'.



(a) Textual progress indicator for a seminar evaluation

(b) Graphical, each box refers to a single page in the survey

(c) Text and graphics combined, providing detailed information about the number of pages

(d) Graphical and textual

Figure 7.2. Possible progress indicators in online surveys.

As can be seen from the examples, progress indicators are commonly used to indicate at what point in a sequence of steps a user finds him/herself in. In my theoretical framework progress indicators are therefore part of the principle of self-descriptiveness (ISO, 2006) with its requirements of "visibility of system status" (Nielsen, 1993), "informative feedback", and "explicitness" (Couper, 1994). Although progress indicators are commonly employed, the question about their effectiveness has to be answered in terms of survey data quality, specifically nonresponse and dropout in online surveys. The next section therefore starts with a review of research on the effects of progress indicators in online surveys.

7.1. Background

In the design of online surveys, progress indicators are widely available in software packages and can easily be turned on or off by survey designers. The implementation of a progress indicator seems intuitively reasonable because people taking part in a paper questionnaire also see how far they have proceeded through the pages. Moreover, guidelines for human interface design (HHS & GSA, 2006) and survey design (Dillman et al., 1999) recommend the use of progress indicators. Some authors argue that respondents who are likely to quit at the end of a questionnaire might benefit from feedback on progress that suggests that they have reached the final questions (Dillman et al., 1999; Couper et al., 2001). Nevertheless, research on progress indicators provided mixed results, showing no effect of progress indicators (Heerwegh, 2004), a tendency towards a positive effect (Couper et al., 2001) or a negative effect (Crawford, Couper, & Lamias, 2001).

> [Recent research provides evidence] that the degree to which the feedback matches respondents' expectations is related to its impact: slower-than-expected progress could be discouraging and increase break-offs while faster-than expected feedback could be encouraging and reduce breakoffs. (Conrad, Couper, Tourangeau, & Peytchev, 2005, p. 1921).

Conrad, Couper, Tourangeau, and Peytchev (2005) showed that early and heavy overreporting of factual progress increased the completion rate, while heavy underreporting in the beginning decreased the completion rate. The difference in completion rates between these two extreme conditions was 10.5% which is more than the 1–8 percent reported by other authors (Couper et al., 2001; Crawford et al., 2001; Heerwegh, 2004).

Respondents can use a progress indicator to reassess the estimated time to completion by comparing the elapsed time with the progress shown. When the estimated time to completion exceeds the time which respondents are willing to spend on the survey dropout occurs. Thus, a survey underreports the progress when it informs respondents that they have finished 20% of the pages when these first pages actually take 51% of the time to completion. In effect such a progress indicator leads to an even higher dropout than no progress indicator. Crawford et al. (2001) made a post-hoc analysis of the elapsed time in comparison with the reported feedback which explains the negative effect of such a progress indicator. Heerwegh (2004) avoided this standard but problematic approach which uses completed pages for progress calculation. Instead, he used completion times for each page from pretests to calculate the progress. This resulted in a very accurate feedback of the necessary time which respondents had invested and still needed to invest to complete the survey. Hence, he found no negative effect of a progress indicator, but on the contrary a tendency of 1.3% higher completion rate in favor of progress indicators was observed.

Summarizing, progress indicators can have a positive effect on completion rates when implemented with care. Researchers should take precautions to make sure that their questionnaire does not lead to an underreporting of progress in the beginning of the questionnaire. This can happen easily when open-ended questions are asked in the beginning. This question type takes considerably more time to answer than rating scales.

As a result an automatic progress indicator as provided by software packages which use the number of the pages as a basis for calculation would underreport the actual survey progress. The countermeasure of overreporting is also problematic as it misleads respondents by an extensive exaggeration of the progress in the beginning to increase completion rates. This is not an option for companies adhering to the codes of conduct. Heerwegh (2004) has shown that a thorough preparation of the progress calculations based on response times can avoid negative effects. However, current surveys do not make this additional effort to calibrate their progress indicators on participation times. Instead, they use the available automatic calculation method based on page numbers. Additionally, time calibrations become complicated when filter paths are employed. Here, respondents would need different progress information on the same pages depending on the questions they have answered or skipped. In the following, my research therefore addresses automatic calculation methods. The next sections explain the problem of 'jumping progress indicators' associated with filter questions and provide a solution.

7.2. Improving the Accuracy of Progress Feedback

7.2.1. Jumping Progress: Problems With Filter Questions

Progress indicators are used to inform participants of surveys about the degree of completion and the remaining numbers of questions. The main aim of progress indicators is to reduce dropout rates. Theory holds that this is accomplished by allowing participants to estimate the remaining time till completion. Participants might base their estimation on the time invested in relation to the number of completed items and the perceived speed of the progress indicator. If the estimated time till completion is beyond acceptance the participant drops out.

A common method displays the number of pages completed and the total number of pages in the survey. These numbers may be visualized by a graphical bar which either substitutes the numbers or supports them. Instead of the raw page numbers the percentage of completed pages may be displayed. These methods can be characterized as *static approaches* in computing the percentage till completion. When using surveys which implement filter techniques this leads to a serious problem: filters used to skip non-appropriate items for groups of participants cause the progress indicator to jump to completion rather than progress in a smooth way. For participants, this behavior results in unpredictable percentages and thus destroys the advantages of predictable time estimations.

To cope with the problem of jumping progress indicators my work describes a *dynamic calculation method*. With an algorithm the overall pages till completion are estimated for the participant on every page. These numbers vary in accordance with the filter path of the survey resulting in a smooth completion of the progress indicator.

7.2.2. Static Calculation Approaches

The most common approaches for calculating the progress in a survey use pagenumbers (eq. 7.1) or average time per page (eq. 7.2) as a basis for calculating the actual progress. In the two formulae, $\mathcal{P}_t$ is defined as the progress for page t. The reported progress for a given page is calculated by dividing the current pagenumber t by the total number of pages in the survey. Similarly, the progress for a page using time estimates is calculated by dividing the average time for the actual page by the average total time needed for the survey. These numbers are available before a survey is conducted. They are independent of real response. This results in a percentage of completion for each page which is equally shown to all respondents. These calculation methods are static in the sense that the reported progress for a given page is known before respondents have participated.

$$\mathcal{P}_t = \frac{pagenumber\ of\ page\ t}{total\ number\ of\ pages} \tag{7.1}$$

$$\mathcal{P}_t = \frac{average\ time\ till\ page\ t}{average\ total\ time} \tag{7.2}$$

7.2.3. The Dynamic Calculation Approach

A solution that overcomes the problem of 'jumping progress' is to calculate the progress during the participation for each person individually. No further information beyond the one already provided is necessary. As one is not able to foresee whether and when a filter is applicable for a person, it is not possible to give the feedback of a really continuous progress rate. Nevertheless, the jump can be flattened so that a participant does not perceive the jump. This is accomplished by increasing the speed of all further progress slightly. I will refer to this as the dynamic calculation method, as it is calculated for each respondent individually during survey participation. Figure 7.3 illustrates how the gain of skipped pages is evenly redistributed across the remaining pages. The differences in the development of progress between a static and a dynamic calculation are depicted in figure 7.4.

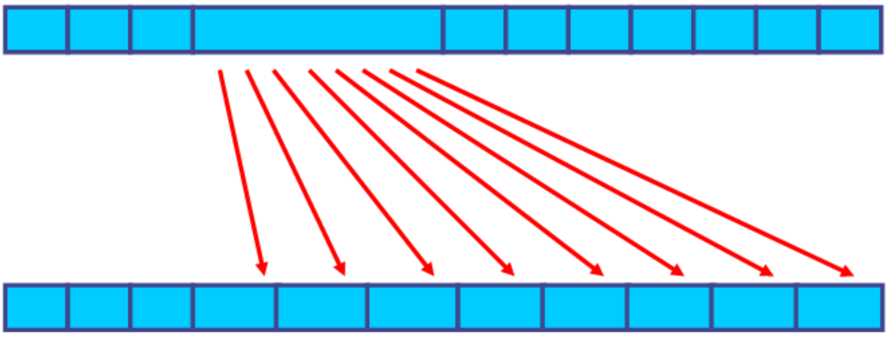


Figure 7.3. Static and dynamic progress indicators. The upper progress indicator uses a static calculation method and shows the increase in progress with a skip of questions. The lower progress indicator uses a dynamic calculation approach and shows how the gain of skipped pages is distributed among the remaining pages.

Equation 7.3 shows the idea of the dynamic calculation. Equation 7.4 is the proposed formula for the dynamic progress indicator and states the necessary variables and constants to calculate the progress for a given participant and page. The progress is calculated on each page, usually as a proportion of 100 percent. The reported progress on a page is the percentage reported on the last page plus the percentage of the new page. This new percentage is simply the remaining percentage of the survey divided by the remaining pages and in this second part of the formula similar to the static approach (equation 7.3). The remaining percentage is 100 percent minus the the percentage so far. Similarly the remaining pages are calculated by subtracting the actual page number from the maximum pages in the survey for a given user (equation 7.4). Because the formula always distributes the remaining percentages among the remaining pages, a jump is flattened and the gained percentages are redistributed among all following pages.

$$\mathcal{P}_t = \mathcal{P}_{t-1} + \frac{remaining\ percentage}{remaining\ pages} \tag{7.3}$$

$$\mathcal{P}_t = \mathcal{P}_{t-1} + \frac{width - \mathcal{P}_{t-1}}{maxPages - t} \tag{7.4}$$

The details of equation 7.4 are as follows: $\mathcal{P}_t$ is the progress shown on page t. Similarly, $\mathcal{P}_{t-1}$ is the progress shown on the previous page. $\mathcal{P}_0$ may be any number between zero

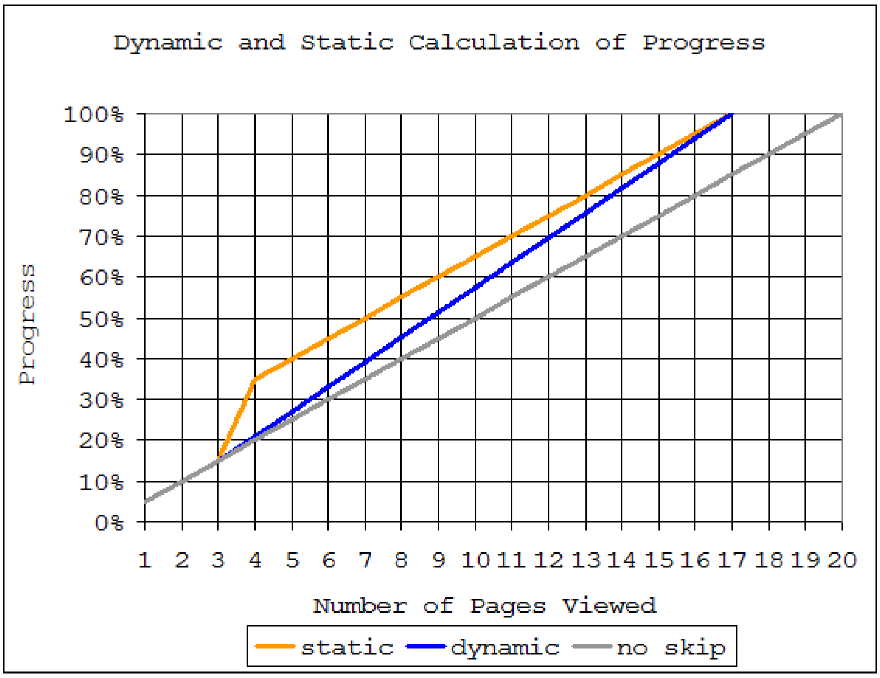


Figure 7.4. Development of progress with static and dynamic calculation.

and *width*. It is an offset for the beginning progress and usually zero. *width* is a constant and should be set as the number to be reached by completion, usually 100 (=100%). In other cases, for example when the progress is directly to be translated into the width of a graphical progress bar, *width* can be set to correspond to the width of a fully completed survey, for example 300 pixels in technical terms. *maxPages* is the maximum number of pages a participant has to visit to complete the survey.

The most flexible way to implement the formula is to increase t by one for every forward navigation in the questionnaire. The start settings are $t = 0$ on the first page (e.g., the invitation page without a progress indicator), $width = 100$, $\mathcal{P}_0 = 0$ and $maxPages$ being the highest number of pages a participant has to view to complete the survey.[2] If a skip occurs, *maxPages* is reduced by the number of skipped pages. The following example uses a survey with 30 pages. The initial settings are $t = 0$, $width = 100$, $\mathcal{P}_0 = 0$ and $maxPages = 30$. If a participant jumps from page 1 ($t = 1$) to page 6, the next values would be: $t = 2$ and $maxPages = 30 - 5 = 25$. *maxPages* is reduced by the number of pages skipped. If pages are conditionally inserted, for example a

[2] If some progress should be shown on the first page, we can set $t = 1$ on the first survey page but must ensure also to increase *maxPages* by one.

question on page one leads to five additional pages, the next values would be: $t = 2$ and $maxPages = 30 + 5 = 35$. $maxPages$ is increased by the number of pages inserted. Whether pages are skipped or inserted depends on the implementation of filters and results in an accelerated or slowed-down progress.[3]

The following list summarizes the dynamic calculation approach:

- The dynamic approach calculates the progress during participation for each person individually.
- There is no need for more information compared to previous calculation methods.
- The remaining percentage is distributed among the remaining pages. This way, the formula avoids a jumping progress in favor of an increased speed of progress.
- The progress indicator can be initialised with any percentage.
- The dynamic approach can also be used with time estimates or item numbers instead of page numbers.
- Inserting conditional additional questions does not decrease the progress.
- The algorithm works in environments where the page numbers are not fixed, for example due to randomized pages or experimental settings.
- The algorithm can be implemented in a way so that even backward navigation increases the progress.[4]

The above section developed a solution against irritating behavior of progress indicators in surveys with filters and skips. The next step was to experimentally compare the proposed solution of a dynamic calculation method with the traditional static calculation method.

7.3. Employing Feedback Dynamically and Individually (Study 6)

The online experiment described here compared the different forms of progress indicators as described in the previous section.

[3] Accelerating progress is similar to the 'slow-to-fast' and decreasing progress similar to the 'fast-to-slow' conditions in the experiments used by Conrad, Couper, Tourangeau, and Peytchev (2005). Because the experiments artificially exaggerated or diminished the progress feedback these terms are avoided in the present context.

[4] Although such an implementation is not recommended, one may accomplish this behavior by increasing t for every navigation forward and backward while adding 1 to $maxPage$ for every backward navigation. This adds progress to every navigation while slowing the whole survey progress down.

7.3.1. Method

The goal of this experiment was to test the different calculation methods in a survey. To avoid interferences induced by real skip patterns, two skips of five pages were simulated at two points in the survey. Therefore, the questionnaire was 20 pages long but it behaved like a 30-page questionnaire with two skips which applied to all respondents. This makes it easy to compare how the two different forms of feedback are affected by skip patterns.

The experimental conditions consisted of four types of feedback on progress:

1. a continuous progress indicator (true progress) which increased 5% per page,
2. a jumping condition (static calculation) which increased 3.3% per page and two times 20%,
3. an accelerating condition (dynamic calculation) which started with 3.3% and ended with 6.8% increase per page, and
4. a condition with no progress indicator.

