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Computer Assisted Self-Interviewing Tailored for Special Populations and Topics

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Abstract:
Self-administered questionnaires have many advantages, especially when sensitive questions are asked. However, paper self-administered questionnaires have a serious drawback: only relatively simple questionnaires can be used. Computer Assisted Self-Interviewing (CASI) can overcome these problems, and make it possible to use very complex self-administered questionnaires.

CASI can take several forms, for instance, it can be a part of a personal (CAPI) interview where the interviewer hands over the computer to the respondent for specific questions. Another form is a computerized version of the mail survey: Disk-by-Mail. We have used both forms in an application for very special populations (primary school children, visually impaired young adults, and parents and children from multi problem families, in which professional guidance for the family was sought).

This paper provides an introduction to computer assisted self-interviewing (CASI) and reviews the advantages and disadvantages of CASI with special attention to data quality. We discus the advantages of CASI when investigating special groups and topics and provide general advice on how to tailor standard CASI procedures for surveys of special groups.

Key words: sensitive questions, special groups, disk by mail, self-administered questionnaire, self-interviewing , CASI, ACASI

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Traditionally, when surveying special or sensitive topics, researchers use self-administered questionnaires (SAQs), either as a mail survey or as a paper questionnaire that is handed over by an interviewer and filled in by the respondent in private, without direct participation of the interviewer. After completion the respondent can seal the questionnaire in an envelope and mail it back or return it to the interviewer. Self-administered questionnaires have the advantage that they evoke a greater sense of privacy and lead to more openness and self-disclosure (Sudman & Bradburn, 1974; Tourangeau & Smith, 1996). Empirical research has shown that paper self-administered questionnaires compared to interviews produce more valid reports of sensitive behavior and less social desirable answers in general (e.g., Aquilino, 1994; Hochstim, 1967; Siemiatycki, 1979; Turner, Lessler & Devore, 1992; for a comprehensive review see De Leeuw, 1992; for an introduction into research on sensitive topics, see Lee, 1993).

In self-administered procedures the respondent is the 'locus of control', who determines the pacing of the question and answer sequence. When filling in a questionnaire, the respondent is in control and may decide to pause, reread a question, or think about an answer. The usually more leisurely pace of the self-administered procedure gives the respondent more time to understand the meaning of the question, and retrieve and compose an answer, which improves the quality of answers (Schwarz, Strack, Hippler & Bishop, 1991). This is especially important when surveying special populations, such as children, adolescents or elderly who need extra attention and time (De Leeuw & Collins, 1997). If mail surveys are used, which are a special form of self-administered questionnaire, additional advantages are low costs and minimum resource requirements (Dillman, 1978). Of course, questionnaires that are handed over during an individual face-to-face interview will be as costly as the interview, but substantial cost savings can be made when questionnaires are given to a larger group of people simultaneously, such as school classes, hospitals, or HIV testing centers (Catania, Gibson, Chitwood, & Coates, 1990).

A serious drawback of paper self-administered questionnaires is that only relatively simple questionnaires can be used (Dillman, 1978, 2000). Complicated skip and branch patterns or adjustments of the order in which the questions are posed, threaten both the data quality and the motivation of the respondent to complete the questionnaire. Examples of complex questionnaires are for instance health survey questionnaires, which use many contingent questions that instruct the respondent to skip questions or branch to a specific section of the questionnaire depending on a previous answer. Even well-educated respondents may have trouble following the instructions for navigating through such a questionnaire. Complex paper self-administered questionnaires, with many skippings and branchings, negatively influence the survey quality in two ways. The length and complex structure enhance the perceived response burden and will lead to more explicit refusals to cooperate. When a respondent is willing to answer the questionnaire, the complexity increases the cognitive burden of the respondent, putting more strain on the question-answer process, which will negatively influence data quality (Schwarz, Strack, Hippler, & Bishop, 1991; Tourangeau & Smith, 1996).

Computer assisted survey techniques overcome these problems and make it possible to use very complex questionnaires without the aid of an interviewer, which is a vast advantage when studying sensitive topics. In computer applications for self-administered questionnaires, the interview program takes over and handles the questionnaire logic and question flow. Respondents read each question from the screen, type in an answer, and are no longer burdened with complex routing instructions for navigating through the questionnaire. Studies comparing computer-assisted self-administered questionnaires with paper self-administered questionnaires concluded that in general data quality was higher because fewer errors are made when completing the questionnaire (De Leeuw & Nicholls, 1996; Nicholls, Baker, & Martin, 1997).

A standard self-administered questionnaire, be it on paper or via a computer, requires that

respondents have adequate reading skills. A recent innovation that solves this problem is audio-computer assisted self interviewing. This application uses the more advanced technology of multi-media computers: respondents view the question on the screen while at the same time they listen with headphones to a recorded version of the question stored in the computer (Turner, Forsyth, O'Reilly, Cooley, Smith, Rogers & Miller, 1998).

