

How the internet is changing the implementation of traditional research methods, people's daily lives, and the way in which developmental scientists conduct research

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Abstract

Recent years have seen an impressive increase in web-based research, of which we review and discuss two main types. First, researchers can create online versions of traditional questionnaires. Using the internet in this way usually does not compromise the psychometric properties of such measures, and participants are typically not less representative of the general population than those of traditional studies. Technical guidelines are provided to set up such studies, and thorny issues such as participants' anonymity are discussed. We will also discuss issues regarding the assessment of minors and the repeated assessment of participants to assess developmental changes via the web. Second, the internet has changed the way people interact with each other. The study of the psychosocial consequences of this development is called cyberpsychology. We review emerging findings from this young discipline, with a focus on developmentally-relevant implications such as the use of the internet by adolescents to disclose personal information.

Keywords

child disclosure, science, social adjustment

Global internet use increased around 400% between 2000 and 2009 and is now a common reality in affluent Western societies. The Scandinavian countries have been among the first to achieve near-universal internet access (i.e., covering around 90% of the population; Internet World Stats, 2001–2009) and other countries are following this trend. In the wake of this development, web-based research is on the rise as well. Skitka and Sargis (2006) reported that four out of 298 studies published in the American Psychological Association's (APA) *Journal of Personality and Social Psychology (JPSP)* between 2003 and 2004 were at least partly based on data collected through the internet. Today, a search of abstracts published between 2008 and 2009 in *JPSP* resulted in 25 out of 343 studies (a relative increase of 543%). It can be expected that the spread of web-based research will advance, further propelled by increased acceptance and the development of more advanced and user-friendly technologies to conduct studies. In this review, we use the term 'web-based research' for all research methods that use internet infrastructure to transmit information to and from participants, covering two kinds of web-based research outlined by Skitka and Sargis (2006): (1) online implementation of traditionally offline instruments; and (2) phenomenological research focusing on the correlates of specific online behaviors.

In recent years, many papers on web-based research have been published. A number of widely-cited reviews have appeared in high-impact journals, such as *European Psychologist* (Michalek & Szabo, 1998), *American Psychologist* (Gosling, Vazire, Srivastava, & John, 2004) and the *Annual Review of Psychology* (Birnbaum, 2004). Also there have appeared numerous books on the issue, both directed at beginners (Fraley, 2004) and advanced users (Gosling & Johnson, 2010; see also Fielding, Lee, & Blank,

2008; Gaiser & Schreiner, 2009). Furthermore, there exist various websites containing exhaustive resources for scientists who want to conduct online studies, such as the excellent online course hosted by the University of Leicester (<http://www.geog.le.ac.uk/ORM/site/home.htm>) or the equally useful Web Survey Methodology project (<http://www.websm.org/>). Finally, detailed recommendations for dealing with ethical issues surrounding web-based research have been published by scientific advisory boards, such as the one by Kraut and colleagues (2004). At various points in this review, we will refer to these and other existing sources in order to save space to discuss other issues.

This review moves beyond such existing materials in a number of ways. To begin, the technological development of the internet is still moving with breakneck speed, so reviews of the phenomenon quickly become outdated. Conversely, some structural features of the internet seem to be relatively enduring determinants of psychological processes. In the current review, we especially focus on two affordances that the internet offers to its users: virtually limitless opportunities for communication, and an increased sense of anonymity. Rather than touching each aspect of web-based research in brief, we will generally refer to other sources dealing with more

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specialized topics. In particular, we focus especially on developmental issues of web-based research, as they have been neglected in previous reviews. Finally, we decided to focus not only on the technicalities of online surveys, but also on the investigation of new substantive phenomena associated with the emergence of the internet (i.e., cyberpsychology).

Advantages of implementing web-based versions of traditional assessment procedures

Ease and economy of collecting data

A major advantage of web-based research is that, because of the increased independence from spatial, chronological and material constraints, it allows for more efficient implementation of psychological assessments when compared with traditional assessment procedures. For example, programming a web-based survey is quite straightforward and can be carried out on a large scale without much of the effort that would accompany traditional methods (e.g., by sending out a large number of invitations via email; see later section “What is needed to conduct web-based surveys?”). Furthermore, as a web-server is capable of serving high numbers of participants at the same time, large samples can be attained within very short periods of time. Potentially, this also includes cross-cultural studies, because once a questionnaire has been translated and/or adapted for use in other cultures, it can be made available to the global internet community with relatively little effort (although regional differences in internet access should not be downplayed; see later). From the perspective of participants, web-based studies are also very convenient, as the comfort of participating in a home environment might increase readiness to participate and lower the compensation necessary to convince members of the target population. Finally, a number of problems that may affect offline studies are solved in advance, for example when participants with physical disabilities face difficulties traveling to an offline lab.

In comparison to traditional methods, web-based research can also be much cheaper, as lab. computers, provision of lab. rooms, and allocation of experimenters and lab. assistance do not have to be purchased. Because the framework for data collection will only have to be set up once and will not cause any noteworthy cost after that (broadband and data-storage capacities have sharply decreased in price), the costs-per-participant ratio actually decreases as a function of sample size. This is not only true for financial cost: environmental burden is also reduced, as participants will not need to travel and compared to pencil-and-paper methods, materials do not have to be printed any more.

Finally, web-based research offers advantages in terms of the recruitment of participants. For example, the acquisition of participants can rely on internet adverts and mailing lists, which are less time-consuming to produce and less costly to distribute than posters, flyers, newspaper adverts or announcements on campus. Besides, they are likely to actually reach not only a much higher number of recipients, but also a higher diversity (or more narrowly-defined target group) by encouraging recipients to forward an email to potentially suited and interested participants. This makes it much more likely for acquisition campaigns to go viral, as it only takes a click for the participant to spread the word – and another click by that person to participate immediately.