The reported progress for each condition is depicted in figure 7.5. The research discussion

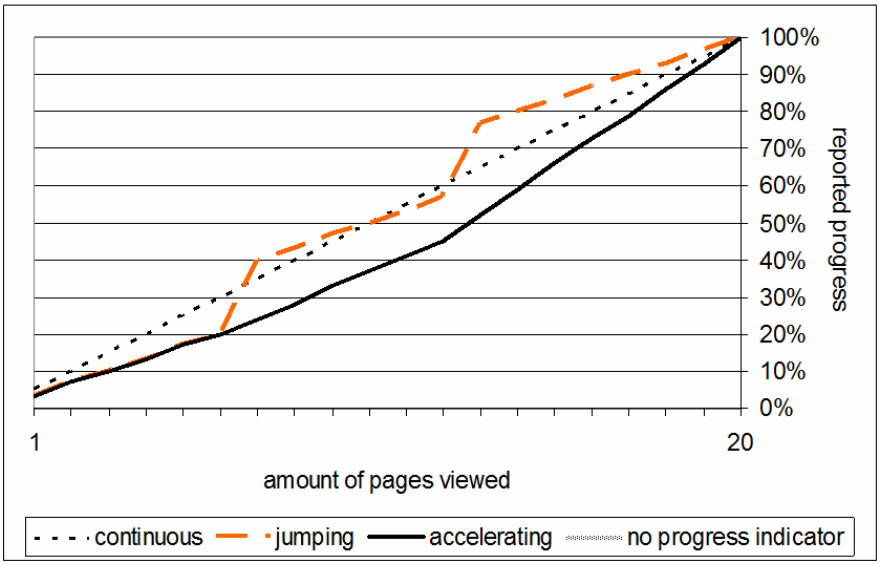


Figure 7.5. Reported progress in the experiment. There is no line for the condition with no progress indicator because no progress was shown.

above has shown that unrealistic feedback on progress is worse than no feedback when the progress is underreported. Such underestimation of progress in the beginning happens in surveys with non-applicable filter questions. In the experiment, this was simulated in the condition with a jumping progress indicator using the static calculation method. Thus, this condition should lead to a lower completion rate than no progress indicator. A true feedback on progress however such as in the condition with a continuous progress indicator should be superior. It is important to note that such a true progress is not available in real survey settings because researchers cannot know whether filter questions apply or not before they are answered. The best estimate in a real survey setting is therefore the condition using the dynamic calculation method. The completion rate in this dynamic calculation condition should be higher than with a jumping progress indicator but lower than with a true –but naturally unavailable– progress feedback. Summarizing the hypothesis for a survey with filter questions, I expect the following order of completion rates across the different forms of progress indicators: static calculation < no progress indicator < dynamic calculation < true progress report.

7.3.2. Questionnaire

The topic consisted of 17 pages on cooking and 3 pages with interim questions (on page 6, 12, and 19) about the perceived burden, perceived time flow, and expected time till completion. A simulated filter jump was attached after pages 6 and 12. The survey took about 8 minutes to complete. To maintain an identical survey for everyone, each participant received the same 20 pages. The only difference consisted of the feedback of the progress indicator.

7.3.3. Participants

Participants were people visiting the Sozioland webpages, which is a site for entertainment surveys and online access panels. The sample was thus a non-probability self-selected sample with people interested in polls as entertainment. 1091 respondents started the survey. 332 participants dropped out on the introduction screen, leaving 759 respondents for the experiment. 620 respondents completed the questionnaire, resulting in a completion rate of 56.8%. Calculating from page two where the experiment begins, the completion rate was 81.7%. Age was asked in categories. Most respondents reported being between 19–29 years old (35%) and 30–39 years old (26%). 495 respondents were asked whether they were male or female. 66.5% of the respondents reported being female, 27.0% reported being male, and 6.5% refused to answer.

7.3.4. Results

The results support the hypothesis (table 7.1). The condition with the static calculation method with its obviously jumping progress indicator has the lowest completion rate of 77.1%, followed by the condition without feedback and the dynamic calculation method which are nearly equal (83.2% vs. 83.0%). True progress feedback resulted in the highest completion rate of 85.9%. A χ^2-test does not show overall significant differences between the progress indicators, $\chi^2(3) = 5.4$, $p = .14$. Nevertheless, a contrast between the best and worst condition reveals a significant difference of 8.8% in completion rates between true feedback and the static calculation method, $\chi^2(1) = 4.7$, $p = .03$. The pattern of completion rates emphasizes the benefit of accurate feedback on progress.

Table 7.1. Completion rates across experimental conditions in study 6

	Static	No PI	Dynamic	True
Dropout	47	32	33	24
Completion	158	158	161	146
Dropout	22.9%	16.8%	17.0%	14.1%
Completion	77.1%	83.2%	83.0%	85.9%
Total	205	190	194	170

Note. The table is sorted in the hypothesized order: static calculation method, no progress indicator, dynamic calculation method, and true feedback on progress (n=759).

On the pages before the simulated page skips three interim questions were asked. They were placed on page 6 and page 12 and asked respondents (i) whether the survey was longer or shorter than expected, (ii) whether the survey was easier or harder than expected, and (iii) how many minutes they expected until survey completion. Near the end of the survey on page 19, respondents were asked the first two questions a third time.

Figure 7.6 shows the mean answers for the perceived duration of the questionnaire. When the question was first asked, respondents stated that the survey was shorter than expected. The second time the question was asked, respondents were mostly undecided and chose the middle category between longer and shorter. The third time, respondents perceived the survey as longer than expected. The reported impression from the first time the questions were asked are probably an effect of the fact that respondents thought the survey to be finished after these questions. Overall, the survey was perceived as taking longer than expected towards the end of the questionnaire as can be shown with a t test contrasting the first and third time the question was asked, $t(591) = -20.8$, $p < .001$, (mean difference $= -.92$) and the second and third time the question was asked, $t(587) = -6.2$, $p < .001$ (mean difference $= -.22$).

Looking at the four conditions one is able to see which feedback is most favorable for the perceived time flow. Here, a survey that is shorter than expected is defined as better than one that is taking longer than expected. On the first interim page no progress indicator yields the best answers. This changes during the survey: On the last interim page the dynamic calculation method yields the best answers while no progress indicator yields the worst. This interaction effect is significant (multivariate test with repeated measures, Wilks' Lambda, $F(6, 1232) = 6.2$, $p < .001$), whereas the difference between the conditions is not, $F(3, 617) = .57$, $p = .63$. This suggests that an accelerated feedback leads to the shortest perception of survey duration.

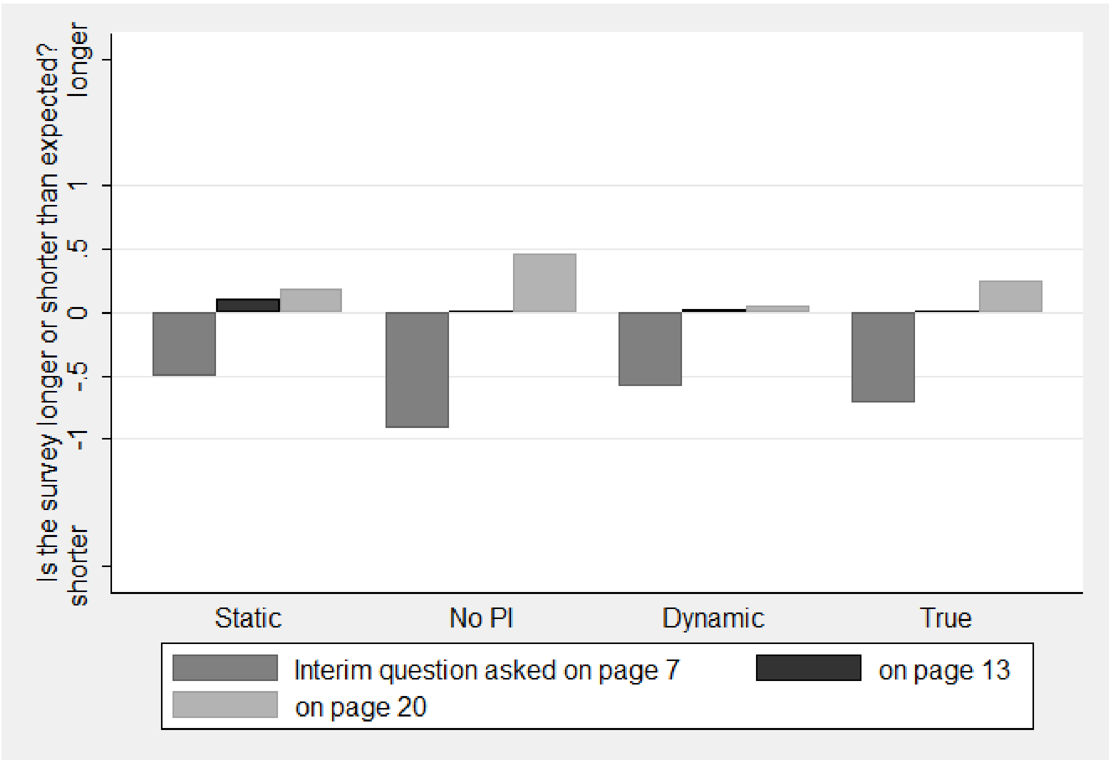


Figure 7.6. Perceived time flow. The answer categories were a fully labeled 5-point-scale.

Figure 7.7 shows the answers for the perceived burden. Overall, the survey is rated as being easier than expected. This is reasonable because the survey questions about cooking should not pose much burden on respondents and the survey was about 8 minutes long. The burden significantly increases along the interim pages, both from the first to the second interim page, $t(156) = 4.0$, $p < .001$, as well as from the second to the third interim page, $t(144) = -2.1$, $p = .03$. Because according to theory burden increases with the length of a survey these results can be interpreted accordingly. The question indeed captures the concept of burden. A comparison of the conditions reveal no significant differences. Nevertheless, the observed pattern is similar to the perceived duration: No progress indicator results in the lowest burden on the first interim page and this advantage is again lost at the end of the survey.

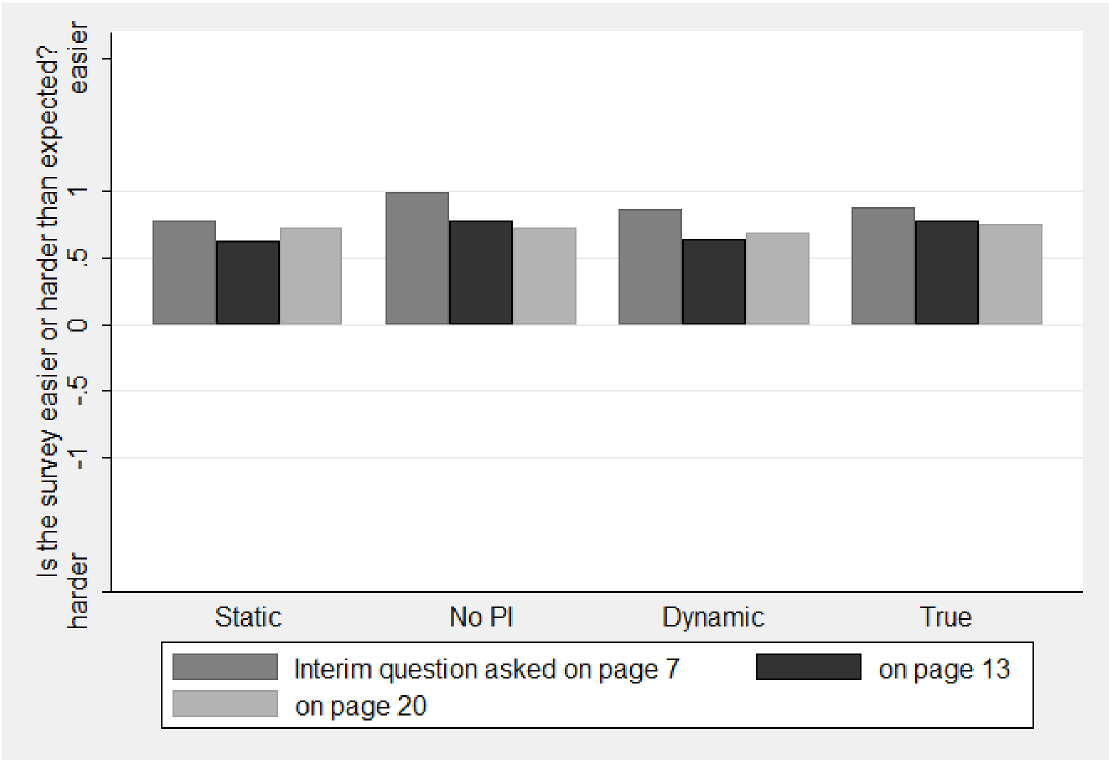


Figure 7.7. Perceived burden. The answer categories were a fully labeled 5-point-scale.

Figure 7.8 shows the expected minutes till survey completion. This question was asked two times during the survey but not at the end. In consistency with their first answer to this question, respondents provided a lower estimate in their second answer: The mean for the question on the second interim page is significantly lower than on the first interim page, $t(611) = 6.5$, $p < .001$. This is also the case within all conditions showing a progress indicator: static, $t(155) = 4.9$, $p < .001$, dynamic, $t(157) = 2.6$, $p = .01$, true, $t(142) = 4.2$, $p < .001$. In the condition with no progress indicator

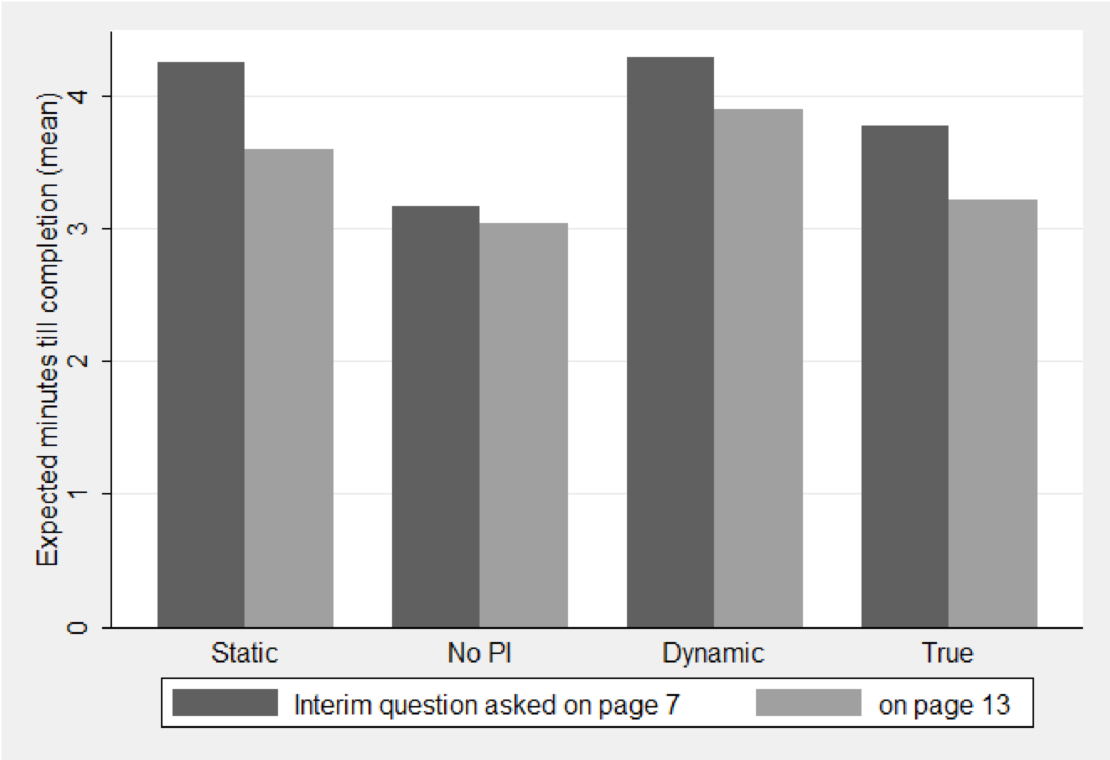


Figure 7.8. Expected minutes till completion. The answer scale was numbered from 1 to 10.

the difference is insignificant, $t(154) = 1.4$, $p = .16$. This can be interpreted as an effect of progress indicator vs. no progress indicator. The progress indicator provides information about the fact that fewer questions and thus fewer time needs to be invested until completion than 6 pages earlier on the first interim page. Respondents without feedback on progress have no additional clues to estimate the time till completion and consequently do not reduce their estimate as much. Thus, a progress indicator really conveys information about the remaining time. This effect is also observable between the conditions. A progress indicator which suggests a faster progress in the beginning (cf., figure 7.5) yields lower time estimates till completion. This assumption is tested by contrasting the condition of true feedback on the one side with the static and dynamic conditions on the other side for the first estimate. The difference is significant with a difference of half a minute, $t(486) = 2.5$, $p = .01$. The difference is also significant for the second estimate, $t(455) = 3.0$, $p = .003$. I conclude that respondents use feedback on progress to estimate the time till completion. Furthermore, the expected time till completion later in the survey is effectively reduced by such feedback. Not only does it make a difference between employing feedback vs. not employing feedback but also the specific amount of reported progress has a measurable effect on the time estimates.