Because of the confidential nature and flexibility, computer assisted self-administered survey methods are especially suited for special population surveys and for surveys on sensitive topics. In this paper we give a general introduction to computer assisted self-administered surveys, describe advantages and disadvantages, review empirical findings, and provide advice on how to use this technology including examples from our experience with special populations. We end with a short section on software and give suggested readings.

COMPUTER ASSISTED SELF ADMINISTERED QUESTIONNAIRES: TYPOLOGY AND DEFINITIONS

In survey research, computer assisted forms of data collection are rapidly replacing paper-and-pencil methods in the USA and Europe. Computer assisted methods in general are often summarized under the global terms CADAC (**C**omputer **A**ssisted **DA**ta **C**ollection) or CASIC (**C**omputer **A**ssisted **S**urvey **I**nformation **C**ollection); in this context the traditional paper methods are often denoted by PAPI (**P**aper **A**nd **P**encil **I**nterviewing). The computer assisted forms of telephone interviewing (CATI) and face-to-face or personal interviewing (CAPI) are well known and hardly need an introduction (for an overview, see De Leeuw & Nicholls, 1996; Nicholls, Baker & Martin, 1997). Computer assisted self-administered questionnaires are less widespread, but as computer use keeps growing, computer assisted questionnaires have a promising future. The acronyms CASI (**C**omputer **A**ssisted **S**elf **I**nterviewing) and CSAQ (**C**omputerized **S**elf **A**dministered **Q**uestionnaire) are used to indicate self-administered forms of data collection using computers in general (Couper & Nicholls, 1998).

Computerized self-administered data collection takes many forms. The oldest is the electronic questionnaire or electronic test, which is used in the medical and psychological sciences (Weisband & Kiesler, 1996). In survey research, a computer assisted self administered questionnaire is frequently used during a face-to face (CAPI) interview on sensitive topics, when the interviewer hands over the computer to the respondent for a short period, but remains available for instructions and assistance. This is the most common use of CASI and is equivalent to the traditional procedure where an interviewer might give a paper questionnaire to a respondent to fill in privately. A promising variant of this method is Audio-CASI or A-CASI, where the respondent listens to the questions read by a computer-controlled digitized voice over a headset, and at the same time views the question on the computer screen. This overcomes literacy problems with special populations and guarantees the privacy of the respondent (Turner et al, 1998; Johnston & Walton, 1995).

In health studies on sensitive topics, such as alcohol and drug use, sexual behavior, HIV, computer assisted self-interviews are often administered at a central site outside the home of the respondent (e.g., in a clinic, a health center, a mobile van). Even in very disadvantaged populations this technology can be used with some adaptations, as has been shown by Thornberry, Bhaskar, Krulewitch,Wesley, Hubbard, Das, Foudin & Adamson (2002). In their study they combined audio and touch screen technologies in computer assisted self-interviews of young, low educated, pregnant women. The computer administered the recorded questions via headphones and at the same time displayed them on the screen. The response choices were

highlighted on the screen when heard on the headphones and the respondents answered by touching the response of their choice on the computer screen.

For the traditional mail survey, computer assisted equivalents have also been developed. Disk-by-Mail is now used on a regular basis, and methodological knowledge on how to implement a successful Disk-by-Mail survey is available (e.g., Ramos, Sedivi, & Sweet, 1998; Saltzman, 1993; Witt & Bernstein, 1992; Van Hattum & De Leeuw, 1999). In a Disk-by-Mail survey (DBM) a disk containing the questionnaire and a self-starting interview program is mailed to the respondent via the postal service. The respondent runs the program on his or her own computer and returns the diskette containing the completed questionnaire. Electronic mail surveys (EMS) or internet/web surveys differ from DBM because respondents receive the request and return the data electronically, either by e-mail or via a web-page. This field is still very much in development. At present electronic mail surveys are only possible with special populations who have internet access, but the limited experience is so far positive (Clayton & Werking, 1998; Schaefer & Dillman, 1998; Couper, 2000, Dillman, 2000). Especially in establishment surveys EMS-techniques are gaining popularity (De Leeuw, Nicholls, Andrews, & Mesenbourg, 2000).

A way to overcome the limited computer access of special groups is to bring a computer to the respondent. This may involve bringing computers to a household, or an establishment, or to a special site like a school or hospital (we will discuss some examples in section 5). A special application of this is computer assisted panel research, in which a panel of households is selected and computers and communication equipment are provided by the research institute. Surveys are then sent electronically to the household members on a regular basis, and after completion are sent back automatically. This approach proved successful for consumer panels in the Netherlands and is being implemented in other countries like the USA (Saris, 1998).