The website <http://www.outofservice.com/> is a prime example of how researchers can combine the advantages of easy and low-cost implementation to gather a previously unthinkable number of participants via web-based studies. For instance, based on this project, Srivastava, John, Gosling, and Potter (2003) published data regarding the age correlates of personality of 132,515 participants who filled out an online version of the Big Five Inventory (BFI) questionnaire. Similarly, on our own German portal <http://www.psytests.de/>, no less than 70,236 individuals have participated in studies since 2005. Such large numbers basically obliterate the usual power concerns and allow a focus on much more circumscribed research populations (i.e., subsamples).

Positive consequences of anonymity

As personal contact between researchers and participants is not necessary, conducting a study online adds to the extent of anonymity. This plays an important role not only regarding the undesired effects caused by experimenter presence described by Kintz, Delprato, Mettee, Persons, & Schappe (1965), which include influences of experimenters' personality, experience, sex, expectancy and performance (modeling effects). As Bargh and McKenna (2004) summarize, the anonymity of the internet has mentionable positive effects on communication, conveyed by a general feeling of comfort. Of these effects, the tendency to lower thresholds to disclose thoughts and feelings (as reported by Spears & Lee, 1994; Valkenburg & Peter, 2009), is of particular interest to researchers. Shy and anxious individuals are faced with less inhibitions to participate, and sensitive topics can be addressed confidentially, whereas undesired effects due to the possibility of faking identities are made less plausible by: (1) the fact that, especially, individuals with stigmatized identities seem to enjoy “finally being themselves” in anonymity; and (2) a general lack of benefit and purpose of giving false answers in a voluntary study.

Potential drawbacks associated with web-based surveys

In the early days of web-based research, pioneering researchers have often felt the need to promote the use of web-based research and “defend” it against attacks by technically conservative critics. With the increased acceptance of web-based research (and the internet more generally), it seems appropriate to be more open-minded about possible drawbacks of web-based research. In the following section, some important drawbacks are reviewed and, if possible, followed by recommendations on how to deal with them.

Measurement equivalence. Questions regarding the equivalence between web-based and traditional versions of questionnaires boil down to the related question of reliability and measurement invariance. Regarding the former, concerns have been raised that web-based implementations of traditional questionnaires are somehow less reliable, perhaps because they are often filled out in a more distractive environment (Gosling et al., 2004). A lot of research has addressed these concerns, usually with encouraging results. Regarding the question of psychometric equivalence, for example, a number of reviews have been published, with emerging consensus that both modes of data collection are generally comparable in terms of reliability and validity (Krantz & Dalal, 2000; McGraw, Tew, & Williams, 2000).

Experimental control. In general, as participants fill out a web-based survey at home, it is more difficult for the researcher to enforce certain test-taking conditions. Whereas a lack of supervision may not typically result in a reduction in the internal consistency of a questionnaire, however, it would be wrong to blindly assume that any traditional method can be automatically implemented online (Buchanan, 2007). For example, ability tests can be implemented as web-based versions, but they are of little use when there is an incentive for participants to cheat by looking up answers to knowledge tests online, or let themselves be helped by other people in the same room. Countermeasures (e.g., monitoring participants using a webcam) are theoretically possible, but they can be time-consuming and technically challenging to implement and appear as disproportional intrusions of participant privacy. Another way to cheat would be taking the test more than once, which is much harder to prevent in (the usual) cases when the identity of survey respondents cannot be verified. When there is little incentive to cheat, however, participants can be motivated to honestly fill out the test themselves (e.g., by presenting the test as a chance to get personal feedback about one's performance). We recommend that researchers think seriously about the required amount of control for their purposes and decide on the feasibility of conducting a web-based study on a case-to-case basis.

For research with minors, the lack of experimental control may often be an especially serious issue, as some children may need guidance in filling out the questionnaire or asking questions after its completion. Without a physically-present experimenter, however, no questions about difficult items can be asked while filling out the survey; in addition, debriefing is limited to materials that are devised a priori and may not properly address unexpected questions or concerns about the research in general and their role as participants in particular. Finally, younger children can be especially distractible when there is no adult "supervising" them while they fill out the questionnaire. Because of these reasons, the lack of experimental control in web-based research may be a more serious drawback in research with children, which needs to be taking into account by researchers planning web-based studies.

Sample representativeness. The second concern that has often been raised regarding web-based studies is that online samples are not representative of the general population. In the early days of the internet, for example, concerns were raised that web users represent a maladaptive section of the population (this was partly informed by results of empirical studies; Valkenburg & Peter, 2009). Research has shown, however, that online participants are not necessarily more emotionally disturbed than participants of traditional studies (Gosling et al., 2004). A more serious concern is the fact that internet access and use are not equally distributed, and a substantial "digital divide" exists between privileged and underprivileged socioeconomic groups and countries. Regarding the former, people with internet access tend to be more educated and affluent (Pullmann, Allik, & Realo, 2009), and regarding the latter, the accessibility of the internet in a country is strongly correlated with gross domestic product (GDP) (Kiiski & Pohjola, 2002). Obviously there is also a close connection between these two levels, as internet users will tend to be more selective in countries with limited overall access.

Of course, a high or even universal spread of internet access in a country does not automatically guarantee that the participants in web-based studies are representative of the overall population as

well. As discussed in more detail later, participants may take part in web-based studies for different motivations, and these may be informed by individual-difference variables. For example, Pullmann and colleagues (2009) found that participants in an Estonian web-based study rated themselves higher in terms of self-esteem than their counterparts in a population-representative sample, a difference that was accounted for by the higher educational level of the internet sample. That said, Gosling and colleagues (2004) showed that internet samples are often more representative than the convenience samples that are often used in traditional research (i.e., female college students). Of course, however, convenience samples are not the gold standard of scientific research, and we recommend a case-by-case deliberation regarding the appropriateness of conducting a study online (vs. offline). For example, when a researcher wants to collect data that are representative of the population in general (e.g., to norm a questionnaire or to find out about the prevalence of a certain phenomenon), traditional measures like stratified sampling based on zip codes may be more appropriate.