7.3.5. Discussion

Survey researchers use progress indicators because they expect a positive effect on completion rates. A straightforward method to calculate the progress to be reported is to divide the page number by the overall amount of survey pages. This results in a percentage for each page which is then shown to the respondents (the static calculation method). Whenever filter questions are employed in a survey, respondents experience the phenomenon of a jumping progress indicator as soon as they skip pages. Because it is impossible to know from the beginning whether a respondent will enter filter paths or not, the static calculation method is prone to underreport the actual progress of the survey. Furthermore, jumping behavior of a progress indicator makes it seem less reliable. To solve this problem I proposed a dynamic calculation method which recalculates the progress on each page for each respondent individually. The experiment compared these two calculation methods in a survey with simulated skip patterns. To allow a thorough analysis it also included conditions with no progress indicators and a progress indicator which reported the true percentage of completed pages. The hypothesized pattern of completion rates according to theory was indeed found in the results. Underreporting the progress in the beginning due to employed filter questions results in lower completion rates than no progress feedback (static calculation < no progress indicator). The dynamic calculation method overcomes this problem (static calculation < dynamic calculation) although it starts with the same percentages as the static calculation method. This is further supported by the fact that a true feedback report results in the highest completion rates (all other conditions < true progress indicator). Because in a real setting a true progress cannot be calculated from the beginning, the dynamic calculation method outperforms the other conditions. The positive effect of the dynamic calculation method is also visible in terms of expected time till completion, perceived burden of the survey, and the perceived time flow.

7.4. Accelerated, Decelerated and Steady Progress Feedback (Study 7)

In the previous study 6 the dynamic method calculated progress in a conservative way based on the longest possible survey path. This always results in underreporting of progress or true progress feedback if no question is skipped. This leads to a speed-up of progress feedback as filter questions apply and pages are skipped. The respondent experiences faster progress towards the end of the survey. Besides beginning with the longest possible survey path to dynamically calculate progress, one can base the calculations on the shortest possible survey path. This different implementation for the dynamic calculation of progress is progressive because it tends to overreport progress in the beginning. The reason is that the calculation starts with the assumption that no filter questions apply. Here, respondents experience a slowdown of increase in progress as filter questions apply and he/she is routed through the additional questions in the filter. The difference between the two methods of dynamic progress calculation is that in the conservative method the progress is slow in the beginning with possible speed-ups in the end, whereas in the progressive method the progress is faster in the beginning and may slow down during participation. The research question addressed in the following study is therefore which of these two methods for dynamically calculated progress should be employed.

7.4.1. Method

The experiment tested whether it is better to overreport progress in the beginning and potentially reduce the added amount of progress reported later on, or whether it is better to estimate the progress based on the worst case and adjust progress feedback as soon as pages are skipped. Three experimental groups were designed. Condition one reported faster progress in the beginning (progressive calculation method with overreporting). Condition two reported faster progress towards the end of the questionnaire (conservative calculation method with underreporting). Condition three serves as baseline and employed a constant increase. It was simply the page number divided by the overall number of pages. Because thirteen pages included a progress indicator the baseline condition reported an increase of 7.7% per page. The progress calculation for the progressive and conservative conditions used an equation which raised the value of the baseline to the power of 1.6. The result was then adjusted so that it fit between 0 and 100 (equations 7.6 and 7.7). Figure 7.9 depicts the percentage respondents were shown on the pages for each condition. As can be seen, the progressive calculation method steadily overreports the progress until the end, whereas the conservative method underreports the progress until the end of the questionnaire.

$$p = b, \text{ baseline, with } p = \text{reported progress}, \ b = \text{baseline input} \tag{7.5}$$

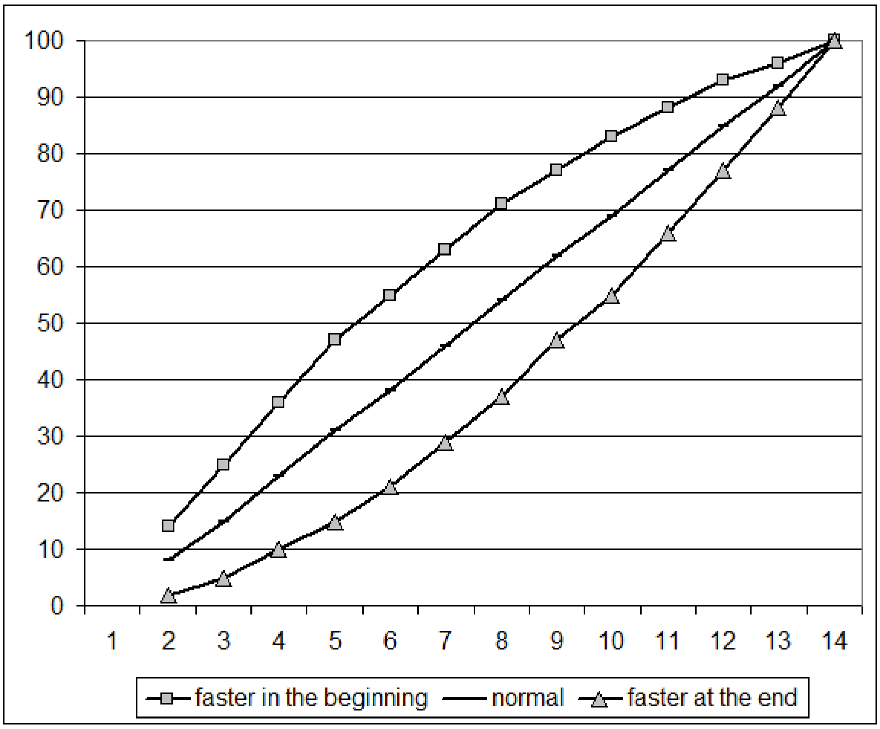


Figure 7.9. Reported progress across experimental conditions. The study used the formulae 7.5, 7.6 and 7.7 for calculating the reported percentage in progress.

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$$p = b + b - \left(\frac{b}{100}\right)^{1.6}, \text{ progressive, begins fast, then slower} \tag{7.6}$$

$$p = \left(\frac{b}{100}\right)^{1.6} * 100, \text{ conservative, begins slow, then faster} \tag{7.7}$$

Results from study 6 showed a negative effect of early underreporting of progress on completion rates. The hypothesis in this study is therefore that the conservative method results in the lowest completion rate whereas the progressive method results in the highest completion rate. A constant feedback on progress which is closest to the true progress should result in a completion rate which lies between the progressive and conservative method.

The manipulation of the progress indicator was not achieved by real filters in the questionnaire. This allows for a testing of the effect of the feedback without the influence of different survey questions. The progress indicator was placed in the upper right side of the questionnaire taking up a rather small amount of the width of the screen (figure 7.10). Respondents were randomly assigned to one of the three conditions on the first page.[5]

7.4.2. Questionnaire

The questionnaire consisted of 15 pages with 79 requested answers. Several pages consisted of matrix questions similar to figure 7.10. On the first and last page no question was asked. One filter question in the middle of the survey could lead to a skip of a single page. The questions focused on working conditions in the context of free/open source software projects. The questionnaire was part of a dissertation on free/open source software development (Jendroska, in preparation). The instructions stated that completion of the survey would take 15 minutes. The mean time to complete the survey was 19 minutes and 44 seconds, the trimmed mean (5%) time was 16 minutes and 7 seconds.

7.4.3. Participants

The respondents of the survey consisted of people who contribute to open source projects. This included for example coders, testers, managers, translators, and developers contributing during spare time or during payed working hours. Access to the survey was not restricted and respondents were invited with e-mails on open source communities (e.g., sourceforge.net) and in related forums.

Age was asked in categories. Most respondents answered being between 20–30 years old (44.5%) and 31–40 years old (25.2%). 123 respondents were male (79.4%) and 7 respondents were female (4.5%). Overall 653 participants started the survey. 272 participants dropped out on the introduction screen. 153 respondents completed the survey. Taking the amount of participants who viewed the first page as basis, the response rate for completions is 23.4%. Participants were randomly assigned to one of three experimental groups in the beginning of the survey.

[5] 39 respondents who had deactivated JavaScript were excluded from the analysis and received no progress indicator because this study used JavaScript to assign the conditions.

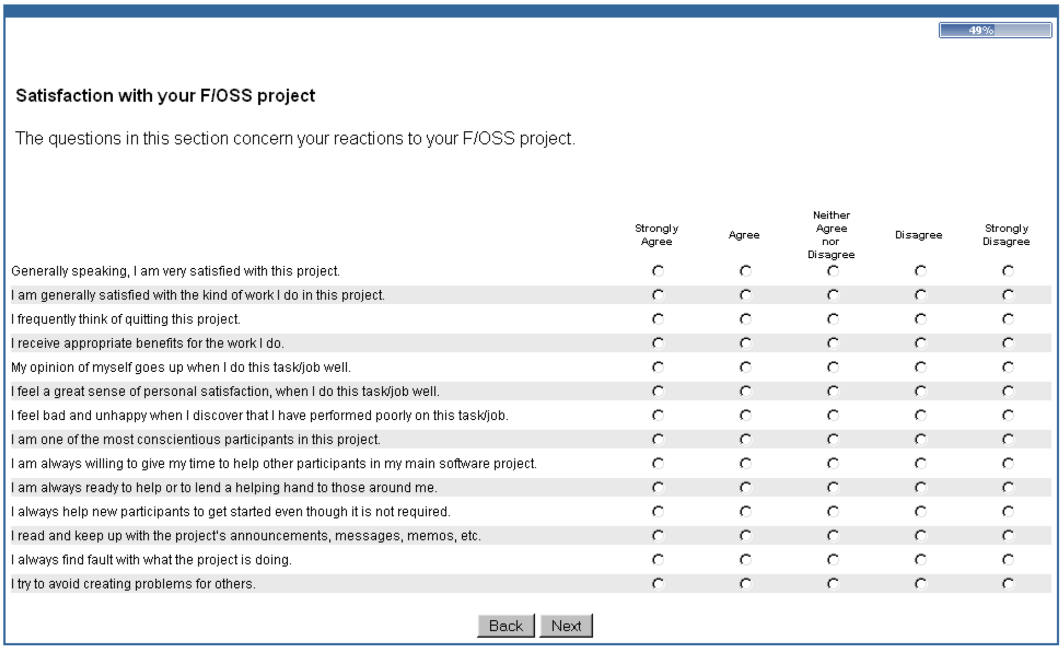

Figure 7.10. Example of the questionnaire used for progress feedback.

7.4.4. Results

The effects of the different progress indicators were analyzed by comparing the different completion rates. The results are summarized in table 7.2. The condition which overreported progress had a 5.7% higher completion rate than the condition which underreported progress. This conforms to the directed hypothesis as stated above. However, an overall χ^2-test reveals that the cell counts do not differ significantly from each other, $\chi^2(2) = 2.98$, $p = .23$. In contradiction to the hypothesis, a higher completion rate in the condition with constant progress was observed than in the condition underreporting progress. Although this points to the wrong direction, it should be noted that this difference is within the range of chance as can be seen when comparing these two conditions only, $\chi^2(1) = .54$, $p = .46$. Similarly, the over- and underreporting conditions are not significantly different from each other, $\chi^2(1) = .90$, $p = .34$. A final comparison contrasting the extremes between the condition with constant progress and the condition with overreporting reveals a marginally significant difference in completion rates, $\chi^2(1) = 3.0$, $p = .086$. Considering the direction of the hypothesis one might argue that the directed hypothesis allows for a one-tailed testing approach which would then be significant. Such an argumentation is problematic because we may not neglect that the completion rates in the constant condition point to the wrong direction, contradicting the directed hypothesis. The results are therefore inconclusive with a tendency to favor a progressive dynamic calculation method.

Table 7.2. Completion rates across experimental conditions in study 7

	Reported progress in the beginning		
	Overreporting	Underreporting	Constant
Dropout	82	82	95
Completion	56	44	42
Dropout	59.4%	65.1%	69.3%
Completion	40.6%	34.9%	30.7%
Total	138	126	137

7.4.5. Discussion

The first experiment on progress feedback has provided evidence that a dynamic calculation method is preferable to the traditional static calculation method. The second study of progress feedback was designed as a decision experiment to determine how the dynamic calculation method should be implemented. The question was whether to base the calculation on the longest possible survey path (conservative) or on the shortest (progressive). Unfortunately, the final number of 401 respondents was below the goal of 964 respondents which would have been necessary to yield a power of 0.80 (Faul & Erdfelder, 1992). As a consequence the results were inconclusive, pointing only tentatively towards an advantage of the progressive approach. The experiment was thus underpowered ($Power = .41$, for a small effect size with $\alpha = .05$, $n = 401$, $df = 2$, calculated with the computer program G*Power provided by Faul & Erdfelder, 1992) making it difficult to detect a small effect. One reason for this was that the target group of the questionnaire were open source developers. The comments given in the questionnaire indicate that people belonging to this group are heavily targeted with solicitation e-mails about open source research. In addition, several respondents remarked on the fact that they are irritated by such unwanted invitations and that their participation was an exception. This is an example for an emerging problem in online surveys: Requests from scientific research compete against masses of unwanted spam e-mails. Finally, some respondents remarked on the progress indicator and technical implementation of the survey although no question or remark about progress indicators was presented in the questionnaire.

The fact that respondents were programmers makes it more likely that they evaluated the technical aspects of the survey implementation while answering the questions. This might have diminished the effect of the treatment as those respondents might have a better understanding of progress indicator inaccuracies and thus do not consider them very much in their estimates of progress.

7.5. Summary and Conclusion

Progress indicators are used to inform participants of surveys about the degree of completion and the remaining quantity of questions. Chapter 2 has shown that such feedback is an important aspect of survey usability. Feedback on progress is part of a successful interaction between respondents and online surveys. From a data quality perspective survey researchers would implement progress indicators to prevent dropout. Theory holds that this is accomplished by allowing participants to estimate the remaining time till completion. Participants might base their estimation on the time already invested in relation to the number of completed items and the perceived speed of the progress indicator. If the estimated time till completion is beyond acceptance the participant drops out.

The type of feedback can be textual, graphical or both. A widely used implementation is to provide a percentage and a graphical bar. The straightforward method which is available in most survey software packages calculates the percentage by dividing the number of pages completed with the total number of pages in the survey. I termed this the static calculation method. Results from research that tested the effect of static approach progress indicators are mixed. The presence of progress indicators seems to have a positive (Couper et al., 2001), negative (Crawford et al., 2001) or no effect (Heerwegh, 2004) on completion rates. Research on the accuracy of feedback which over- and underreports the progress experimentally showed that overreporting increases completion rates, while underreporting can do more harm than omitting a progress indicator (Böhme, 2003; Conrad, Couper, Tourangeau, & Peytchev, 2005). The mixed findings can therefore be explained by inaccuracies of the feedback. Crawford et al. (2001) suggest that the negative impact of the progress indicator in their experiment might be due to an underreporting of the progress in the beginning. This happened because the authors used open ended questions in the beginning. In combination with the progress indicator this suggested a much longer questionnaire than was actually the case. The study of Heerwegh (2004) is an example that careful calibration of the progress indicator avoids higher dropout rates. The calibration used a pretest to estimate the progress that should be visible on each page.