ADVANTAGES AND DISADVANTAGES: A REVIEW OF THE LITERATURE ON DATA QUALITY AND COST

One of the main reasons that computer assisted data collection has become popular so quickly was the general expectation that it would improve data quality and efficiency and reduce costs. This could be attributed to technological possibilities, psychological processes, and logistic changes in survey procedures affecting timeliness and costs.

Prevention of errors and data quality

Data quality in computer assisted surveys may be improved by technological factors. In an optimally implemented computer assisted self-interview many errors may be prevented. Compared to an optimally implemented paper-and-pencil interview, the optimally implemented computer assisted interview has three apparent advantages.

(1) There are no routing errors. Based on previously given answers the program decides what the next question must be and guides the respondent through the questionnaire. Missing data because of routing and skipping errors does not occur.

(2) Data can be checked without delay. A well-implemented data collection program performs some internal validity checks. Simple checks are range checks that compare the given response to the range of possible responses. Thus the program refuses the response '4' when only three response categories are possible. More complicated are consistency checks that analyze the internal consistency of several responses. Here, the researcher must anticipate all valid responses

to questions, list possible inconsistencies, and devise a strategy for the program to cope with them. In a paper-and-pencil study, internal validity checks are conducted at the data cleaning stage after the data collection stage, and inconsistencies are then usually recoded to a missing data code because it is no longer possible to ask respondents what they really meant. In a computer-assisted interview there is an opportunity to rephrase the question and correct range and consistency errors. This should lead to fewer data entry errors and missing data.

(3) The computer offers new possibilities to formulate questions. One example is the possibility to randomize the order of questions within a scale, giving each respondent a unique question order. This eliminates systematic question order effects. Response categories can also be randomized, which avoids question format effects. The computer can also assist in the interactive field-coding of open questions using elaborate coding schemes, which would be unmanageable without a computer.

When we look at the empirical evidence, we see that the technological possibilities of CASI have indeed a positive influence on data quality. Item nonresponse is minimized by computer controlled routing and by checking whether an answer or a 'do-not-know' is entered before proceeding to the next question. A consistent finding in the literature is that item-nonresponse caused by respondent errors is virtually eliminated, but that there is little reduction in rates of explicit 'do-not-know' and 'no-opinion' answers (Nicholls, Baker & Martin, 1997). Computer Assisted Self Administered Questionnaires (CSAQ) and Computer Assisted Self Interviewing (CASI) make it possible to use very complex questionnaires without the aid of an interviewer. But also in standard, less complex self-administered questionnaires, CASI reduces item nonresponse considerably (Ramos, et al, 1998; Van Hattum & De Leeuw, 1999; Kwak & Radler, 2002; Schaeffer & Dillman, 1998). Finally, a small number of studies have explicitly compared respondent entry errors in computerized versus paper and pen questionnaires. Fewer respondent errors are reported in CASI than in paper and pen self-administered questionnaires. For an overview, see Nicholls et al (1997).

Psychological processes and data quality

The visible presence of a computer may affect data quality, apart from the technical aspects of using a computer. As with most technological innovations part is a ‘novelty’ effect. After some time, one gets used to the new machine, and its influence on the situation diminishes. Compared to traditional paper and pencil methods, the presence of a computer could lead to the following effects (positive and negative) on how the whole data collection procedure is perceived.

(1) Reinforcing. It is new and has a high attention value. People notice it and react to it. For instance, a Disk-by-mail survey will be noticed more quickly and positively between all ‘junk’ mail, than a standard paper questionnaire. This effect will decrease over time, when people get used to the new technique.

(2) Less privacy. When one is unfamiliar with computers there could be a 'big brother' effect, leading to more refusals and socially desirable answers to sensitive questions. When researchers first started to use computer assisted data collection, this was a much feared effect.

(3) More privacy. Using a computer could also lead to the expectancy of greater privacy by the respondents; responses are typed directly into the computer and cannot be read by anyone who happens to find the questionnaire. Much depends here on the total interview situation and how the survey is implemented.

Empirical research on respondents' reactions shows that respondents generally appreciate the various forms of computer assisted self-administered questionnaires; they evaluate it positively, find it interesting, easy to use, and amusing (Zandan & Frost, 1989; Witt & Bernstein, 1992; Ramos et al, 1998). Beckenbach (1995) reports that more than 80% of the respondents had no problem at all using the computer and the interviewing program, and that only very few respondents complained about physical problems such as eyestrain. Furthermore, respondents tend to underestimate the time spent answering a computer-assisted questionnaire (Higgins, Dimnik & Greenwood, 1987).