Study dropout. Finally, concerns have been raised about dropout from online studies, leading to missing data (as reported by Reips, 2002, the average dropout rate in web studies is 34%, with a range between 1% and 87%). As stated earlier, the reduced level of experimental control combined with the anonymity of web-based research is associated with a greater likelihood that participants will quit a study before they are finished. A number of papers deal with classifying (Bosnjak & Tuten, 2001) and handling (Johnson, 2005) patterns of incomplete data. Furthermore, Fan and Yan (2010) summarize the corresponding literature based on a theoretical model of factors affecting responses in web-based studies, providing a detailed list of measures that researchers can take to avoid missing data. Conversely, web-based research can also facilitate the collection of complete data. For example, scripts can be implemented that prevent users from proceeding with a questionnaire when answers are missing (of course, such measures should be accompanied by active non-disclosure options, such as "I do not want to answer this question"; Joinson, Woodley, & Reips, 2007). In addition, automatic emails can be sent to remind participants to contribute data (e.g., in longitudinal research).

Recommendations for researchers. Although psychometric properties of web-based questionnaires generally seem to be sound, and sampling bias seems far less extreme than initially feared, web-based researchers are still faced with some formidable conundrums that should be taken into account on a case-by-case basis. For example, the issue of experimental control seems especially relevant for complicated, taxing or emotionally-upsetting test batteries, whereas surveys dealing with "simpler" methods may not suffer much from the lack of a person supervising the assessment. The issue of representativeness is also tricky, with internet convenience samples being ill-suited for producing mean-level estimates that are representative of the general population; in uncovering (within-person) associations between variables, such methods seem somewhat more robust, however (Pullmann et al., 2009). Finally, dropout may not matter much if researchers are not interested in representative samples or if attrition is expected to be unrelated to variables of interest. However, sample retention is a key requirement, especially in longitudinal studies, not only in terms of representativeness but also to retain sufficient statistical power. In these cases, we recommend that researchers do everything in their power to motivate

participants to take part in retest assessments (e.g., by providing monetary rewards, sending reminder emails, etc.). It should be noted, however, that sample retention in longitudinal research has always been very difficult and time-consuming even before the advent of web-based studies (Block, 1997).

What is needed to conduct web-based surveys?

In this section, a general overview about necessary and optional equipment, technologies and skills is given. Depending on the focus or unique requirements of a study, other elements might become necessary. In this overview, we take a conventional web-based survey as an example, as this is still the most common application and recommended especially to beginners.

Server

A web-server program takes care of the communication between server and client computer. Servers not only store such data for users to download (e.g., HTML files) but may also combine and manipulate data before sending it to the users. Such features require a server-side scripting interpreter capable of HTML generation/pre-processing, of which PHP is commonly used (other programming languages are also possible; for example, the book by Fraley, 2004, focuses on a combination of Common Gateway Interface (CGI) and Perl; to date the most versatile and advanced web development framework is *Ruby on Rails*, <http://rubyonrails.org>). The most commonly-used web server that serves most purposes is currently the *Apache* web-server, an open-source project that can be downloaded without any licensing costs.

Questionnaire/survey

In the basic form, web-based questionnaires would be an online version of a conventional pencil-and-paper survey. There exist a number of commercial providers of tools for survey generation, so research labs do not need to program basic surveys from scratch (see Wright, 2005, for a list of the pros and cons of various service providers). Also, using the services of a commercial provider out-sources the need to set up an own server, as explained earlier. However, when unconventional features like adaptive testing, individualized feedback, or instruments other than self-report, one-shot Likert-type surveys are needed, the range of technical possibilities offered by these frameworks is soon exhausted. In these cases, programming an individual application by hand is the recommended option.

Just like in studies using traditional methods (e.g., pencil and paper), researchers contemplating the use of web-based technologies targeted at young children should think carefully about making their materials child-friendly. This includes the avoidance of difficult words and long texts, as younger children may not be cognitively mature enough to fully understand them. In addition, the increased distractibility of children should be taken into account when planning the length and scope of the questionnaire. To ensure that materials are developmentally appropriate, they should be piloted with children from the targeted age group and adjusted if necessary. Research from a large web-based data collection suggested that, from age 10 onwards, children's personality can be assessed using the internet, even though responses from younger

children (until age 14) tend to be strongly influenced by acquiescence bias and should be corrected for that (Soto, John, Gosling, & Potter, 2008). For more information about a range of issues related to the construction of methodologies to study children, we refer the reader to the methodological resources of the www.eukidsonline.net project.

Database

The data supplied by participants have to be saved in a convenient format, which can be done using a database. An SQL-database will suit most researchers' requirements. Most SQL-database software is also available open-source and free of charge. We recommend using the latest version of the *MySQL Community Server*. It needs to be pointed out that the storage of personally-identifiable information (PII) is regulated by law in both the United States (US) and the European Union (EU), with the EU laws being more restrictive in terms of privacy protection (for a thorough comparison of the two systems, see Baumer, Earp, & Poindexter, 2004). Regardless of the country in which the research is being done, however, we believe it is not just important to meet minimal legal requirements but to also strive for best practice. This involves notifying participants of the nature of the storage of PII, obtaining their consent before doing so, allowing them to access and correct PII data, and storing such data in a way that meets state-of-the-art security standards.