The static calculation method together with calibration works in questionnaires were all respondents answer the same pages and thus experience the same flow of questions. Unfortunately, this is seldom the case in social science research where filter questions are employed to skip unapplicable questions. The demographical standards (Statistisches Bundesamt, 2004) alone include enough skip patterns in household and employment questions so that an overall progress estimate for a given question is most probably inaccurate. Moreover, skips lead to the phenomenon of an unsteady or jumping progress indicator making it seem unreliable to respondents. To solve these problems I developed two dynamic calculation methods. They estimate the progress for each respondent individually while he/she is proceeding through the pages. Study 6 demonstrated the advantage of the dynamic calculation method against the static calculation method in terms of completion rates. The study also showed that respondents indeed use progress indicators for the estimation of the time until completion. Because the dynamic approach needs an initial assumption about the overall survey length, study 7 was designed to decide whether a conservative or progressive approach should be used. In the static calculation method the overall survey length is equal to the number of total survey questions. In the dynamic approach however the overall survey length can be based on two approaches: The conservative way is to take the longest possible survey including all filter paths. The progressive approach uses the shortest possible survey. Results from study 7 tend to favor a progressive approach.

To reach a final conclusion, I will now compare the results of study 6 and 7 with the results of other authors. First, study 6 showed that underreporting of the true progress produces higher dropout. Because the conservative implementation is an approach which rather underreports progress on the basis of the longest survey path it should be avoided in favor of the progressive implementation. Conrad, Couper, Tourangeau, and Peytchev (2005) tested how encouraging (overreporting) and discouraging (underreporting) information in progress indicators affects completion rates. They found a significant lower dropout rate of 10.5% percentage points in the encouraging condition (see also Conrad, Couper, & Tourangeau, 2003). Such a strong effect can be explained by the extremeness of the over- and underreporting of progress in the experiment. In the encouraging condition a respondent had to complete only 9 pages to pass the 50% mark but had to complete further 36 pages to reach the 90% mark. Study 7 used less extreme formulae to allow for a better generalization to surveys with filter questions. Böhme (2003) experimented with the accuracy of progress indicators and found that the dropout rate for overreporting progress was significant 9 percentage points higher than in the condition underreporting the progress. From these findings and the ones presented in the studies 6 and 7 I conclude that completion rates are positively affected by a progress indicator using the progressive dynamic calculation method. The easier to implement static method should only be used in questionnaires without filters and skip patterns to avoid an otherwise occuring increase in dropout. Inaccurate progress indicators have resulted in a 5.9% lower response rate (Crawford et al., 2001). Successful implementations of progress indicators have resulted in an increase of observed response rates between 1.3%–3.5% compared to conditions without progress indicators. The possible maximum gain of the progressive dynamic calculation method will possibly be around 10% (cf., Böhme, 2003; Conrad, Couper, Tourangeau, & Peytchev, 2005). The benefit of the method increases with the number of filter questions in a survey.

Nevertheless, survey researchers should also consider the ethical aspect of their decision. Should they choose to overreport progress in the beginning for some respondents while providing accurate feedback to others as the findings suggest? Or should they choose to underreport progress for respondents with ineligible questions, but accurately report progress for respondents who are going to be asked the most survey questions? To solve this issue survey researchers could estimate the likelihood and amount of respondents who are expected to take all survey questions. If only a few proportion of respondents are expected to take the full questionnaire then a progressive method seems more justifiable.

Generally, survey researchers should invest some time in the accuracy of feedback on progress because inaccurate progress indicators are known to do more harm than when no progress indicator is visible. With accurate feedback in the form of a progressive dynamic calculation method completion rates are equal or higher than without a progress indicator.

8. Discussion

Online surveys continue to increase their market share in the canon of data collection methods. The reasons are mainly low costs and fast availability of results. As budgets for surveying are cut, online surveys become more appealing. Western European countries, the US and Canada are using the online survey mode as part of a multi-mode approach for their censuses or are considering the implementation in the next round of data collection. Automatic data collection and processing provide fast access to results which is only matched by computer assisted telephone interviews.

However, a problem of online surveys is that they are not able to reach the general population because not everyone has Internet access (coverage problem). Special panel projects where participants are provided with necessary equipment are currently filling this need for a full population sampling frame. Nevertheless, there already are special target groups where the coverage problem does not exist making online surveys an adequate survey mode: examples range from establishment surveys over employee surveys to seminar evaluation at universities.

A second area of problems centers around nonresponse. Not all contacted persons start participating in a survey (unit nonresponse), and not all respondents complete a survey (partial response) or even answer all questions (item nonresponse). This introduces a bias when respondents differ from nonrespondents since population parameters are estimated on the basis of respondents answers.

My work focused on the nonresponse aspects of partial response and item nonresponse. According to the survey life cycle model (figure 1.1 on page 6) this is the stage where respondents participate in a survey. The general goal was to develop instruments and methodological designs with which respondents' behavior could be observed and nonresponse could be reduced. The theoretical background was shaped by combining concepts from human-computer interaction and survey methodology into a framework which I termed human-survey interaction. The theory proved to be fruitful in that it fostered new design ideas and beneficial in that the designs successfully reduced nonresponse when compared to traditional designs using online experiments.

In total, seven studies were presented with one study including three waves of measurement. The studies targeted a wide range of people: students, people above forty, visually impaired and blind people, and survey panel members. Overall, data from 33,821 individuals were analyzed. A first set of studies aimed to improve and assess the available instruments (paradata, response time measurements, technical availability of survey design features) which were then used in the second set of studies. The goal of the second set was to apply human-survey interaction to the design of online surveys to increase item completions (decrease item nonresponse) and survey completions (decrease the number of dropouts). This was done in four online experiments which tested various methodological strategies for applying visual feedback to respondents. A summary of research goals, constructs, conducted studies and their relation to the chapters in this book is presented in table 2.4 on page 47.

8.1. Summary of the Results

The starting point was to fit this work into the life cycle of online surveys and the total survey error framework. This research was concerned with the phase in which respondents read and answer online survey questionnaires. It focused on reducing three sources of nonresponse error: unit nonresponse, item nonresponse and partial response (dropout). The first type occurs when respondents are unable or unwilling to access the survey. The second type occurs when respondents proceed through a survey but fail to answer all questions, whereas the third type occurs when respondents dropout or abandon a survey.

Chapter 2 developed the theoretical background and proposed a framework of human-survey interaction. The human part of the framework incorporated theories of the response process. Here, the satisficing/optimizing-approach is of importance because it mediates the data quality of responses. While increasing response rates is a major goal, this should not lead to an increase in satisficing behavior. Several indicators for satisficing were later analyzed to ensure that no loss in data quality occurred. The survey part of the framework subsumed theories of questionnaire design. Here, the response burden which is imposed by the survey can be seen as one of the most important reasons for dropout. The interaction part of the framework was concerned with visual changes in online surveys due to respondents' actions. A review of human-computer interaction and usability principles led to the conclusion that principal aspects of successful interaction are error tolerance and feedback. Subsequent chapters therefore assessed the possibility of errors due to technology and errors in providing answers. Furthermore, feedback techniques were employed to reduce both item and partial nonresponse.

Chapter 3 applied the framework to questionnaire design for visually impaired and blind people. The research problem was to accommodate the questionnaire design to the different reading habits and constraints of this specific group. Impairments of the visual field and a braille text need approaches which make up for the loss of visual overview and layout. Twelve guidelines were developed through a series of respondent observation and pretesting. The guidelines focus on providing and supporting overview, navigation and orientation aids, and on streamlining the answering process. The survey was conducted with a paper version with large font, a braille version, and an online version (study 1). The online version allowed blind people to participate without the help of other persons via screen readers and other technical aids which is an advantage over the other survey modes. Although the mean age was 67 and no incentive was offered, an overall response rate of 45% was obtained. This was possible because the survey considered the special design requirements of the target group in all phases of the survey life cycle. This included simple measures such as free return envelopes and more complicated ones such as instructions on how to answer with a braille type writer. The study demonstrated that the theoretical framework can be used to develop design guidelines, that these guidelines can be applied to survey design, and that these considerations and implementations lead to a successful human-survey interaction.

In chapter 4 I developed a data box model for the concept of paradata. Paradata are process data in surveys which can be collected while respondents answer a questionnaire. Paradata provide insight into respondents' behavior such as response times, changes in answers, and mouse clicks. In addition, paradata serve as performance indicators for surveys: Dropout patterns, item nonresponse, and response rates are key measures for the success of a survey. Paradata is already widely used in survey research. Nevertheless, paradata lack a concise conceptualization. Therefore, the developed data model distinguishes four levels of paradata in the dimensions respondents, variables and time. The higher levels are aggregations of lower levels over single or multiple dimensions. The lowest data level consists of single actions such as mouse clicks. They are easy to collect but difficult to analyze because they lack conceptualization. The second level aggregates over actions, resulting in content which is conceptually relevant for researchers, for example interaction failure measured as the number of mouse clicks which missed an answer option. The third level aggregates over variables to summarize in concepts such as the overall number of items missing. The third level also includes aggregations over respondents, resulting in concepts such as the average response time on each page. The fourth level is the most abstract aggregation and summarizes across respondents, variables and time to yield a single measure such as the average time to complete the survey or the response rate.

The model clarified that hitherto available instruments for collecting paradata had blind spots which prevented survey researchers from collecting certain aspects of paradata: Only successful interaction with a survey was collected. Therefore, an instrument was developed (universal client-side paradata approach) which allowed to observe all mouse clicks whereas earlier methods only captured mouse clicks on answer elements. Study 2 used this instrument to determine a new indicator for the success of human-survey interaction, specifically how many respondents suffer from click failures. More than 35% of the respondents made unsuccessful mouse clicks. They clicked in the vicinity of answer buttons which did not result in a valid answer, so a reclick was necessary. The conclusion was that standard interface elements in online surveys are too difficult to interact with. The proposed solution was to enlarge the clickable area to encompass the surrounding of the answer elements. The easiest way to accomplish this is by making the table cells sensitive to mouse clicks. (Study 5 which is described below followed this recommendation and tested it against the current design standard.)

The paradata model also provided a deeper understanding for operationalizations. Seemingly identical concepts of response latencies were shown to differ significantly (study 3). Response latencies are part of the second level in the paradata model. Accordingly, the data at the lowest level –the response times– can be collected as different actions. The following three types of response times were already used by other survey researchers and were therefore collected in the study: mouse clicks on answers, page submission times and server times. Usually, survey researchers decide to implement one of these measures and conduct their analyses on this basis. In study 3 however, the goal was to identify the differences between these three types of paradata which are usually summarized under the same concept of response latencies. The study used an experimental variation of question wordings which were known to covary with the required time for a response. It was therefore possible to compare the three response time measures in their suitability to detect these differences. The results showed that the client-side paradata of mouse clicks on answers was able to statistically detect the difference in response latencies between the two conditions. However, the other two measures were not significantly different between experimental groups. In conclusion, the paradata model helped in identifying the difference between seemingly identical concepts. The study showed that the easier to collect server side time measures should be avoided because their payload is a loss of necessary accuracy in the measurement of response latencies.

Summarizing, chapter 4 identified a lack of conceptualization for paradata. Therefore, a paradata model was developed and a new instrument provided to fit the need for indicators of failed human-survey interaction. Two studies applied the paradata model. Study 5 determined the amount of unsuccessful response behavior while study 3 specified and compared different measures for response latencies. Both studies provided solutions for the associated methodological problems.

Chapter 5 focused on the technology employed in online surveys. Survey researchers can utilize technologies to solve methodological problems or to increase survey quality and the respondents' experience. However, if a respondents' computer does not support the implemented technology in an online survey, s/he will not be able to view all survey questions or will be unable to access the survey. The addressed research question was therefore to estimate the coverage or availability of different technologies in online surveys among respondents. This enables survey researchers to make an informed decision for or against specific technologies and to weigh the advantages against a potential increase in nonresponse. To address these issues data was collected from all student applicants at the University of Mannheim during three semester.

The results show that JavaScript has a coverage of more than 99% making it the first choice when it comes to implementing interactive survey design features. Two additional studies using a probability sample and a quota sample suggested equally high coverage for the general Internet population. The measurement of the persistence of cookies showed that they might be used in single sessions but are not sufficient to control participation in intercept surveys. Java and Flash are widely available extensions to HTML which suit special needs for interface design and control. The main video player is the Mediaplayer, followed by Quicktime and Realplayer. It is advisable to support at least the first two, so that subgroups (e.g., Mac-users) of the Internet population are not excluded. An alternative is to employ Flash technology for video and audio. The standard width for screen design was previously 800 pixels. In 2006 such low resolutions had diminished to a proportion of 5% of all applicants at the University of Mannheim. The most common screen resolution is 1024x768 pixels. When testing for design flaws at least the two most common browsers, Microsoft Internet Explorer and Firefox, should be included in the testing procedures. Concluding, the chapter discussed the advantages of several technologies for survey methodology and provided data about their coverage to allow estimations of associated nonresponse.

Chapter 6 showed that visual aids and visual feedback are able to reduce item nonresponse. The research question was concerned with the positive influence of additional feedback on human-survey interaction. A first experiment used a visual cross which followed mouse movements and a change in color of the row after an answer was provided. Contrary to expectations, the visual cross increased the number of items missing because it distracted respondents from their task to complete the questions. However, visual feedback after a selection was made resulted in fewer items missing compared to a condition with no feedback and no alternating background stripes.

The second experiment combined feedback techniques and an enlarged clickable area in a single treatment condition to test a combined effect of less obtrusive feedback. Here, only the immediate surrounding of an answer category, the table cell, was highlighted following mouse movements. Additionally, the answer category changed its color to a dark grey after an answer was provided. The results showed that the combined effects in the condition with feedback successfully increased item completion rates by 3.5 percentage points compared to the condition with no feedback.

The increase in item completion rates had no negative impact on data quality in terms of response times, changes in answers, or nonsubstantial answers in the form of 'don't know'. Overall, the results showed that visual feedback can successfully reduce the number of items missing.

Chapter 7 examined feedback methods to report on survey progress and their effects on completion rates. In this context, progress indicators are often employed to reduce dropout. They allow respondents to estimate the time till completion and weigh this against their willingness to spend more time in survey participation. A review of the research on progress indicators showed the consequences: When feedback is unreliable and underreports survey progress, respondents are more likely to dropout. This is necessarily the case with surveys employing filter questions. As survey researchers cannot know whether a respondent traverses a filter path, standard implementations of progress indicators underreport the progress in the beginning. To solve this problem a dynamic calculation method was developed.

The first experiment compared the new method for calculating progress feedback with the traditional method, no feedback, and ideal feedback. The experiment was able to use ideal feedback because the filter paths were emulated so that all respondents received the same questions. The results showed that the dynamic calculation method is able to compensate for the problems which are imposed by filter questions leading to an increase in the completion rate. The dynamic calculation method can be implemented with either a progressive or a conservative estimation of progress. The second experiment was designed to identify which approach yields the highest completion rates. The results indicated that the dynamic calculation method results in higher completion rates with a progressive algorithm. This results in an accurate reporting of progress for respondents who skip filter paths but overreports the progress in the beginning for respondents who traverse into the filtered questions.

Concluding, survey researchers should invest in the accuracy of progress feedback because inaccurate progress indicators can result in lower completion rates than a survey with no progress indicator at all. With accurate feedback in the form of a progressive dynamic calculation method however, completion rates are equal or higher than without a progress indicator.

Summarizing the results, the first part of this work shaped a framework for human-survey interaction and derived guidelines for accessible survey design. The second part developed the instruments for survey research within the framework. It was concerned with paradata, interaction errors, response time measurement and technology-induced nonresponse. The third part tested feedback techniques to enhance the interaction between humans and surveys beyond current design practices. The application of the instruments showed that data quality was maintained while nonresponse was reduced. Finally, answers from respondents indicate that response burden is reduced when feedback techniques are applied to surveys.