The generally positive appreciation of CASI also shows in the relatively high response rate with Disk by Mail (DBM) surveys. DBM response rates vary between 25% and 70%, and it is not unusual to have response ratio's of 40 to 50 percent without using any reminders (Saltzman, 1993). If DBM is typically used with a special population interested in the research topic, a comparable, well conducted paper mail survey using no reminders may be expected to yield about 35% response (Dillman, 1978; Heberlein & Baumgartner, 1978). The high response rates may be partly caused by the novelty value of DBM in the early studies. It should be noted that Ramos et al (1998) found no evidence for higher response rates in DBM in academic and government surveys in the USA.

When e-mail and web surveys are compared to traditional paper mail surveys, one sees the opposite pattern; paper mail surveys have in general a higher response rate than an equivalent web or e-mail survey (Kwak & Radler, 2002; Couper, Blair & Triplett, 1999; Schaeffer & Dillamn, 1998). Perhaps the novelty value is wearing off, as electronic junk mail is rapidly increasing. Also, one mouse-click is enough to through away anything unwanted or uninteresting, making it easier to ignore a web survey than a Disk By Mail survey.

As respondents are generally positive about CASI, we expect that respondents will experience a higher degree of privacy and anonymity, which should lead to more self-disclosure and less social desirability bias. Several studies showed more self-disclosure on sensitive topics (e.g., abortion, male-male sexual contact) when using CASI (cf. Turner, et al., 1998; Tourangeau & Smith, 1998). There is some evidence that the use of Audio-CASI shows the same effect (Turner et al., 1998; O'Reilly,et al., 1994). Weisband and Kiesler (1996)carried out a meta-analysis on 39 comparative studies and report a significant effect in favor of computer forms. This effect was stronger for comparisons between CASI and face-to-face interviews, but even when CASI was compared with self-administered paper-and-pencil questionnaires, self-disclosure was slightly higher in the computer condition. The effect reported was larger when information that is more sensitive was asked. Weisband and Kiesler (1996) also report the interesting finding that the advantage of CASI has been diminishing over the years, but it did not disappear totally, They attribute this to a growing familiarity with computers among the general public. Richman, Kiesler, Weisband & Drasgow (1999) partly corroborated these findings. They found clear effects of less social desirability distortion on computerized forms compared with face-to-face interviews. When computerized forms were compared to paper self-administered questionnaires no consistent effects were found; much depended on the questionnaire and on other variables, such as whether the respondent was alone when completing the questionnaire. The interview situation and the perceived privacy seem to be more important than the use of the computer as such.

The effect of computerization on the quality of the data in self-administered questionnaires has also been a concern in psychological testing. In general, no differences between computer assisted and paper-and-pencil tests were found in test reliability and validity (Harrel & Lombardo, 1984; Parks, Mead & Johnson, 1985). This is confirmed by a meta-analysis of 29 studies comparing conventional and computerized cognitive tests (Mead &

Drasgow, 1993). There are some indications that time pressure interacts negatively with the perceptual and motor skills necessary for reading questions from a screen and typing in answers correctly. Respondents, especially when they are a special or 'difficult' group should never be put under time pressure.

Logistic factors and data quality

Going from paper-and-pencil to computer assisted interviewing asks for an initial investment, not only in equipment, but also in time. One must invest in hardware, software and in acquiring hardware- and software-related knowledge and skills. In addition, constructing, programming, and checking a computer assisted questionnaire takes considerable time. One the other hand, no questionnaires have to be printed and there is no separate data entry phase. Thus, no extra errors are added during data entry, and the first tabled results can be available soon after the data collection phase. Thus, a well-planned computer-assisted survey has a real advantage when the results must be quickly available right after data collection (as in election forecasts).

After the initial investments are made, a computer-assisted survey may be less costly and quicker than traditional data collection, but it all depends on the study: its complexity, its size, and its questionnaire. To evaluate the cost efficiency and timeliness of a computer assisted survey, a distinction should be made between front-end processing and back-end processing. In general, front-end processing (i.e., developing, implementing, testing the questionnaire) takes more time and is therefore more expensive. On the other hand, no data-entry is needed and data editing and data cleaning take less time; back-end processing is faster and less expensive. In general, there is no difference in the total time needed for the research. But once data collection has started, results are available much faster than in traditional paper-and-pencil interviewing (Kwak & Radler, 2002; Couper, 2000; Schaeffer & Dillman, 1998). Samuels (1994) mentions a reduction of delivery time of 50% for the results of an omnibus survey. When timeliness and a fast release of results are important for a client, this is an important advantage of computer-assisted data collection over paper-and-pencil methods (Nicholls & De Leeuw, 1996).