Participants

For the recruitment of participants in web-based studies, researchers can rely on a variety of methods. First of all, they can use traditional, "local" methods, such as posters, handouts, or announcements in popular media. To fully exploit the scale advantages of the internet, however, virtual recruitment methods are available as well. First, web-based studies can be posted on sites devoted to online research (for example, John Krantz of Hanover College maintains an excellent site; <http://psych.hanover.edu/research/exponnet.html>). However, visitors of such sites may be highly selected in being interested in psychological experiments, so more exhaustive methods may be considered as well. One option would be to advertise the study through the use of web banners, which can be posted on websites that are popular with the intended target group (of course, this is associated with costs, but these may well pay off in terms of sampling ease and representativeness). Another option is to send an announcement regarding the study via email (perhaps using mailing lists) or post it in forums. Such recruitment techniques should be used with caution, however, because many internet users do not appreciate unsolicited messages, which are (rightly) regarded as spam.

In terms of recruitment, researchers focusing on children are faced with some very tricky dilemmas. After all, unsolicited contacting of minors is regarded with suspicion and many children are told by parents and teachers not to respond to such efforts. In addition, children are known to be more easily influenced by persuasive messages, and this trusting attitude should not be abused by researchers (and neither by marketers, of course). Perhaps the best way to address this dilemma is to generate attention to the study in a way that is appealing to children (e.g., by using bright colors and motives from child pop culture), while careful and age-appropriate instructions and explanations are displayed on the website that the advertisement links to (this information should be the

basis for obtaining informed consent, which is discussed in the corresponding section below).

Participant motivation is as crucial in web-based research as it is in traditional research. Although participants' time expenses can be compensated by financial reimbursements, this may not alleviate boredom, which has a negative influence on motivation and thereby on the reliability and validity of the results obtained. Therefore, careful consideration has to be paid to aspects other than financial incentives to raise and maintain participants' motivation and avoid frustration. These include an attractive design, thoroughly explained and comprehensible tasks, and a carefully debugged and checked technical architecture. It has to be kept in mind that participants will be all by themselves without any access to help by the experimenter. Therefore even the most obvious aspects of the study need to be explained, and an intuitively and easily accessible manual has to be supplied. For more detailed recommendations, see Reips (2000) and Peden and Flashinski (2004), who point out many common mistakes in the design of web-based studies.

Of course, before these aspects even come to play, people have to be motivated to participate at all. The effects of financial incentives are well known and investigated, for example by Göritz (2006), with regard to web-based studies. According to our experience, offering individualized feedback is one of the most crucial aspects, which often seems to outweigh even financial compensation. The prospect of obtaining scientifically-founded feedback about the self seems to be very attractive. For example, Marcus, Bosnjak, Lindner, Pilischenko and Schütz (2007) could partly counter the negative effects of low topic salience on response rates by promising individualized feedback, which heightened personal involvement. In addition, personal involvement should raise compliance and willingness to disclose. Providing Big Five profiles or attachment types, for example, promotes self-insight and encourages reflecting one's own personality and relationships, which is generally seen as contributing to psychological well-being (Vogt & Colvin, 2005).

The chance that participants might overestimate the feedback's meaningfulness and take it into account for relevant decisions in their life adds to the ethical duty to provide well-established and valid research results instead of vague guesses and folk wisdom. Of course, as the feedback is provided mostly to laypeople, careful instructions on how to interpret and deal with the results have to be included. In research with minors, this issue becomes even more important, as children (especially adolescents) experience periods of confusion regarding their identity (see later), so feedback that disconfirms their existing views may exacerbate such feelings or result in an uncritical adoption of unwarranted feedback. Depending on the nature of one's research, recommendations about whom to contact in case of further questions or even problems induced by the results should be included in the feedback.

Measurement of change

In many ways, web-based studies are ideally suited to study the investigation of change, so it is surprising that longitudinal web-based studies are actually quite rare. We will briefly discuss two possible methods that can be applied online. First, web-based studies can track participants over longer periods of time to study the mean-level trajectory of certain psychological constructs or to investigate correlates of individual differences in change. Web-based studies potentially make the re-contacting of participants easier, especially if they have moved to a different location. It needs to

be kept in mind, however, that many people change email addresses during the course of their lives (e.g., some addresses are deactivated when people change jobs or finish studying). Because of this, it seems prudent to collect data that allow alternative ways of re-contacting participants, such as phone numbers or friends' email addresses. Of course, the collection of such information raises questions about data security and privacy, which should be cleared with the institutional review board (IRB) and (if available) local privacy commissioners.

A second way to study change is to focus on more short-term fluctuations by means of micro-longitudinal studies (e.g., diary studies or contingent sampling of recurrent events). For example, participants could be asked recurring questions about their social interactions and affective reactions at the end of each day in order to study individual differences in social-emotional reactivity (this was done in the Berlin Diary Study of which the data can be freely downloaded and analyzed for publication; Denissen, 2005–2008). Web-based techniques are well-suited for the implementation of such studies because they provide a convenient way for filling out daily questionnaires (as long as people have frequent access to the internet at home or the workplace). In addition, the timing and duration of participant responses can be automatically tracked to ensure compliance with survey procedures (e.g., checking if participants indeed fill out a diary at the end of the day).

Challenges of web-based research

Secure storage of participants' data

Using the internet to gather personally-sensitive information offers a number of potential advantages in this area, but also some striking threats by numerous potential security issues. When thinking about anonymity arrangements, it should be kept in mind that theft or vandalism of the collected data can be made less likely, but probably never impossible. Resulting ethical and legal consequences pose yet another reason to take anonymity seriously and to record the obtained results with the techniques explained in the following, which touch both data transmission and storage. In any case, researchers need to make sure that data are stored according to state-of-the-art security requirements, which involves frequent security updates and monitoring of (suspicious) web traffic, among others.