8.2. Limitations

All of the above presented studies have certain limitations which are discussed in this section. Study 1 focused on the application of the human-survey interaction framework in a real survey setting. The special requirements of the target population who were visually impaired and blind people led to design guidelines. Although, the questionnaire was designed and pretested in several rounds before it was conducted, the study did not develop competing design guidelines and included no experimental comparison with a traditional survey design. After having put considerable effort into development and pretesting, it would have been impossible to reason for the use of a 'good' and a 'bad' design. Therefore, the specific impact of each guideline on the response rate could not be assessed. As a case study however, study 1 demonstrated how the framework is able to shape the life cycle of a survey in three survey modes, extending the framework to paper-based and braille surveys.

Study 4 analyzed data from student applicants to estimate the degree of available technologies for survey research. The three censuses of all student applicants at the University of Mannheim provide a profound understanding of this target population. However, the findings are not generalizable to other populations in a statistical sense because no probability sampling was invoked from a more general population. In how far can the findings be applied to other populations then? The findings might provide reasonable estimates for all students in Germany to the degree that potential students from all over Germany apply at the University of Mannheim. This makes the estimations better for the surrounding federal states but less valid for the eastern part of Germany. To overcome this problem results from two additional samples were reported for the most important technology JavaScript. Both samples targeted the general Internet population. The first study used a follow-up online survey of a survey with a probability sample of the general German population. The second survey used a market research approach and applied quota sampling within an online panel. Both studies confirmed the high availability of JavaScript of more than 99%. Besides the estimate for JavaScript, the other findings of study 4 should not be considered as valid point estimations for other population groups. However, a comparison of the availability between technologies seems reasonable. There is no reason to believe that students who are technically most developed should show lower estimates for the availability of for example video players than the general population. The findings of study 4 therefore allow researchers to estimate the potential risk in terms of nonresponse associated with the different technologies.

Studies 2, 3, 5, 6, and 7 employed experiments. Here, the focus resided in internal validity to analyze effects of different treatments. As such, the studies were able to identify causal effects. Because no probability sampling was involved in these studies the findings cannot be generalized statistically. Nevertheless, the different effects were shown to be present in different samples. For example the positive effect of feedback was shown in samples targeting survey panel members and people above forty, thus including the harder to reach older people.

Finally, this work is not based on a single theory of human-survey interaction. Rather a framework is proposed which subsumes several models from different disciplines and which is therefore inclusive rather than exclusive. This was necessary because no models exist in human-survey interaction or survey methodology which encompass the research goals of this work. The models which were discussed as part of the framework are not exhaustive. For example, further research may show that response burden is also related to concepts of split-attention and cognitive resources as put forward by Kalyuga, Chandler, and Sweller (1999). Furthermore, the theory of reasoned action and the theory of planned behavior have been shown to explain reasons for nonresponse which relate to all aspects of the framework (Bosnjak, 2002; Ludwig, 2004; Heerwegh, 2005; Peytchev, 2007). However, an overall explanation of nonresponse was not the goal of this work. This work strived for an interdisciplinary approach and therefore focused on models which could be subsumed under one of the three aspects of human-survey interaction. The framework illuminated the relations between the models, leading to new instruments and design strategies. The principal goal was to bring together the human sciences and the technical sciences for the benefit of survey research and respondents.

8.3. Implications

Every day, numerous people all around the globe interact with all kinds of surveys, online forms, and questionnaires. These interactions are not always completely voluntary and can add a huge amount of stress to daily life. However, the importance of providing an easy-to-handle and usable interface is not always reflected on the side of those who develop these interfaces. Unlike paper-based surveys, online surveys are a technology-driven survey mode. Therefore, people from the field of technical sciences are involved in decisions about survey design implementations. They usually focus on the best possible implementation in terms of software and hardware. When survey researchers design online surveys they usually focus on the questionnaire. This specialization can lead to suboptimal design decisions in online surveys. With the words of Vincente (2004, p. 32):

> Unfortunately, this traditional approach has created two breed of Cyclops – the one-eyed Humanist who can focus on people but not technology, and the one-eyed Mechanistic variety who knows about technology but not people. We're all walking around half-blind. To make matters worse, the Humanistic and Mechanistic world views rarely meet, as anyone who has set foot on a university campus knows.

The goal of this work was to combine these two views into a framework fostering successful human-survey interaction. The survey design strategies which were put forward in this work achieved this goal in several ways.

Visual feedback in survey questions was found to increase item completion rates between 2.1 and 3.5 percentage points compared to no interactive feedback. This would amount to 1,050 fewer items missing in a survey of short (30 questions) to moderate (50 questions) length if 1,000 respondents were interviewed. This increase in data quality helps to reduce the need for data imputation and increases the accuracy of estimations.

Visual feedback about the progress was found to increase the survey completion rates between 5.7 and 8.8 percentage points compared to bad but common implementations of progress indicators. Not alone are these differences in completion rates substantial, they also point out the importance of considering the interaction between the survey which reports on the progress and the respondents who interpret the numbers. Although surveys may indicate progress in terms of pages, respondents relate these numbers to their experience of time flow. This perception of time is crucial for the motivation of respondents as described by Conti (2001, p. 1):

> Results showed that higher intrinsic motivation was associated with checking and thinking about time less often, a subjective experience of time passing more quickly, and more of a tendency to lose track of time. The experience of time awareness was accompanied by a subjective sense of time moving slowly, a tendency to overestimate the time, and a more negative affective experience. These findings suggest that time perception is an important dimension of motivational experience.

The increase in completion rates can also be compared to other efforts which aim at reducing nonresponse. Instead of investing resources in reducing dropout rates, researchers could try to increase initial response rates. Here, a plausible approach is to invest in incentives. An exceptional high return on investment was reported by Bosnjak and Tuten (2003) who found a significant higher completion rate of 23.4% for prize draws compared to 12.9% in the condition with no incentive on the basis of successful contacts while investing 200 Dollars in prizes. However, a meta-analytical summary of studies using small amounts of incentives with an average of 115 Dollars in online panels by Göritz (2006) showed no reliably increase of response rates. In the realm of other modes than online surveys, Singer (2002) reported for studies on household surveys an increase in response rates of 2.8 percentage points for offering 20 Dollars or 0.9 percentage points for offering 10 Dollars vs. no incentive. Thus, ten responses more in a sample of 1000 contacts would cost 10,000 Dollars. These calculations vividly illustrate that investments in human-survey interaction are able to achieve similar improvements while inducing much lower costs. This is especially important when survey researchers have to make decisions within a fixed budget to reduce total survey error (Groves, 1989). As soon as the design strategies are implemented in online survey software they are readily available for survey design without creating additional costs for programming.[1]

The studies presented in this work have implications not only for survey design but for online forms in general. Many cities in Germany are maintaining their own websites

[1] For example the company Globalpark implemented the dynamic calculation method for progress indicators as put forward in this work.

from small villages like Sörup with 4,200 residents to larger cities like Mannheim with 310,000 residents. The studies provide suggestions which technologies can be used so that webpages remain accessible to residents. Furthermore, many cities and government agencies expanded their citizen services to the Internet. With online forms citizens are able to order parking IDs or fill in their tax return. The presented research suggests that citizens would extremely benefit from implementing feedback techniques in complicated online forms. Similarly, using less error-prone interaction elements as suggested in chapter 7 could reduce frustration among people who interact with online shopping carts, official forms, or online forms in general.

Human-computer interaction literature provides much anecdotal evidence of users who abandon their tasks at the computer frustrated by difficult and unintelligible interface designs. It is my hope that the results and solutions of this work will help people to successfully interact with online surveys in the future. This work will hopefully also help respondents of online surveys in their experience of a motivating and valuable contribution to social science research, thereby furthering our knowledge of what constitutes the increasingly important aspect of the interaction between humans and machines.

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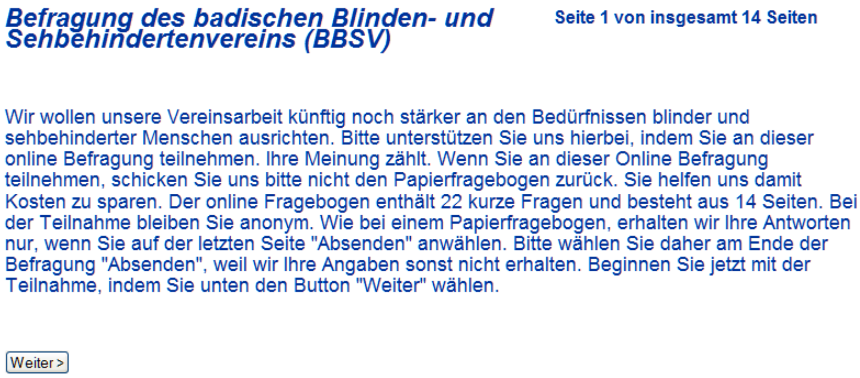
Appendix for Study 1

The following figures provide examples of the online version of a questionnaire for visually impaired and blind people in Baden (BBSV). The study and the guidelines leading to the survey design are described in chapter 3. The results of the survey are described by Wolff and Schick (2007).



Befragung des badischen Blinden- und Sehbehindertenvereins (BBSV)

Seite 1 von insgesamt 14 Seiten

Wir wollen unsere Vereinsarbeit künftig noch stärker an den Bedürfnissen blinder und sehbehinderter Menschen ausrichten. Bitte unterstützen Sie uns hierbei, indem Sie an dieser online Befragung teilnehmen. Ihre Meinung zählt. Wenn Sie an dieser Online Befragung teilnehmen, schicken Sie uns bitte nicht den Papierfragebogen zurück. Sie helfen uns damit Kosten zu sparen. Der online Fragebogen enthält 22 kurze Fragen und besteht aus 14 Seiten. Bei der Teilnahme bleiben Sie anonym. Wie bei einem Papierfragebogen, erhalten wir Ihre Antworten nur, wenn Sie auf der letzten Seite "Absenden" anwählen. Bitte wählen Sie daher am Ende der Befragung "Absenden", weil wir Ihre Angaben sonst nicht erhalten. Beginnen Sie jetzt mit der Teilnahme, indem Sie unten den Button "Weiter" wählen.

Weiter >

Page 1.

Befragung des badischen Blinden- und Sehbehindertenvereins (BBSV) Seite 2 von insgesamt 14 Seiten

Informationsmedien des BBSV

Die folgenden Fragen beziehen sich auf verschiedene Medien über die Sie Informationen vom BBSV erhalten können.

1 In welcher Form erhalten Sie das Rundschreiben des BBSV?
(Eine Antwort möglich.)

- ○ in Schwarzschrift
- ○ in Punktschrift
- ○ per E-Mail

2 In welcher Form möchten Sie am liebsten vom BBSV informiert werden?
(Eine Antwort möglich.)

- ○ auf Kassette
- ○ auf CD
- ○ auf CD im Daisy- Format
- ○ Normalgröße in Schwarzschrift
- ○ Großschrift in Schwarzschrift
- ○ in Punktschrift
- ○ per E-Mail
- ○ über das Internet (BBSV-Homepage)

[< Zurück] [Weiter >]

Page 2.

Befragung des badischen Blinden- und Sehbehindertenvereins (BBSV) Seite 12 von insgesamt 14 Seiten

Abschließende Bewertung

Die letzten drei Fragen dienen der Bewertung der Umfrage und sollen zukünftige Befragungen verbessern helfen.

18 Konnte der Fragebogen ohne die Hilfe Dritter ausgefüllt werden?
(Eine Antwort möglich.)

- ○ ja, der Fragebogen ist in Ordnung
- ○ nein, zukünftige Fragebögen müssen verbessert werden, und zwar:

19 War die Teilnahme leicht oder schwierig?
(Eine Antwort möglich.)

- ○ leicht
- ○ eher leicht
- ○ eher schwierig
- ○ schwierig

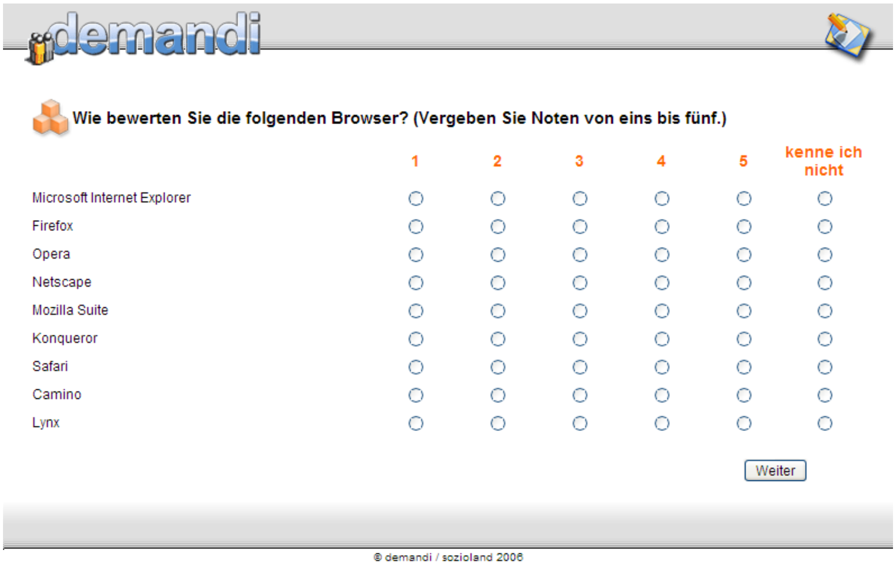
[< Zurück] [Weiter >]

Page 12.

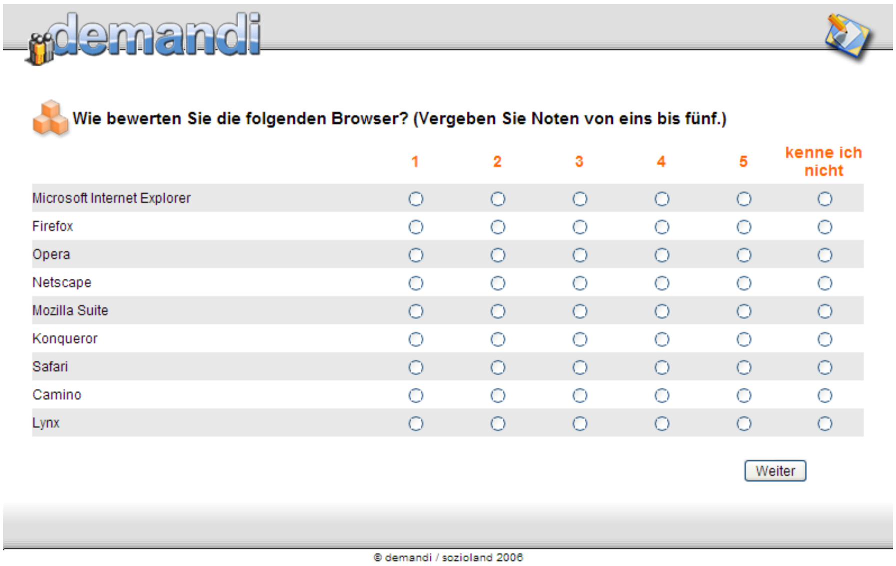
Appendix for Study 2

Questionnaire in the Experimental Design

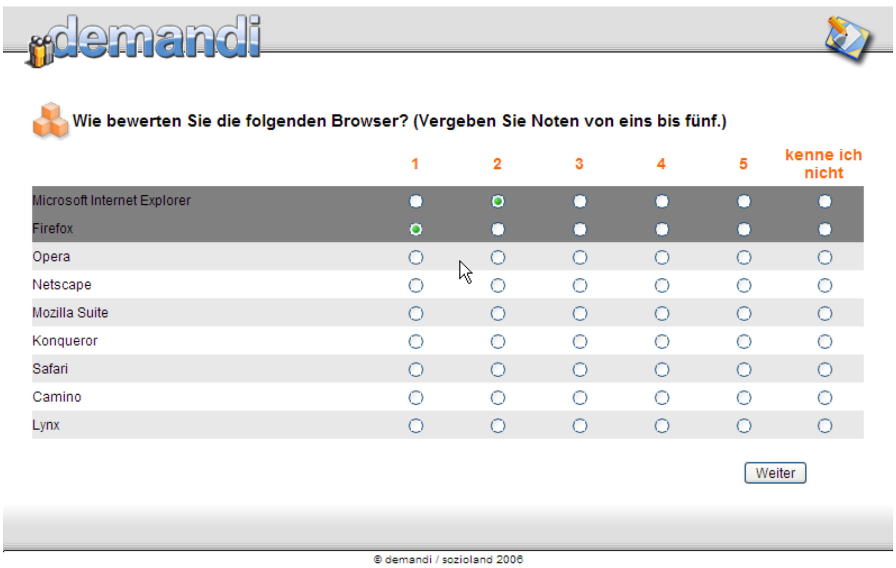
The following figures show the questions and their design in the five experimental conditions of study 2. The experiment used three subsequent matrix questions with five conditions each. All participants received the same questions. The experiment is described in chapter 6.2. The topic of the survey was security in the Internet.