Computer assisted self-administered questionnaires and Disk-by-Mail and internet surveys have the advantage that no interviewers are needed, so in comparison with survey procedures that do need interviewers, such as CATI and CAPI, they save costs. This is one of the main reasons why Baker (1998) predicts a decline of interviewing and a rise of computer assisted self-administered methods. When one compares computer assisted self administered procedures with the traditional paper mail survey, cost savings are not so obvious. As with all forms of computer assisted data collection, the extra investment in programming the questionnaire and debugging only pays off for large surveys where printing and editing of a paper questionnaire would make the paper form more costly (Ramos, et al, 1998). In Disk-by-Mail, the mailing costs include a special protective envelope. Also, a disk is heavier than a short paper questionnaire, which makes DBM in generally somewhat more costly than paper mail questionnaires (Saltzman, 1992). However, when large numbers of longer questionnaires have to be mailed, DBM can be a real cost saver. Van Hattum and De Leeuw (1999) systematically compare the costs for a DBM and a paper mail survey of 6000 pupils in primary schools. They conclude that the average cost for a completed questionnaire is 1.01 US dollars for their Disk-by-Mail survey and 3.22 US dollars for their paper-and-pen mail survey.

E-mail and web surveys are reported to reduce research costs in the USA, where transmission costs (telephone/modem connect time) are practically zero (Kwak & Radler, 2002; Clayton and Werking ,1998). However, unlike the USA, in most European countries local

telephone calls are not free and have a rate per minute. This slightly increases the costs for the researcher, but may considerably increase the costs (connect time both receiving and sending) for the potential respondent. To ensure high response rates, one should find ways to reduce respondent costs comparable to prepaid return postage in mail surveys, or reimburse costs of respondents. This will increase the costs of web surveys in Europe compared to the USA.

Summing up: Empirical comparisons between paper-and-pencil and computer assisted self-administered questionnaires point to less item-nonresponse and slightly more self-disclosure in the computer assisted form. Furthermore, eliminating interviewers saves costs. When large surveys are done, a computer assisted self-administered survey is less costly than a standard paper mail survey.

ADAPTING COMPUTER ASSISTED INTERVIEWING TO SPECIAL GROUPS

Computer assisted data collection methods improve data quality, and are widely used in general surveys. Because of its flexibility and facility to ask complex research questions (Sikkel, 1998), it is an attractive method for surveying special groups. However, for a successful survey of special groups, adaptations have to be systematically incorporated in the standard current best methods of computer assisted data collection (De Leeuw & Collins, 1997).

The main points for adaptation are: optimize the *design* by pre-analysis of the goal of study, the group to be surveyed, and the logistics, follow this up by using the full potential of computer assisted data collection to optimize the *questionnaire* and procedures, then check the total design by *pretests* of questionnaire, implementation, and procedures, and finally build in *repairs* for the rare cases that errors will occur. One should always aim to anticipate problems and have a repair mechanism available. We want to stress that all this can be implemented using existing, flexible software. In the case studies discussed in section 5, we will give examples of how we used these principles in surveys of special groups.

Optimizing the design.

The essential first step is a systematic analysis of the group to be surveyed and of the research problem. What do we want from this special survey? What makes the research question special? Why is the group under study special? To answer these questions for a computer assisted self administered survey, one has to consider the following points: (1) how well are the cognitive skills of the respondent developed, for instance, consider the different developmental stages in children or the potential for reduced mental capacity in elderly; (2) which channel capacities can be used during data collection, for instance, can one use visual stimuli or only audio, as in the case of visually impaired respondents; (3) what are acceptable social customs for the group under study; (4) are there potential hazards to eye-hand coordination, could one use a keyboard or mouse or should one use a touch screen or special equipment, for instance, for hospital patients, or handicapped; (5) how used are the potential respondents to computers, how computer literate are they; (6) is there easy access to computers, either the respondents' own or a company or school computer; (7) if not, how easy is it to provide respondents with a computer on a temporary basis, for example having a computer delivered to a key contact at a hospital (consider of the risk of theft); and (8) are there key persons or contacts available to introduce the survey, for instance a teacher in school surveys, a social worker in a health center.

Using CAI-potential fully

The strength of computer assisted data collection is that intelligence can be built into the program. A complex questionnaire, for instance a questionnaire with checks of answers, complicated branchings, and randomization of response categories, can be used safely in a self-administered situation, since the computer program takes care of the complex navigation through the questionnaire. Nevertheless, it remains important that to the respondent the questionnaire appears to be logical and simple. The magic words are '*appear*' and ''*to the respondent*'. What the respondent sees on the screen should be simple, while what happens in the program may be complex! To achieve this goal sophisticated questionnaire design, as described by among others Fowler (1995), and Dillman (2000), should be combined with the flexibility of computer assisted interview programs (see also Sikkel, 1998).