Data transmission. In web-based research, data need to be transmitted between the computer of the participant and a server that hosts the survey of the researcher. Although the technical effort to actually read out data during the process of transmission will in most cases outweigh the potential interest anybody might have in them, we strongly recommend making use of data encryption via *https*, if only to demonstrate a concern about confidentiality, as otherwise transmission will be potentially readable.

Anonymous storage of participants' data. For a better understanding of issues regarding storage of participants' data, it is necessary to distinguish between participant responses and PII. As stated earlier, the collection of PII is limited by legal obligations that differ between countries. Of course, the best way to avoid these issues is not to record any PII data at all. In this regard, however, it needs to be kept in mind that apparently "technical" information, especially IP addresses, are sensitive person-related data as well, as they theoretically allow for identification of the household from

Table 1. Concepts of anonymization and when to use them

	Separate storage in 2+ tables	Storage in one table	No storage
Person-related data	Person-related information <i>has</i> to be recorded, for example bank account for compensation.	To be avoided due to ethical and judicial reasons.	Gold-standard of anonymity—identification, merging and linking is impossible.
Anonymous ID codes	(a) No person-related information is needed and no tracking, merging or linking intended. Sole use of code: proof of participation. Compensation has to be picked up.	(b) No person-related information is needed, but tracking, merging or linking is intended. Examples: longitudinal studies, re-display of results, linking results of different studies.	

which participants' responses were submitted. In addition, researchers need to keep in mind that identities of individuals can be traced back "directly or indirectly" using "one or more factors specific to [their] physical, psychological, mental, cultural or social identity" (quoted from Article 2(a) of the EU Information Directive, 1995). This requires researchers to think critically about their handling of particular bits of information, especially if they link back to distinguishing characteristics of participants. For example, knowing that a person is a U2 fan and likes to watch soccer is not likely to reveal much about that person's identity, but knowing about highly idiosyncratic musical or sports tastes may provide more direct clues (especially for acquaintances of the person in question).

Sometimes, however, PII data need to be collected when participants are to be re-contacted (e.g., in longitudinal studies) or financially compensated for their time and effort in taking part in a study. We present two independent concepts of anonymization, which can be used by themselves or in combination. These concepts concern separate storage of person-related data and participant responses, and anonymization via ID codes. See Table 1 for an overview and recommendations on when to use which concept.

Separate storage of person-related data and participant responses. By using different tables within a database, a web-based research framework can be programmed to store participant responses separate from PII such that both cannot be linked. Specifically, PII information can be recorded in a *participants* table, for example to register whether certain individuals have successfully taken part in the study (e.g., to avoid sending them reminder emails). Separate from that, all provided participant responses (i.e., the information that is relevant for scientific analysis) could be stored in a *results* table. This is more secure than manually deleting PII information after the completion of the study, since this is prone to human error and data could be intercepted before that. Information about the timing of participation should not be stored in both databases and the rows of at least one database should be shuffled upon each new entry to avoid linking both tables according to their chronological ordering.

Identification of participants via identification codes. In the above example, person-related data are separated from potentially private participant responses. Still, the idea that person-related data are stored might promote (justified) distrust. Also, participants of a study about psychological problems or deviant behavior might not feel comfortable with their names being stored in a *participants* table, even if separated from the results. In these cases, it is better to identify persons through anonymous

participant codes instead of person-related information. Participant codes can be thought of as pseudonyms which allow linking participants to their data without requiring them to supply confidential PII. Depending on the intended use of the code, it can be either stored separately or in one table with participant responses. Codes can be generated and assigned either randomly, or by the participants.

Random participant codes should consist of a sufficient number of digits and its generation must not be based on any static rules such as consecutive numbering. Codes that meet these criteria can be constructed using a random number-generating function, and displayed to the participant to write down. However, such codes are cryptic and hard to memorize, and therefore bound to inconveniences and problems in reproduction.

Personal participant codes are codes that are created by the participant. For privacy reasons, participants should be discouraged from using a code that resembles their name or email address. A good alternative is letting participants generate a code that consists of single letters or digits from static PII (e.g., first two letters of city of birth). This code will not need to be memorized, as it can be reconstructed whenever necessary. When participant codes are used to display feedback that is stored after the completion of the study, they should not consist of information that may be known by acquaintances. Alternatively, feedback should be protected by a password that is generated by the participants.

Communicating with participants in follow-ups and longitudinal studies

In longitudinal studies, participants need to be contacted to ask them to take part in an additional wave of data collection (it is not very realistic to expect participants to remember when each wave is going to take place and independently log on to the questionnaire site using a code, as anonymity purism would prescribe). To achieve this in the most secure and convenient way, servers can be set up to automatically contact participants when their follow-up data are due, and remind them in case they do not react to first contact attempts. A more tricky aspect concerns communication attempts made by participants: an anonymous contact form should be provided to store participants' questions anonymously with the option to answer them publicly (e.g., by creating an FAQ section).

Extensive testing and debugging

Computers are known to be exact in following the instructions given to them in form of programming code, so "computer problems" like security holes and bugs usually originate in human failure. If such human failure occurs in the planning period of

traditional studies and the unforeseen happens, chances are the error will be detected by an experimenter and corrected in the course of the study. The aforementioned quality of web-based research being able to serve vast amounts of participants at the same time and conducting the desired study in a short period of time increases the potential impact of such human failure. Therefore, the study has to be carefully planned (considering aspects such as the order of tasks and questionnaires) and checked for errors and problems, especially in reaction to unanticipated participant behavior such as leaving out questions, making longer pauses, trying to go back to change answers, etc.