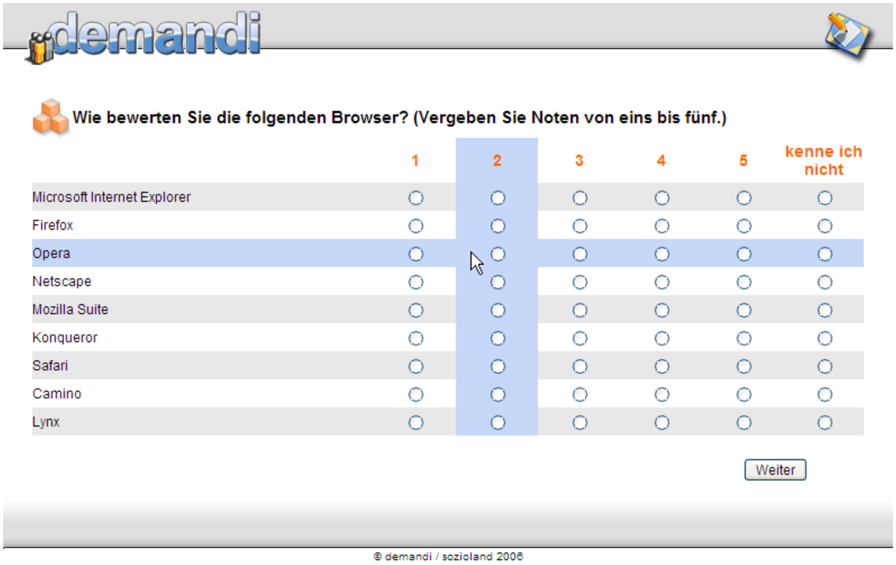
Page 7, 'How do you rate the following browsers?´, condition 1 with white background.



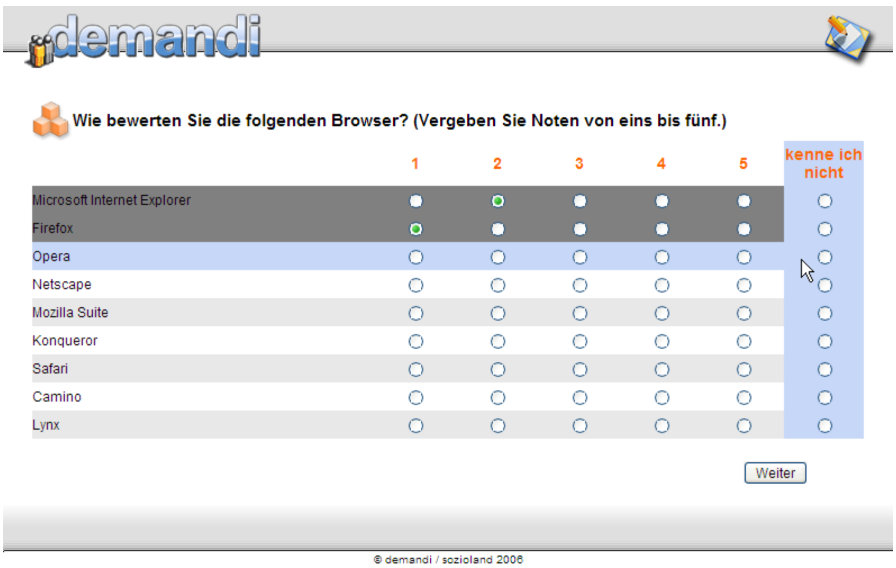
Page 7, 'How do you rate the following browsers?´, condition 2 with standard alternating stripes.



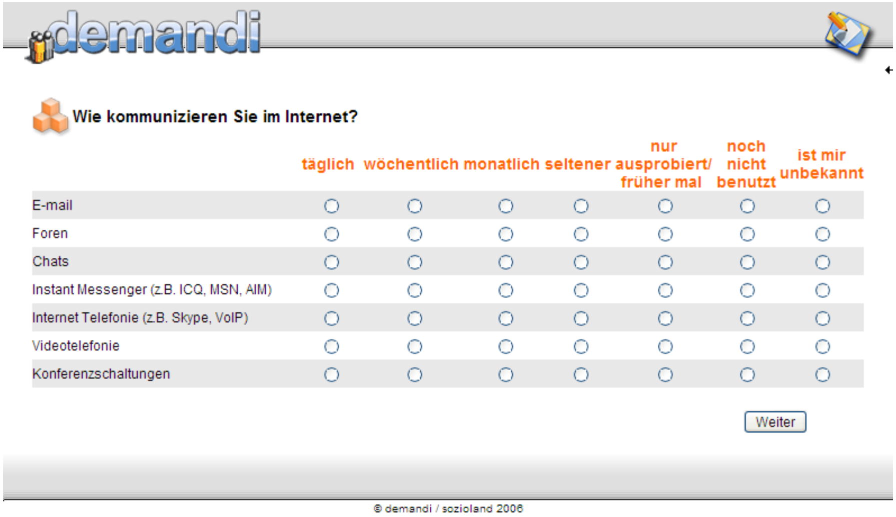
Page 7, 'How do you rate the following browsers?´, condition 3 with feedback in the post-selection phase.



Page 7, 'How do you rate the following browsers?´, condition 4 with feedback in the pre-selection phase.



Page 7, 'How do you rate the following browsers?´, condition 5 with feedback both in the pre- and post-selection phase.



demandi

Wie kommunizieren Sie im Internet?

	täglich	wöchentlich	monatlich	seltener	nur ausprobiert/ früher mal	noch nicht benutzt	ist mir unbekannt
E-mail							
Foren							
Chats							
Instant Messenger (z.B. ICQ, MSN, AIM)							
Internet Telefonie (z.B. Skype, VoIP)							
Videotelefonie							
Konferenzschaltungen							

Weiter

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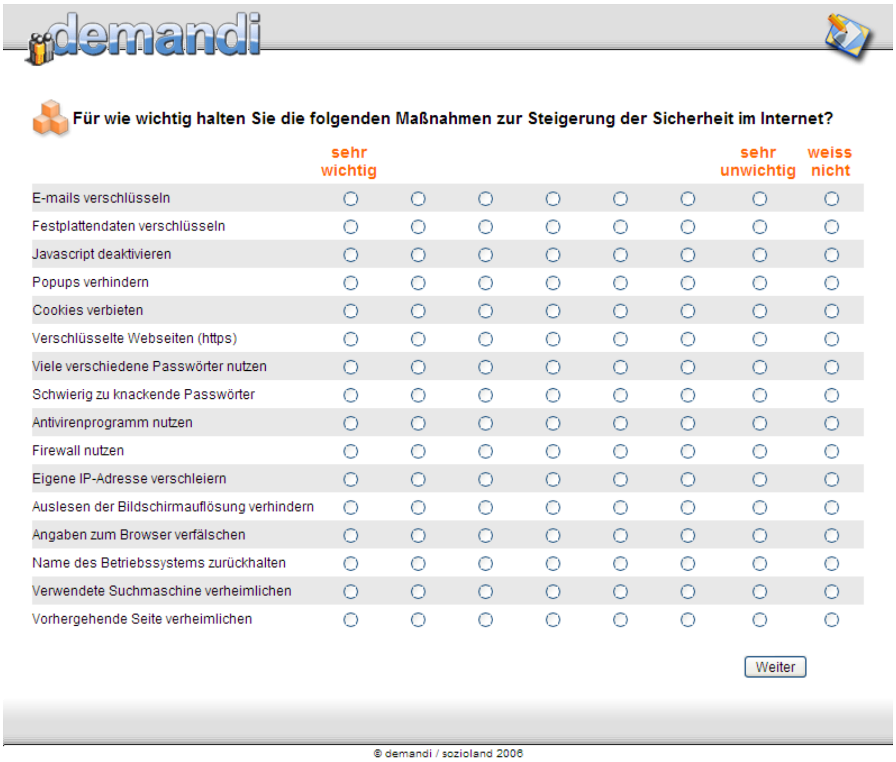
Page 8, condition 2 with standard alternating stripes. The other conditions are equal to the visual design on page 7 and are therefore not repeated here. The question asks about the frequency of use of different Internet communication channels.



demandi

Für wie wichtig halten Sie die folgenden Maßnahmen zur Steigerung der Sicherheit im Internet?

	sehr wichtig						sehr unwichtig	weiss nicht
E-mails verschlüsseln								
Festplattendaten verschlüsseln								
Javascript deaktivieren								
Popups verhindern								
Cookies verbieten								
Verschlüsselte Webseiten (https)								
Viele verschiedene Passwörter nutzen								
Schwierig zu knackende Passwörter								
Antivirenprogramm nutzen								
Firewall nutzen								
Eigene IP-Adresse verschleiern								
Auslesen der Bildschirmauflösung verhindern								
Angaben zum Browser verfälschen								
Name des Betriebssystems zurückhalten								
Verwendete Suchmaschine verheimlichen								
Vorhergehende Seite verheimlichen								

Weiter

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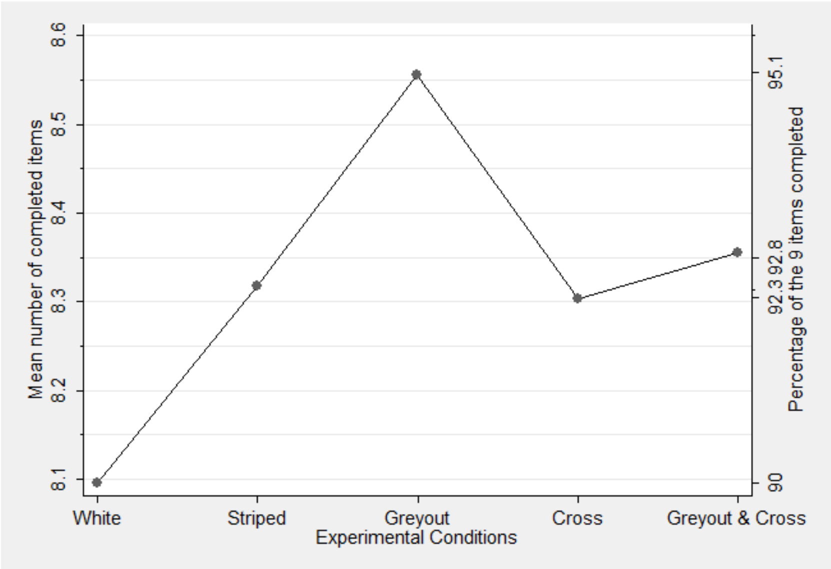
Page 9, condition 2 with standard alternating stripes. The other conditions are equal to the visual design on page 7 and are therefore not repeated here. The question asks to rate the importance of several possible measures to enhance the security in the Internet.

Results for the First and Second Matrix Question

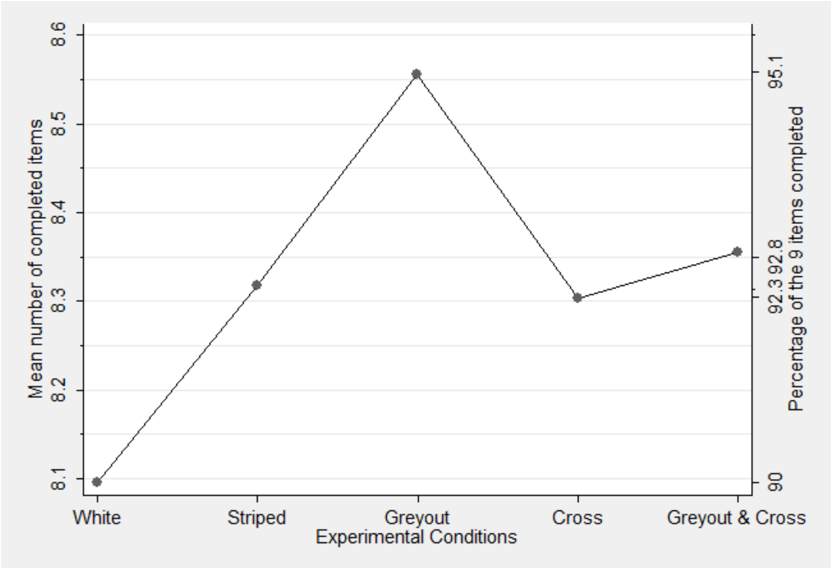
The following figures show additional results for the first and second matrix questions.



Item completion rates on page 7 in the survey.

Frequency of the number of completed items on page 7 in the survey. The table can be read as: 309 respondents answered all 9 items in the condition 'White'.

Completed items	Conditions					Total
	White	Striped	Greyout	Cross	Both G&C	
0	31	21	14	21	23	110
1	1	3	2	3	3	12
2	2	1	2	2	2	9
3	1	1	0	0	0	2
4	0	0	2	0	1	3
5	0	1	0	0	0	1
7	2	2	0	0	1	5
8	19	17	11	14	8	69
9	309	322	367	306	365	1669
Total	365	368	398	346	403	1880



Item completion rates on page 8 in the survey.

Frequency of the number of completed items on page 8 in the survey. The table can be read as: 322 respondents answered all 7 items in the condition 'White'.

Completed items	White	Striped	Conditions Greyout	Cross	Both G&C	Total
0	30	22	15	19	23	109
1	0	1	1	1	2	5
2	2	1	2	1	1	7
3	0	0	2	0	1	3
4	4	1	2	1	0	8
5	0	0	0	1	1	2
6	7	10	5	14	8	44
7	322	333	371	309	367	1702
Total	365	368	398	346	403	1880

Results of Logistic Regression in Study 2

The goal of the logistic regression is the same as that of the linear regression: to find the best fitting model between independant variables and a dependant variables or outcome. The most important difference is that the dependant variable is binary. The parametric model reflects this (Hosmer & Lemeshow, 2000). The findings presented here are identical to the statistical material presented in the main text. The dependant variable is one for respondents who answered all items and zero for respondents who failed to answer at least a single item.

Results of a logistic regression for matrix question 3, comparing with the condition 'white'. The condition 'greyout' is significantly different from the condition 'white'.

Condition	Odds Ratio	Std. Err.	z	p	95% Conf. Interval	
Striped	1.27	.261	1.17	0.242	.850	1.902
Greyout	1.53	.319	2.03	0.042	1.015	2.300
Cross	.85	.166	-0.82	0.411	.582	1.248
G&C	1.27	.254	1.18	0.236	.856	1.878

$\chi^2(4) = 10.06$, $p = .039$, $n = 1880$

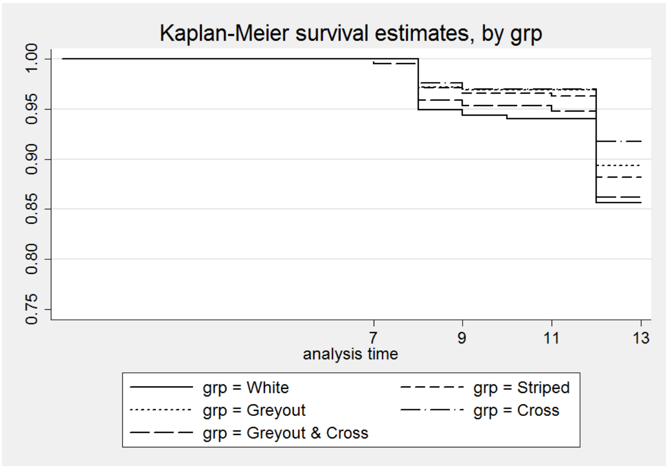
Results of a logistic regression for matrix question 3, comparing with the condition 'striped'. The condition 'cross' is significantly different from the condition 'striped'.