In constructing a computer assisted survey for special groups one must keep in mind that: (1) the questionnaire should be experienced as simple, short, and structured, to compensate for potentially lesser cognitive skills and smaller channel capacity; (2) the point of reference is always the respondent, what is simple and logical for the respondent is not necessarily logical or easy for the program designer; (3) the questions should be grouped in a logical order, in blocks of questions that use the same question format as far as possible; (3) as texts are harder to read on a monitor than on paper, ergonomical text presentation and careful screen design is very important; (4) as perceptual and motor skills necessary for responding to a computer assisted questionnaire are more complicated and take somewhat more time than those necessary for paper-and-pen tests, one should avoid any suggestion of time pressure, especially with inexperienced users. If eye-hand coordination is expected to be sub-optimal, one should allow for extra time, but (5) in all cases simple keystroke combinations must be used for answering.

Finally, the full power of computer assisted data collection should be used. Therefore, everything a system can do to minimize respondent burden, it should do. For instance, starting the questionnaire, making back-ups, keeping administrative records, stopping and resuming at the right point should be automatic. In the case studies in section 5 we discuss this further.

Pretest and check

Often there is not enough time and/or money for extensive pretests and a full pilot study. However, this is not an excuse for omitting pre-testing altogether. Carefully planned, small-scale pretests can be implemented at relatively low costs. As a start, dry runs without any real respondents can be done in-house to check the programming. This can be followed by qualitative interviews with a small number of real respondents in order to detect errors in the questionnaire. In this type of interview respondents are explicitly asked to point out what they do not understand, or what is strange in the formulation of questions or not handy or ergonomical in the computer setup. Observation of a respondent, in combination with in depth interviewing after the performance is a good method for testing the implementation.

A full scale pretest program involves three steps. First of all, one has to pretest the questionnaire itself. The issue here is whether the respondent understands the meaning of the question, the meaning of terms used, and the response categories. This type of pretest can be done early in the research process with a paper version of the questionnaire. In this type of pretest, a small focus group or a limited number (5-7) of depth-interviews are used with carefully selected persons, who resemble the intended respondents on important background characteristics (cf. Forsyth & Lessler, 1991; Fowler, 1995; Snijkers, 2002). The second step consists of pretests of routings in the questionnaire and the computer implementation (e.g.,

starting-up, making back-ups). For these technical pretests no respondents are necessary; these tests can be done by the researchers and/or programmers in-house (e.g., Kinsey & Jewell, 1998). The third step is a usability test of the final product (e.g., Dumas & Redish, 1994). Important in this usability test is to have some naive respondents try out the computer assisted questionnaire in a 'real life' situation. to test the user-friendliness of system, the screen layout, and if applicable the use of special keys touch screen, etc. Full pretesting requires an extra investment in terms of time, effort, and money in the beginning (front-end processing), but part of this is regained at the end of the research (back-end processing, such as data editing and data analysis).

Build in repairs

Even in the best-tested questionnaires something can go wrong. To quote Murphy's law: "if something can go wrong, it will, and at the worst possible moment." Therefore, help-options are extremely important. There is a range of possibilities from a simple help-message on the screen to a specialized helper on site.
When the questionnaire is programmed, the researcher should give clear instructions on extra information or help texts that will be used. For instance, internal checks on 'out-of-range' answers and consistency checks are almost automatically employed in a computer assisted questionnaire. If an error is detected, this should be followed by a clear message on the screen, and an opportunity for the respondent to give a different response.
When an error occurs, or the respondent realizes that the answer just given is incorrect, inexperienced respondents often do not know what to do and may stop. Built-in help functions are usually then not enough, as they may confuse the flustered respondent even more. Therefore, always have a short list on paper with instructions and essential information, such as what to do if one typed in the wrong answer and how to go back to a previous question. Print this information on lightly colored paper, slightly heavier than normal, and use a large character type without serif (e.g. Helvetica 20).
Sometimes a real life person is needed to help-out. Have a help-desk available or use informed key-persons in the vicinity as help. Make sure that 'first-aid' disks are available with a complete back up of the questionnaire and the system requirements, either with the key-persons or at the help-desk ready to be mailed out immediately.

CASE STUDIES

Case 1: A Disk by Mail Survey of pupils in primary schools[1]

In Spring 1995 a Disk By Mail survey was implemented in 106 primary schools that formed a random sample of primary schools, scattered all over the Netherlands (Van Hattum,& De Leeuw 1999). The respondents were 6428 pupils, aged 8-12; the topic of the questionnaire was bullying. The questionnaire of 99 questions contained questions on attitudes regarding bullying, handling of bullying by teachers and parents, and actual bullying, either as a victim or as an active culprit.