Other ethics-related issues

Respecting and assuring anonymity and privacy are undoubtedly necessary, yet not sufficient, aspects of research ethics. For consideration of different disciplinary frameworks and methodological issues, as well as a discussion of participants' expectations, rights and interests, see Ess (2007) and the ethics guide of the Association of Internet Researchers (Ess & Association of Internet Researchers, 2002).

Informed consent is a central requirement of ethically-responsible research and is achieved by letting participants declare that they understand and accept the procedures of the study in which they are being asked to participate. Informed consent is especially tricky when it comes to minors, who are protected by laws such as the Children's Online Privacy Protection Act (1998). According to this law, children under the age of 12 are not allowed to participate in online studies, unless researchers secure the written permission of their parents. For children between the ages of 13 and 17, many IRBs require scientists to obtain written consent from both adolescents and their legal guardian, although exceptions are possible when this conflicts with youths' emerging desire for privacy and independence from their parents (Friedman, Lin, & Miller, 2005). In any case, explicit permission must always be granted by a researcher's IRB before web-based studies can specifically target children (see Buchanan, 2003, for two chapters dealing with the legal details concerning children as participants). For sample informed consent forms for parents as well as children, see Addendum 3 of the ethics guide of the Association of Internet Researchers (Ess & Association of Internet Researchers, 2002).

Another issue that should be taken into account is the possibility that minors try to access survey websites that are designed for adults. In cases where this may be a serious concern (e.g., due to the content focus of the questionnaire), we refer to recommendations provided by Nosek, Banaji, and Greenwald (2002) to prevent this from happening, such as implementing an age-check system.

Cyberpsychology: The internet as a unique psychological phenomenon

In the previous section, we have reviewed and discussed methodological implications of implementing traditional surveys on the internet, with a special focus on developmental research. Of course, however, the internet is much more than just a tool for researchers; it is drastically changing life in Western industrialized societies. For example, it allows individuals to communicate much more efficiently with other people and to access a virtually unlimited amount of information. It also enables users to move in the virtual world more or less anonymously, or even while using a completely

different identity than the one in the offline context. As with all societal innovations, the fundamental nature of this change in communication patterns has given rise to concerns about their developmental and psychological consequences. In the following, we will first review research addressing the potentially negative consequences of internet use for psychological adjustment, as this has been a major source of societal concern. After that, we will review research that investigates how the internet has changed interpersonal communication, with a special focus on developmental implications.

Associations between internet use and psychological adjustment

The anonymity of the internet may result in the exacerbation of undesirable consequences of behaviors such as viewing pornography (Peter & Valkenburg, 2009) and gambling (Ladd & Petry, 2002). Critics have also voiced concerns that changing patterns of communication in the online world are having a deleterious effect on interactions in the offline world (Bargh & McKenna, 2004). In the following, we will review research that has addressed these concerns.

The scientific study of the psychological implications of living in the virtual world is called cyberpsychology (for a comprehensive reference list of publications on various topics, see <http://construct.haifa.ac.il/~azy/refindx.htm>) and has led to the establishment of a host of new journals such as *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *Cyberpsychology, Behavior, and Social Networking* and the *International Journal of Internet Science*, as well as handbooks such as the *Oxford Handbook of Internet Psychology* (Joinson, McKenna, Postmes, & Reips, 2007). This emerging research has led to first results regarding the correlates of internet use, which seem to assuage initial fears about damaging consequences disseminated in many popular media outlets (Bargh & McKenna, 2004; Valkenburg & Peter, 2009).

In fact, there are several aspects of online communication that benefit certain individuals who experience problems in offline contexts. Interpersonal interactions in offline contexts can be highly unpredictable and complex, thus requiring a certain degree of self-assurance and spontaneity that not everyone can muster. The lack of face-to-face contact and the ability to "think through" a response before sending a message in the internet context may therefore provide a "safe setting" for shy and low self-esteem individuals (Campbell, Cumming, & Hughes, 2006; Valkenburg & Peter, 2009). Steinfield, Ellison, and Lampe (2008) reported evidence that the use of social networking sites like Facebook was associated with increased social capital (operationalized as participants' degree of involvement in and identification with their university surroundings), especially for low self-esteem individuals. In addition, Selfhout, Branje, Denissen, van Aken, and Meeus (2010) reported that online chatting was associated with increases in emotional adjustment (mediated by differences in social skills), but only for introverted individuals.

Also, the relative lack of geographical boundaries on the internet allows minority individuals to establish groups of like-minded peers, which would be difficult, if not impossible, in offline contexts (as a somewhat exotic example, consider the internet community of people who like to chew ice: <http://icechewing.iswhaticrave.com/>). In addition, the relative anonymity of the internet makes it easier for stigmatized individuals to discuss their experiences with

like-minded peers (e.g., forums for people with discriminated sexual identities). By providing each other with social and identity support, engaging in internet communication can be a highly adaptive way of establishing meaningful social relationships for such individuals. Of course, there is also another side of this coin, in that people with pathological or socially-undesirable characteristics may reinforce their proclivities, leading to more maladaptive outcomes (e.g., in the case of online forums for anorexic girls).

Some final words need to be devoted to the issue of internet addiction (Young, 1998), which is being discussed as a new diagnostic category for the upcoming (version V) Diagnostic and Statistical Manual of Mental Disorders (Block, 2008). This proposed condition consists of three or more subtypes: online gambling addiction, addiction to internet pornography, and addiction to email and text messaging. It is suggested to be associated with classical addiction characteristics, such as excessive use, withdrawal, tolerance, and adjustment problems, with a reported prevalence of around 2% in 6–9-year-old children (Block, 2008). One longitudinal study showed that adolescents who spent more than 16 hours a week online had a high risk of developing Compulsive Internet Usage one year later (Meerkerk, Van den Eijnden, & Garretsen, 2006). Internet addiction, in turn, is associated with higher levels of social isolation, depressive symptoms and lower self-esteem. Thus, internet addiction is a unique online problematic behavior that may form a risk factor for other problematic behaviors. A recent review of the phenomenon by Widyanto and Griffiths (2006) came to the conclusion that internet addiction indeed exists, although it affects only a very small percentage of the population. We recommend conducting more research on this phenomenon, focusing on the question what is so addictive about the internet, if and how this addiction differs from more traditional addictions, and what types of individuals are particularly vulnerable to develop it.