Condition	Odds Ratio	Std. Err.	z	p	95% Conf. Interval	
White	.786	.162	-1.17	0.242	.526	1.176
Greyout	1.201	.260	0.85	0.397	.786	1.837
Cross	.670	.136	-1.97	0.049	.450	.998
G&C	.997	.208	-0.01	0.988	.662	1.500

$\chi^2(4) = 10.06$, $p = .039$, $n = 1880$

Results of Survival Analysis in Study 2

Survival analysis can be used to analyze the time until the occurrence of dropout. In this case the time is usually depicted as the page number in the questionnaire (cf. Peytchev, 2007). To test for differences between conditions the generalized Wilcoxon test of Breslow and Gehan is used. "The Wilcoxon test places additional weight to tables at earlier failure times—when more subjects are at risk—than to tables for failures later in the distribution." (Cleves, Gould, & Gutierrez, 2004, p. 116). This makes it the most suitable test among the available tests in survival analysis because it emphasizes the onset of the treatment while taking into account a continued effect on the following survey pages. The survival analysis presented here starts with page 7 because this was the onset of the treatment. This is done to prevent carry-over effects of earlier pages. The survival analysis was not able to detect effects due to the treatments.



Kaplan-Meier survival estimates. The graph depicts the degree to which respondents proceed to the final page.

Results of a Wilcoxon (Breslow) test for equality of survivor functions. No differences between conditions was found.

Conditions	Events observed	Events expected	Sum of ranks
White	48	39	15645
Striped	41	41	-354
Greyout	41	46	-8613
Cross	27	39	-20590
Greyout & Cross	53	45	13912

$\chi^2(4) = 8.23$, $p = .0834$

Non-Substantial Answers in Matrix Question 3

Frequency of the number of 'don't know'-answers on page 9 in the survey. The table can be read as: 22 respondents answered don't know in one item in the condition 'white'. This table is referred to on page 107 .

Completed items	Conditions White	Striped	Greyout	Cross	Both G&C	Total
0	249	232	255	212	252	1200
1	22	21	21	25	35	124
2	16	13	12	15	14	70
3	8	16	10	10	11	55
4	14	14	16	13	12	69
5	11	18	19	14	27	89
6	11	12	23	13	9	68
7	7	10	12	18	15	62
8	10	6	12	8	7	43
9	5	10	6	9	8	38
10	6	8	4	3	6	27
11	1	1	2	0	1	5
12	1	2	1	1	2	7
13	1	1	0	1	2	5
14	1	0	1	1	0	3
15	0	0	0	1	0	1
16	2	4	4	2	2	14
Total	365	368	398	346	403	1880

Changes in Answers in Matrix Question 3

Frequency of the number of changes in answers on page 9 in the survey for all 16 items. Respondents who did not answer an item were excluded item-wise. The table can be read as: 71 respondents changed their answer once in the condition 'white'. This table is referred to on page 106 .

Completed items	Conditions					Total
	White	Striped	Greyout	Cross	Both G&C	
0	155	176	224	184	225	964
1	71	70	82	62	62	347
2	40	39	32	34	38	183
3	24	18	13	22	19	96
4	9	12	5	8	6	40
5	5	4	9	0	1	19
6	4	4	4	3	3	18
7	4	6	1	2	4	17
8	0	2	0	2	3	7
9	1	0	1	0	1	3
12	0	2	0	0	0	2
15	0	0	0	0	1	1
29	0	1	0	0	0	1
Total	313	334	371	317	363	1698

Appendix for Study 3

The following figures exemplify the survey design of study 3.

UNIVERSITÄT
MANNHEIM

Herzlich willkommen!

Vielen Dank, dass Sie sich dazu bereiterklärt haben, an dieser Umfrage teilzunehmen. Sie ist Teil meiner Abschlussarbeit an der Universität Mannheim, in der ich mich mit der Verständlichkeit von Fragebogen-Fragen beschäftige.
Im Folgenden möchte ich Sie bitten, einige Fragen zu verschiedenen Themen wie Politik, Gesellschaft und Umwelt zu beantworten. Für die Beantwortung der Fragen benötigen Sie nur etwa 10 bis 15 Minuten Zeit.

Bevor wir jedoch beginnen, möchte ich Sie bitten, diese Seite **aufmerksam** durchzulesen:

Auf die Fragen gibt es weder richtige, noch falsche Antworten. Antworten Sie bitte so, wie es Ihrer Meinung am besten entspricht.

Ihre Daten werden selbstverständlich vertraulich behandelt. Die Umfrage ist anonym, d.h. Sie müssen zu keinem Zeitpunkt Ihren Namen angeben.

Als Dankeschön werden unter allen Teilnehmern 10 Amazon.de-Gutscheine im Wert von jeweils 10€ verlost. Falls Sie an dieser Verlosung teilnehmen möchten, müssen Sie lediglich Ihre Email-Adresse am Ende der Umfrage angeben.

Wie wird der Fragebogen ausgefüllt?

Bitte beantworten Sie die Fragen in der vorgegebenen Reihenfolge. Überspringen Sie keine Fragen und kehren Sie auch nicht zu bereits beantworteten Fragen zurück.

Für die Beantwortung müssen Sie meistens nur eines der vorgegebenen Kästchen anklicken. Benutzen Sie dazu bitte die Computermaus.

Bevor Sie mit der Umfrage beginnen, möchte ich Sie bitten, alle weiteren Anwendungen (Media Player, Downloads, usw.) zu schließen, da es ansonsten zu sehr langen Ladezeiten der Seiten kommen kann.

Es ist sehr wichtig, dass Sie sich auf die Fragen und ihre Beantwortung konzentrieren können. Schalten Sie daher bitte Geräte wie Fernseher oder Radio aus und versuchen Sie es zu vermeiden, dass andere Leute Sie während der Umfrage stören.

Ich wünsche Ihnen viel Spaß beim Ausfüllen.

Nochmals herzlichen Dank!

Weiter

Page 1.

UNIVERSITÄT MANNHEIM

Zunächst ein paar Fragen zu Ihrer Person.

Sie sind...

- ○ männlich
- ○ weiblich

Weiter

Page 2.

Was ist Ihre Muttersprache bzw. Erstsprache?
Bitte nur eine Antwort anklicken!

- ○ Deutsch
- ○ Englisch
- ○ Spanisch
- ○ Italienisch
- ○ Türkisch
- ○ Französisch
- ○ Eine andere:

Page 3 without header and footer.

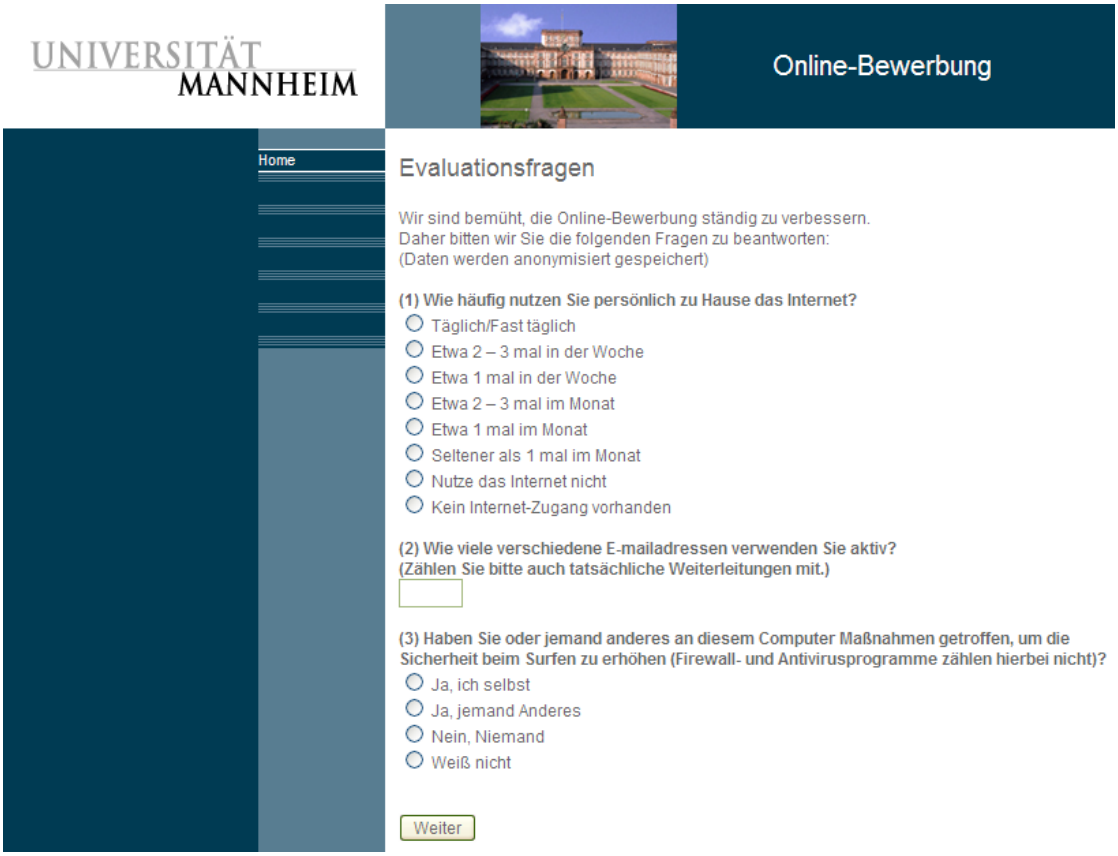
Es gibt viele Möglichkeiten, mit denen einzelne oder Vereinigungen gegen eine Regierungsmaßnahme protestieren können, wenn sie diese Maßnahme entschieden ablehnen. Geben Sie bitte an, inwieweit in diesem Zusammenhang Ihrer Meinung nach die unten aufgeführte Protestaktion erlaubt sein sollte.
Bitte nur eine Antwort anklicken!

	Sollte auf jeden Fall erlaubt sein	Sollte schon erlaubt sein	Sollte eigentlich nicht erlaubt sein	Sollte auf keinen Fall erlaubt sein
Öffentliche Versammlungen organisieren, um gegen die Regierung zu protestieren	○	○	○	○

Example of a question in the experiment without header and footer. The order of the questions in the experiment were randomized.

Appendix for Study 4

The following questions were asked at the end of the application form. The results are presented in chapter 5.



UNIVERSITÄT MANNHEIM

Online-Bewerbung

Home

Evaluationsfragen

Wir sind bemüht, die Online-Bewerbung ständig zu verbessern.
Daher bitten wir Sie die folgenden Fragen zu beantworten:
(Daten werden anonymisiert gespeichert)

(1) Wie häufig nutzen Sie persönlich zu Hause das Internet?

- Täglich/Fast täglich
- Etwa 2 – 3 mal in der Woche
- Etwa 1 mal in der Woche
- Etwa 2 – 3 mal im Monat
- Etwa 1 mal im Monat
- Seltener als 1 mal im Monat
- Nutze das Internet nicht
- Kein Internet-Zugang vorhanden

(2) Wie viele verschiedene E-mailadressen verwenden Sie aktiv?
(Zählen Sie bitte auch tatsächliche Weiterleitungen mit.)

(3) Haben Sie oder jemand anderes an diesem Computer Maßnahmen getroffen, um die Sicherheit beim Surfen zu erhöhen (Firewall- und Antivirusprogramme zählen hierbei nicht)?

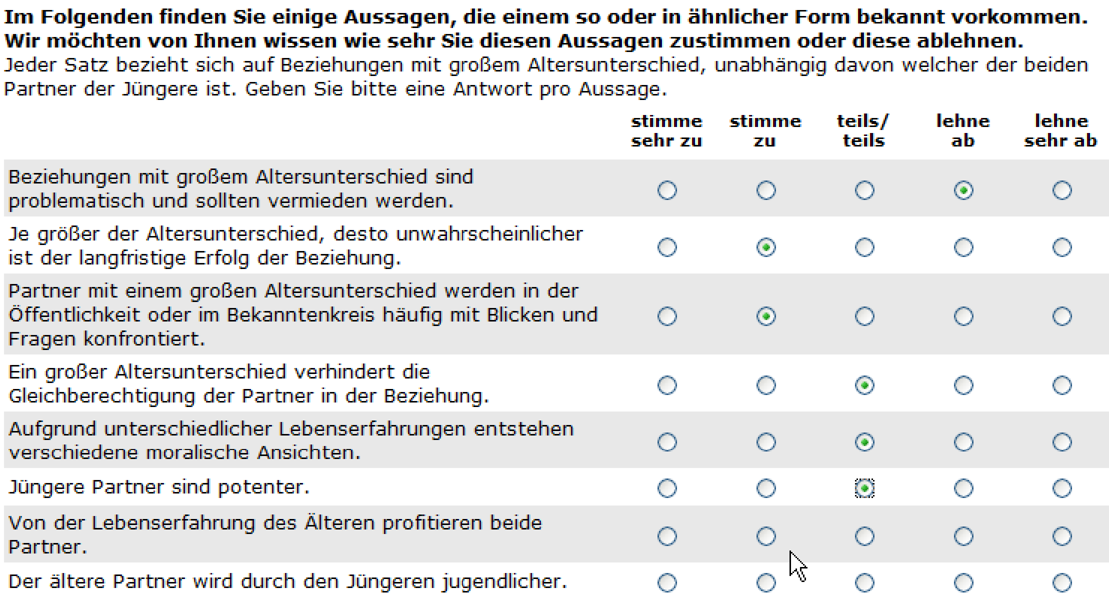
- Ja, ich selbst
- Ja, jemand Anderes
- Nein, Niemand
- Weiß nicht

Weiter

Questions on the last page of the application form which needs to be completed to apply as a student at the University of Mannheim.

Appendix for Study 5

The following figures show the questions and visual design in the experimental conditions of study 5. The experiment used two subsequent matrix questions on page nine and ten of the questionnaire. The experiment is described in section 6.3. The treatment condition implemented three aspects: (i) Feedback in the pre-selection phase was achieved by highlighting the cell in a light blue color at the mouse pointers position. (ii) Feedback in the post-selection phase is achieved by colorizing the cell in dark grey. (iii) The treatment condition also interpreted a click on the cell as a valid answer. The baseline condition used the standard implementation of current surveys without extra feedback. The topic of the survey was large age differences in relationships.



Im Folgenden finden Sie einige Aussagen, die einem so oder in ähnlicher Form bekannt vorkommen. Wir möchten von Ihnen wissen wie sehr Sie diesen Aussagen zustimmen oder diese ablehnen.
Jeder Satz bezieht sich auf Beziehungen mit großem Altersunterschied, unabhängig davon welcher der beiden Partner der Jüngere ist. Geben Sie bitte eine Antwort pro Aussage.

	stimme sehr zu	stimme zu	teils/ teils	lehne ab	lehne sehr ab
Beziehungen mit großem Altersunterschied sind problematisch und sollten vermieden werden.					
Je größer der Altersunterschied, desto unwahrscheinlicher ist der langfristige Erfolg der Beziehung.					
Partner mit einem großen Altersunterschied werden in der Öffentlichkeit oder im Bekanntenkreis häufig mit Blicken und Fragen konfrontiert.					
Ein großer Altersunterschied verhindert die Gleichberechtigung der Partner in der Beziehung.					
Aufgrund unterschiedlicher Lebenserfahrungen entstehen verschiedene moralische Ansichten.					
Jüngere Partner sind potenter.					
Von der Lebenserfahrung des Älteren profitieren beide Partner.					
Der ältere Partner wird durch den Jüngeren jugendlicher.					

Questions on page 9 without header and footer, baseline condition.