Traditionally this type of research is done with group administration of paper self-administered questionnaires in the classroom. Analysis of the *research problem and group* to be studied made us opt for computer assisted self-interviewing. Pupils are in general reluctant to talk about bullying, even to their parents or teachers, and consequently we sought after a procedure to enhance feelings of privacy, to reduce the influence of close proximity of classmates, and to create a more informal, relaxed mood (cf. Scott, 1997). The pupils were

young, and to keep them motivated to complete the questionnaire it was important that the questionnaire *appeared* simple and attractive. An additional point was that printing and mailing such a large number of questionnaires is costly. We were in the fortunate circumstance that, thanks to a large government sponsored project to improve computer literacy among the young, in 1995 all primary schools in the Netherlands were equipped with personal computers of the same type, and teachers received a basic knowledge of computer technology. Therefore, the basic requirements for a successful Disk By Mail were met (Witt & Bernstein, 1992): all pupils had *easy access* to computers and knowledgeable teachers were available as *key-contacts.*

Logistics DBM

A Disk by Mail version of the questionnaire was developed using the CI3-program (Sawtooth, 1994). We used the full *potential* then available in computer assisted interviewing, so range checks were defined for all questions, and questions were randomized within blocks of related questions. A special code was defined for 'do-not-know', which did not appear on the screen, but was explained to the pupils in a separate instruction. Special attention was given to a simple but attractive screen lay-out. Only simple key-strokes were used to answer the questions. To accommodate the needs of this special population, the possibility was created for a temporary stop when a child was tired or when the teacher needed a pupil. The pupil could resume answering the questionnaire at a more convenient time.

The questionnaire implementation was thoroughly *pretested,* and a paper version of the questionnaires was available as back up. Six schools used this paper version; the main reason was that those schools were extremely large and that it would take the teachers too much time to have their pupils take the individual computer questionnaire.

A small package was sent to the teachers of the participating schools, consisting of two or more disks (depending on the number of computers), three short printed instructions and an accompanying letter. To make the procedure as simple as possible for the teachers, the disk contained automated batch-files for installing the interview programs. Other batch files were used to automate the tasks of starting the questionnaires, pausing and resuming, saving the data, and making back-ups. Two of the printed instructions were for the teacher: the first gave instructions on how to start up the children's questionnaire; the second gave instructions to start up a special teacher's questionnaire. The third instruction, a yellow card with eight points in large letters, was developed for the pupils. This instruction was simple and to the point and was always kept next to the computer, so pupils could refer to it whenever they felt the need. Main points in the instruction were the use of <enter> and <back space>, and an explanation of the 'beep' used to indicate that a child gave an out of range answer or used <enter> without giving an answer. The instruction also stated that they were allowed to type in '9' if they *really* could not give an answer to a specific question.

The teacher installed the questionnaire and allocated pupils to answer the questionnaire individually on the computer; so the teachers acted as helpers and key persons. To keep the pupils motivated they got positive feedback by the system at regular intervals (e.g., 'you are doing fine', 'great, thank you').

A telephone help desk was available for the entire data collection period, and people were stand-by to go to a school with problems if necessary. Several university laptops were available as back up if hardware problems occurred occur or if large schools needed an additional computer for. Only one school asked for on-site personal assistance because they were worried if they could do the 'computer things'.

Acceptance, Data quality, & Costs

We investigated the acceptance of the method, the data quality, and the costs involved. At the end of the data collection period the participating teachers received a personalized report based on the results of own their class, and they were asked to complete a short evaluation questionnaire. The teachers were very positive, even older teachers and teachers with limited computer experience. The children, even the youngest, also liked the procedure. The teachers reported only few problems. These problems were mainly general reading or language problems, not technical ones concerning the computer or keyboard.

We could also compare the results of the computer-questionnaire in 245 classes (5,872 pupils) with those of the paper-and-pen questionnaires that were used in a limited group of very large schools (18 classes, 556 pupils). The classes were comparable with respect to their teacher characteristics (e.g., teaching experience, education, and class level). The paper condition had a far higher percentage of question *missing values* (p=0.00). In the computer-condition the mean of the percentage missing values was 5.7 while in the paper and pen-condition the mean of the percentage missing values was 14.1. A very interesting result is that the corresponding standard deviations also differed strongly between the groups. In the computer-condition, the standard deviation was 3.4; in the paper-and pen-condition, the standard deviation was 25.0. These results suggest that not only the average amount of missing data is less in computer assisted data collection, but also that the individual variability, indicated by the standard deviation, is less. This may be attributed to the fact that with a paper questionnaire children, who are not very concentrated or who are careless, can easily skip a question or even a whole page by mistake. The computer forces children to be more precise by preventing skipping mistakes, and at the same time keeps the children motivated by giving positive feedback.