Changes in interpersonal communication patterns associated with internet use

According to Skitka and Sargis (2006), a relatively small percentage of web-based research is devoted to the study of novel communicative phenomena made possible by the internet. Such phenomena can be studied from observing communication patterns that can be tied to specific online identities. An obvious example would be a personal website that is being updated by a certain individual, but personal information is also available through social network and blogging sites, or even by information tied to accounts at various web services. Most of this research can be labeled as observational, as such publicly-available data from users are used to address certain questions. As an example, Vazire and Gosling (2004) used personal websites by letting independent judges provide personality impressions based on this information, whereas Gosling, Gaddis, and Vazire (2007) used Facebook profiles for the same purpose. Many Facebook users update and foster their profiles meticulously on a daily basis while they stay faithful to the site for several years. For researchers interested in certain phases of development, this might constitute a whole new way of collecting data. As another example, Rentfrow and Gosling (2003) sampled the online music libraries of internet users as listed in file-sharing platforms. In principle, any kind of “behavioral residue” that is left on the internet can be picked up by researchers and used for research.

Such information also includes contributions in online forums, time spent online on certain websites, etc.

The ease of observing people’s social and communicative behavior online has led many researchers to jump on this bandwagon and publish studies on social network profiles, personal websites, blogs, and so on. Traditional ways of thinking about ethical questions, which are still predominant in many university IRBs (McKee & Porter, 2008) do not always apply to cyberpsychological questions, however. For example, written communications in chat rooms and on social network sites may technically be in the public domain: users have probably clicked a button declaring that they are aware of the fact that service providers allow other people to see such communications. However, oftentimes users do not behave “as if” they were aware of the public visibility of their online expressions. As an anecdote, a while ago a search engine was introduced that allowed people to search public expressions of users of a popular social network site (Facebook). It turned out that many people had disclosed highly embarrassing information (sensitive results even turned up after searching for the quote “don’t tell anyone”). To be fair, it may not be easy for all members of the online community to be acutely aware of the public character of their communications. After all, most people use social network media primarily to communicate with their existing friends (Valkenburg & Peter, 2009) and the privacy settings of many sites have been criticized as overly complex.

We agree with McKee and Porter (2008) that it is very difficult to provide clear-cut recommendations regarding the ethical conduct of cyberpsychological observation studies, and support their plea to make decisions after careful consideration and on a case-by-case basis. Of course, this does not mean that “anything goes”: McKee and Porter (2008) have provided a number of distinctions that can be used to frame the ethical aspects of web-based observation research. For example, researchers need to evaluate whether the communications they observe on the internet are “sensitive” in terms of their potential repercussions in the offline world. For example, a person may write about a secret affair in a chat room and this information may have important consequences for the relationship in which the cheating takes place. In such a case, researchers are clearly observing things they are not “supposed” to observe and they should possibly refrain from doing so—even when the information was obtained entirely legally in the public domain. Another distinction refers to online users writing texts as an “author” as opposed to as a “person.” In the former case, individuals are publishing information that is intended for use by a broader audience but in the latter case, they may express thoughts and feelings that contain personal appeals for those who read them. For example, if a researcher reads about a blogger’s suicidal thoughts, he or she should consider contacting the person in question and offering to facilitate contacting mental health professionals (McKee & Porter, 2008).

Developmental considerations

As is normal for new technologies such as the internet, young people were generally quicker to pick up on this development and to integrate it into their daily lives. A new generation of children growing up in industrialized societies does not know a world other than one in which the internet plays a dominant role (accordingly, they have been termed “digital natives”; Bennett, Maton, & Kervin, 2008), whereas many adults are still getting used to the

opportunities provided by this new medium. This discrepancy in experiences may be one of the reasons for the anxiety of some adults regarding potentially harmful effects of internet use on their children (Livingstone & Haddon, 2009). Such fears are exacerbated by the relatively anonymous nature of the internet, providing opportunities for malicious adults to exploit the trust of children by falsely identifying themselves as under age. In addition, this anonymity, combined with the initial unfamiliarity of many parents with the internet, probably left many in the dark as to what their offspring were actually doing in this strange new virtual world. Lacking parental guidance, children may be more prone to engage in online risk behaviors, which has led developmental psychologists to formulate guidelines for parents (see Greenfield, 2004).

Developmentally relevant topics. Although it can be expected that the increased dissemination and acceptance of the internet will lead to near-universal usage in all age groups, the specific pattern of use will likely vary across different periods of the life span. From a developmental perspective, each period comes with a certain set of developmental tasks and conflicts that shape the individual's dealing with the outside world. From an Eriksonian viewpoint, for example, adolescence is the time when people grapple with issues of identity, so it may come as no surprise that online activities of adolescents (e.g., in using social networks) have often been described as ways to promote a sense of identity by stressing relationships with peers (Livingstone, 2008). Consistent with this, Subrahmanyam, Garcia, Harsono, Li, and Lipana (2009) content-analyzed adolescent blogs and found that their authors wrote most about peers and their daily (school) life, and used this writing for the expression of feelings and analysis of situations. This suggests that online contents may reflect the developmental reality of adolescents rather closely.