Im Folgenden finden Sie einige Aussagen, die einem so oder in ähnlicher Form bekannt vorkommen. Wir möchten von Ihnen wissen wie sehr Sie diesen Aussagen zustimmen oder diese ablehnen.
Jeder Satz bezieht sich auf Beziehungen mit großem Altersunterschied, unabhängig davon welcher der beiden Partner der Jüngere ist. Geben Sie bitte eine Antwort pro Aussage.

	stimme sehr zu	stimme zu	teils/ teils	lehne ab	lehne sehr ab
Beziehungen mit großem Altersunterschied sind problematisch und sollten vermieden werden.	○	○	○	◉	○
Je größer der Altersunterschied, desto unwahrscheinlicher ist der langfristige Erfolg der Beziehung.	○	◉	○	○	○
Partner mit einem großen Altersunterschied werden in der Öffentlichkeit oder im Bekanntenkreis häufig mit Blicken und Fragen konfrontiert.	○	◉	○	○	○
Ein großer Altersunterschied verhindert die Gleichberechtigung der Partner in der Beziehung.	○	○	◉	○	○
Aufgrund unterschiedlicher Lebenserfahrungen entstehen verschiedene moralische Ansichten.	○	○	◉	○	○
Jüngere Partner sind potenter.	○	○	◉	○	○
Von der Lebenserfahrung des Älteren profitieren beide Partner.	○	○	○	○	○
Der ältere Partner wird durch den Jüngeren jugendlicher.	○	○	○	○	○

Questions on page 9 without header and footer, experimental treatment.

Bitte geben Sie auch zu den folgenden Aussagen an wie sehr Sie diesen zustimmen oder diese ablehnen.
Jeder Satz bezieht sich auf Beziehungen mit großem Altersunterschied, unabhängig davon welcher der beiden Partner der Jüngere ist. Geben Sie bitte eine Antwort pro Aussage.

	stimme sehr zu	stimme zu	teils/ teils	lehne ab	lehne sehr ab
Ein jüngerer Partner kann im Krankheitsfall den Älteren länger unterstützen.	◉	○	○	○	○
Ein älterer Partner bietet finanzielle Sicherheit.	○	◉	○	○	○
In einer Beziehung mit einem großen Altersunterschied haben die Partner zu unterschiedliche Interessen.	○	◉	○	○	○
In Beziehungen mit großem Altersunterschied sind tiefgehende Gespräche nicht möglich.	○	○	○	○	◉
Ein jüngerer Partner ist unternehmungslustiger, offener und ausgelassener als Partner gleichen Alters.	○	○	◉	○	○
Jüngere Partner sind körperlich attraktiver.	○	○	◉	○	○
Wenn die Frau jünger ist als der Mann, ist es besser für die Beziehung.	○	○	○	○	○
Ältere Männer erfahren mit einer deutlich jüngeren Partnerin Bestätigung durch die Gesellschaft.	○	○	○	○	○

Questions on page 10 without header and footer, experimental treatment. The baseline condition used the same questions without interactively colorizing the table cells.

Appendix for Study 6

The following figures show the question design in study 6. The study is described in chapter 7. The experiment varied the feedback which the progress indicator reported: static, dynamic, truthful, and without a progress indicator. No filter questions were included. The last figure includes an example of how the progress indicator was implemented (textual and graphical).


Liebe Teilnehmer,

Sozioland begrüßt Sie herzlich zur Umfrage "Kochen 2004".

Unter allen registrierten Teilnehmern verlost sozioland.de in Zusammenarbeit mit dem Matthaes-Verlag eins von sechs Kochbüchern "Edle Desserts" (von Norbert Frank) und weitere Kochbücher in Zusammenarbeit mit Butlers.

Sozioland wünscht Ihnen viel Spaß bei der Umfrage!

Anmerkung: Diese Umfrage wird wie üblich absolut **anonym** durchgeführt. Am Ende der Umfrage haben Sie aber die Möglichkeit, sich bei Sozioland als Premium-Nutzer registrieren zu lassen und verschiedene Vorteile zu genießen. Sie werden dann regelmäßig zu Sozioland-Umfragen eingeladen. Generell nähere Informationen zu Sozioland erhalten Sie auf der Homepage **www.sozioland.de**.

Abbrechen Weiter

Page 1 without header and footer. This is a single condition (and the usual way of starting a survey) in another experiment which compared different beginnings of a survey. This other experiment is not presented in the present work.

In letzter Zeit wurde viel über Genfood (genetisch manipulierte Lebensmittel) diskutiert. Im Folgenden listen wir Ihnen einige Aussagen zu diesem Thema auf.

Bitte bewerten Sie diese Aussagen!

	trifft voll und ganz zu	trifft zu	teils / teils	trifft nicht zu	trifft ganz und gar nicht zu	Weiß nicht
Genmanipuliertes Essen sollte auf jeden Fall gekennzeichnet sein.	○	○	○	○	○	○
Durch Gentechnik kann der Hunger in der 3. Welt beendet werden.	○	○	○	○	○	○
Gentechnisch manipulierte Pflanzen entlasten die Umwelt.	○	○	○	○	○	○
Die Langzeitfolgen von Genfood auf den Menschen sind noch nicht ausreichend erforscht.	○	○	○	○	○	○
Genfood ist länger haltbar und dadurch besser als herkömmliche Lebensmittel.	○	○	○	○	○	○
Genfood ist Essen wie jedes andere auch.	○	○	○	○	○	○

Page 2 without header and footer.

Bitte beantworten Sie drei kurze Fragen über diese Umfrage.

Ist die Umfrage länger oder kürzer als erwartet?

länger	eher länger	teils/teils	eher kürzer	kürzer
○	○	○	○	○

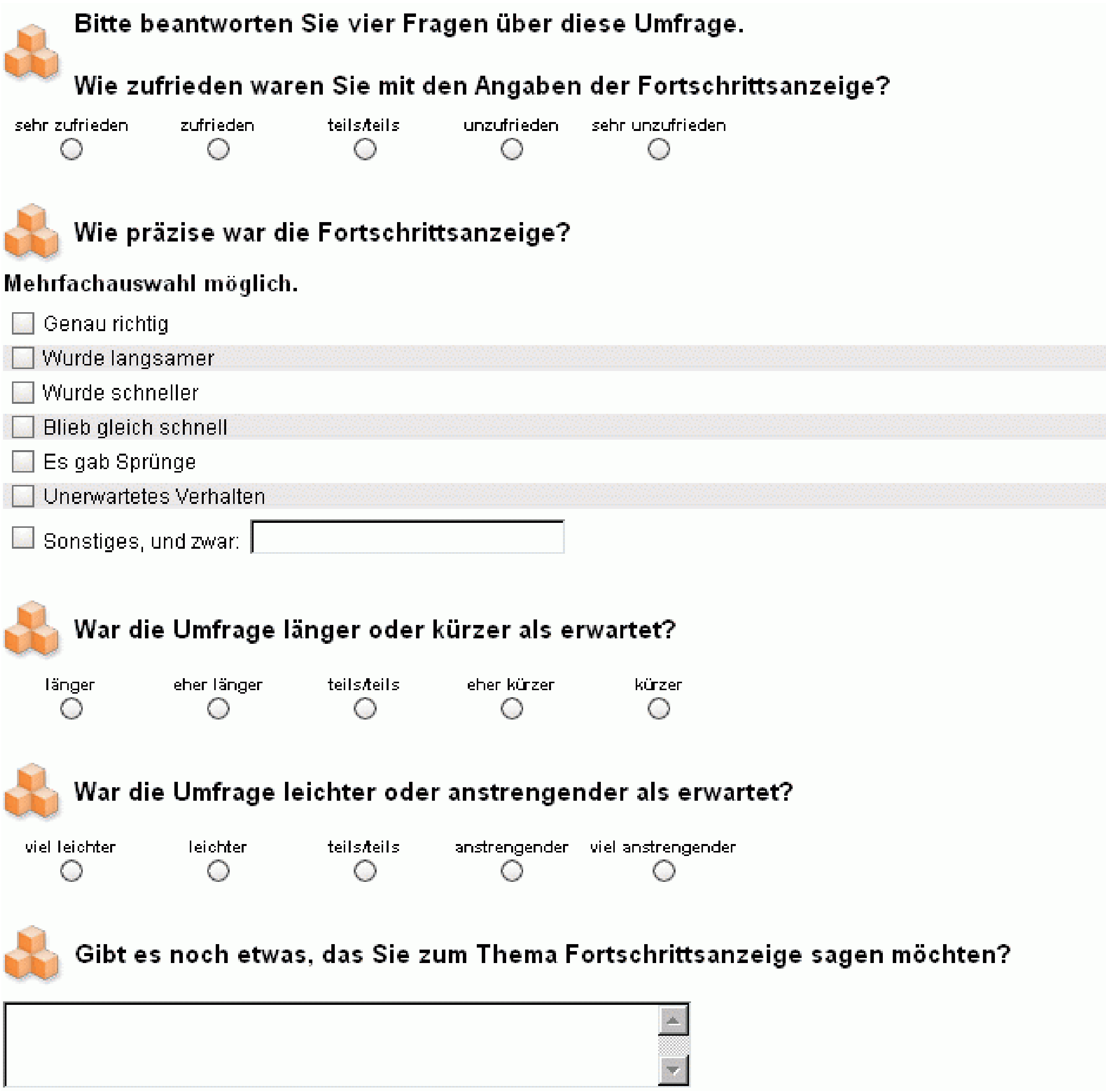
Ist die Umfrage leichter oder anstrengender als erwartet?

viel leichter	leichter	teils/teils	anstrengender	viel anstrengender
○	○	○	○	○

Mit wie vielen Minuten rechnen Sie noch bis zum Ende der Umfrage?

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

Page 6 and 12 without header and footer. First and second time the interim questions were asked. The screenshot was scaled to fit the page width. The original size did not differ from the other pages.



Bitte beantworten Sie vier Fragen über diese Umfrage.

Wie zufrieden waren Sie mit den Angaben der Fortschrittsanzeige?

sehr zufrieden	zufrieden	teils/teils	unzufrieden	sehr unzufrieden
○	○	○	○	○

Wie präzise war die Fortschrittsanzeige?

Mehrfachauswahl möglich.

- ☐ Genau richtig
- ☐ Wurde langsamer
- ☐ Wurde schneller
- ☐ Blieb gleich schnell
- ☐ Es gab Sprünge
- ☐ Unerwartetes Verhalten
- ☐ Sonstiges, und zwar:

War die Umfrage länger oder kürzer als erwartet?

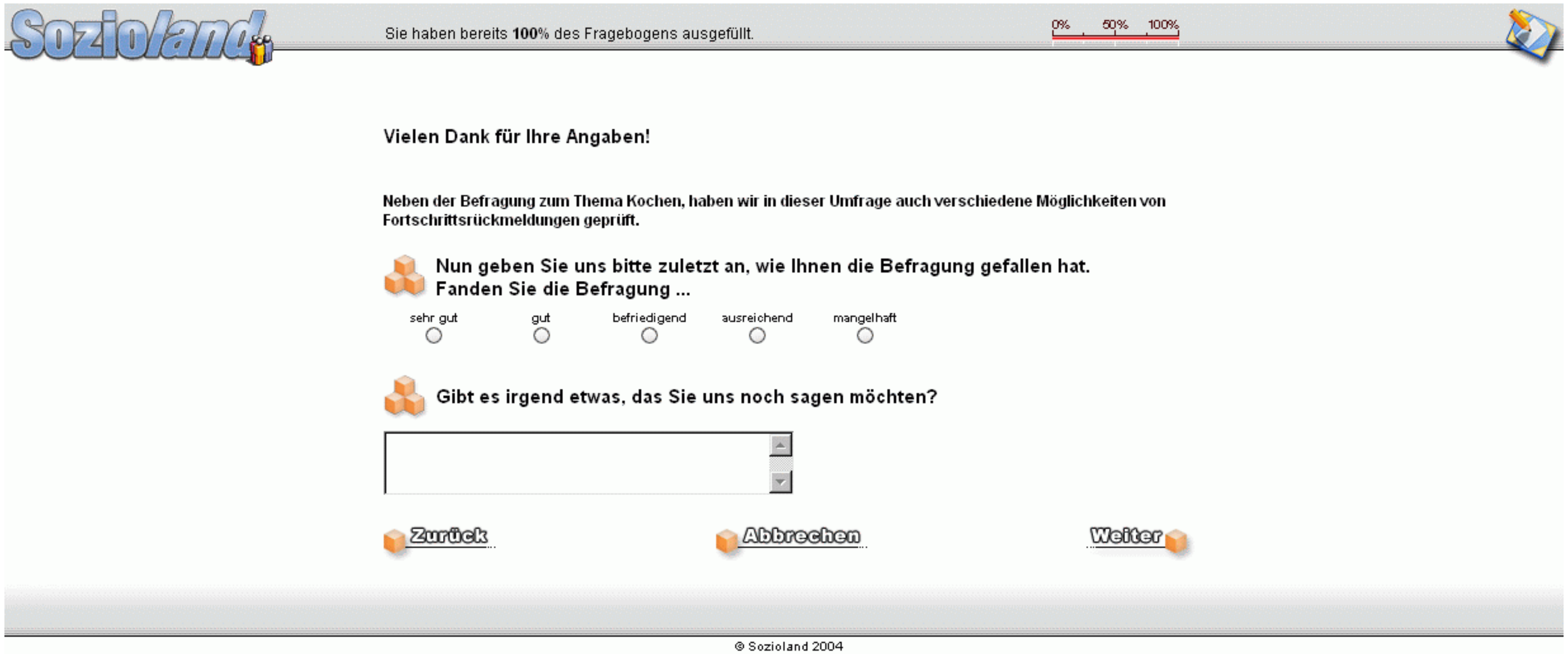
länger	eher länger	teils/teils	eher kürzer	kürzer
○	○	○	○	○

War die Umfrage leichter oder anstrengender als erwartet?

viel leichter	leichter	teils/teils	anstrengender	viel anstrengender
○	○	○	○	○

Gibt es noch etwas, das Sie zum Thema Fortschrittsanzeige sagen möchten?

Page 19 without header and footer. Third time the interim questions were asked.



Page 20. This figure shows the visual design of the progress indicator (textual and graphical) including the header and footer of the survey. The screenshot was made with a screen width of 1280 pixels.

Appendix for Study 7

The following figures show the beginning pages in the questionnaire of study 7 as an example of the survey design. Beyond the first pages the questionnaire continued with matrix questions and long pages which needed scrolling to provide answers.

Dear contributor to Free/Open-Source Software!

Welcome to an online survey of Free/Open-Source Software development. This survey is conducted by the Open-Source Research Group of the University of Würzburg (Germany).

This survey analyzes the **working conditions** within the open-source community. The goal of our project is to improve processes and organization of software development. The results will be published under the Creative Commons License.

We need your answers if you **contribute** to Open Source projects (e.g. as coder, tester, manager, translator, developer) no matter if you do it during your spare time or as part of your work. Completing the questionnaire will take about **15 minutes**.

We will keep your answers **confidential**. Reporting will be based on aggregated data only so that single users cannot be identified.

If you have any **questions** about the study, please feel free to contact us via e-mail (Dirk Jendroska, dirk.jendroska@stud-mail.uni-wuerzburg.de or Prof. Guido Hertel, hertel@psychologie.uni-wuerzburg.de).

In **previous research projects** we examined the motivation of Linux Kernel and Wikipedia contributors as well as the influence of payment on open-source developers.

Our Open-Source Research Projects:
http://www.psychologie.uni-wuerzburg.de/ao/research/open_source.php?lang=en

Page 1 without header and footer.

In your main Free/Open-Source Software project, what has been your main task/job during the last three months?

- ○ Requirements Engineering
- ○ Software Design
- ○ User Interface Design
- ○ Coding/Debugging
- ○ Testing
- ○ Documentation
- ○ System Administration
- ○ Management/Coordination
- ○ User Support
- ○ Translation/Localization
- ○ Others

Page 2 without header and footer.

Author Index