Conversely, adolescents may also use the internet to experiment with new identities. For example, Valkenburg, Schouten, and Peter (2005) found that 50% of adolescents use the internet to experiment with their identity, and most of them did so by pretending to be an older person. Indeed, adolescents declared that they pretended to be another person for reasons of self-exploration, followed by social compensation (overcoming shyness) and social facilitation (meeting new people). Such online self-exploration can be successful, as Valkenburg and Peter (2008) found that adolescents who engaged in this behavior more often communicated with people of different backgrounds, which in turn had a positive effect on social competence (particularly for lonely adolescents).

It can be expected that internet use in other age segments also focuses on corresponding developmental tasks, such as the issue of generativity in middle adulthood. Using social network sites like Facebook, for example, it could be tested whether older adults indeed show a decrease in the size of their online network as they concentrate on a smaller number of high-quality relationships (Carstensen, 1992). Although there have been some studies that focus specifically on the correlates of internet use in older age (e.g., Alterovitz & Mendelsohn, 2009; Chen & Persson, 2002), investigations of developmental differences is still extremely sparse and more research is badly needed.

Developmental consequences. An important focus of cyberpsychological research has been the study of the developmental consequences of internet use. In this regard, early scientific reports of maladaptive consequences of internet use seemed to

confirm critics' suspicions that communication in the virtual world was impoverished relative to face-to-face interactions and therefore led to loneliness and depression in its users. For example, a longitudinal study by Kraut and colleagues (1998) demonstrated that social connections and well-being of adolescents decreased after they started using the internet. Later research, in contrast, has found predominantly positive effects of internet use (for reviews, see Bargh & McKenna, 2004; Valkenburg & Peter, 2009). For example, Kraut and colleagues (2002) reported that the negative effects in their original sample had dissipated and that new users of the internet actually showed somewhat superior adjustment. It seems that this discrepancy was caused by state of dissemination of the internet: in the early days, not many people had internet access so online users interacted primarily with strangers, whereas nowadays many people in developed countries have internet access and use it to interact with existing peers, which has been found to be associated with increases in relationship quality and well-being (Blais, Craig, Pepler, & Connolly, 2008; Valkenburg & Peter, 2009).

One of the mechanisms that may be responsible for the positive associations between internet communication within existing friendships is self-disclosure. Several studies have shown that people tend to disclose more information online than offline, because they feel relatively more secure and protected by the anonymity (Valkenburg & Peter, 2009; Williams, Caplan, & Xiong, 2007; Zur, Williams, Lehavot, & Knapp, 2009; of course, this increase in anonymity may also result in the expression of negative affect, as is the case in cyberbullying; Patchin & Hinduja, 2006). Particularly shy and inhibited youths tend to disclose more online than offline, and experience online communication as a way to compensate for their lacking social capacities offline (Selfhout, Branje, Ter Bogt, Delsing, & Meeus, 2009; Valkenburg & Peter, 2009). The facilitation of self-disclosure in internet communication has also been found to be associated with increases in friendship quality in adolescents, which in turn predicts increases in well-being and adjustment (Valkenburg & Peter, 2009).

Recent findings (Frijns, Keijsers, Branje, & Meeus, 2009; Kerr & Stattin, 2000) show that adolescents' disclosure also has a specific role in the development of delinquency: adolescents' own disclosure regarding their delinquent activities to their parents, and not parental behaviors such as monitoring and soliciting for information, predict decreases in delinquency. Thus, because internet communication may trigger more disclosure, and disclosure may play a crucial role in prevention of delinquent behaviors, examining online disclosure may present new insights into the development of delinquent behaviors.

General conclusion

In the current article, we reviewed current web-based research, including its possibilities, potential limitations, requirements and challenges. In doing so, we have not only focused on translations of "traditional" research methods using a web-based format, but also on the psychological correlates of using the internet. We now end with some final conclusions regarding this way of doing research.

First of all, we firmly believe that the rise of web-based research is unstoppable and will only consolidate in future years, due to technological improvements and increased acceptance of corresponding methods. We believe that the popularity of web-based research is warranted, as it provides a cost- and time-efficient way to stimulate

participants to disclose more personality information and contribute information on a daily basis, and allows researchers to add interactive components to their studies. Such studies will become more flexible and advanced as the technology necessary to implement web-based studies becomes more and more accessible to researchers. One specific example of such more advanced designs is the implementation of online diary studies, which can be used to collect data about participants' daily fluctuations of thought, affect and behavior.

Second, however, if this growth is not carefully checked and canalized, online researchers risk discrediting this highly useful research tool in the eyes of both participants and colleagues. Therefore, we believe that the IRBs of universities should publish clear recommendations regarding the conduct of web-based research, incorporating the suggestions regarding privacy issues that were discussed in the current article. Such issues can be quite thorny, as there are always trade-offs between participants' desires to stay anonymous and researchers' needs to collect information. We encourage researchers to take a careful, case-by-case approach in dealing with these issues and refer them to the excellent discussion by McKee and Porter (2008), who emphasize some general principles and questions that should guide the conduct of ethical research.

Third and finally, web-based research offers unique possibilities for developmental science. This is partly because the internet is a new phenomenon, with younger individuals traditionally being among the first to embrace a new technology. This early adoption has initially given rise to a kind of generational "digital divide," but as the acceptance of online technologies is spreading across age groups, we predict that qualitative differences in the internet use across different developmental periods will increasingly become the focus of research. For example, the anonymous nature of the internet, combined with the existence of social networking tools, seems especially attractive during adolescence and emerging adulthood, with their emphasis on peer acceptance and identity development. As research accumulates, however, the need for theoretical models becomes more and more transparent in order to integrate isolated research findings. With the aid of such models, we are confident that web-based research will provide a vital tool to enrich and boost research in developmental psychology.

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