The main pupil's questionnaire also contained a short test for the tendency to give *socially desirable answers.* A high score on this nine-item test indicates that a child has the tendency to give honest, socially undesirable answers. There was a significant difference between the two conditions (p= .00). Children in the computer-condition gave slightly more undesirable answers (mean= 30.6) than children in the paper-and-pen-condition (mean= 29.9). The standard deviations did not differ between conditions.

Regarding *openness* and *self-disclosure,* we looked at the answers on both the bullying test and the victimization test. Children in the computer-condition reported that they were actively involved in more bullying than children in the paper-condition (p= .00). The mean score for the computer-condition was 30.5, while the mean score in the paper-condition was 27.7. In the computer-condition, also more victimization was reported (p= .00). The mean score on the victimization test was 26.4 for the computer-questionnaire and 23.1 for the paper questionnaire. Again, standard deviations did not differ between conditions.

Besides data quality, *costs* are an important factor. Cost comparisons are always difficult, because they depend strongly on the organization one works in. To present a reasonable comparison we calculated the costs we made, and compared this with the costs we would have made if we had done the same survey by paper-and-pen. The costs of sampling, of developing the questionnaire, and of keeping account of the returned questionnaires are not taken into account; these would have been approximately the same in both cases. In the computerized Disk By Mail-case, we included costs for acquiring the CI3-program, for computer disks, programming, staffing the help-desk and mailing. For the paper equivalent, we included printing and mailing costs using the cheapest mailing procedures. We also included the costs for data entry and coding. For the Disk By Mail -procedure the total costs were $1.01 for each completed questionnaire, in a paper mail survey this would have been about $ 3.22.

Summing up, this case shows that:

1). A Disk-by-Mail survey can be successfully implemented in Dutch primary schools.
2). Children from the age of 8 years on can successfully complete a computer assisted self-administered questionnaire, and enjoy it.
3). Even teachers with few computer skills can assist in carefully designed computerized surveys and enjoy it
4). Data quality in the computer-assisted group was better than in the paper and pencil group.
5). DBM results in fewer costs for each completed questionnaire compared to a paper mail survey.

Case 2: A mixed-mode CAPI and CASI survey of visually impaired and blind adolescents and young adults

The second challenge was a study of blind and visually impaired adolescents and young adults (aged 14-24). In total, 354 respondents scattered over the Netherlands had to be interviewed about their personal network, perceived social support, feelings of loneliness and self-esteem, well-being, and handicap-acceptation. This resulted in a complex questionnaire of more than 260 questions (Kef, 1999). Especially a number of questions on the ego-centered network were complex for interviewers to administer. For these questions, every important network member in specific domains (e.g., family, friends, neighbors) had to be enumerated. This was followed by questions on practical and emotional support for each listed network member. To ease the task of the interviewer and to minimize interviewer error, a computer-assisted procedure seemed appropriate. In CAPI (computer assisted personal interviewing) the interview program takes over and handles the complex questionnaire logic, which prevents interviewer errors, and has the additional advantage that the interviewer can concentrate on the special needs of the respondent and establishing rapport (De Leeuw, Hox & Snijkers, 1995).

The questions on self-esteem, well-being, and loneliness were judged to be sensitive and private. Analysis of the *research problem and group* led to the decision that a mixed-mode CAPI-CASI survey was the best choice, with special adaptations to accommodate the special needs of the blind and visually impaired respondents. For the sensitive questions, computer assisted self interviewing was used, while the other questions were asked by the interviewer using computer assisted personal interviewing, to ease the burden on the respondent.

Logistics

A computer version of the questionnaire was developed using CI3 (Sawtooth, 1994). We used the full potential of computer assisted interviewing for this complicated network questionnaire. So, lists of persons were programmed in a roster-routine with the network questions, and range checks were defined for most of the questions. In addition, additional instructions to the interviewers were programmed in to ease the interviewer burden, for instance, when to hand over the computer to the respondent for the CASI part of the survey. Some extra adaptations had to be programmed for the CASI-application. For instance, the limited channel capacity of visually impaired forced us to compensate for visual stimuli by using audio and paralinguistic cues, and Braille was used for keyboards and response cards.

We opted for a ‘manual’ Audio-CASI. At the time of our survey Audio-CASI equipment was still in the developmental stage (Johnston & Walton, 1995; O'Reilly et al, 1994), and standard software could not handle audio. We devised a procedure which used the interviewer. The interviewer handed over the computer to the visually impaired respondent, making clear by shifting audibly the chair that she could not see the screen or keyboard. The interviewer had the

text of the questions in writing and read them out aloud to the respondent, who typed in the answers. To synchronize the text of the question on the screen with the one the interviewer was reading, a series of 'beeps' was programmed to sound after a response was typed in by the respondent. The questions were all rating-scale type, and the respondent had to type in just one numerical key. For this Audio-CASI application, a special hardboard template was developed to cover the keyboard. In the template, the part for the numbers from 1 to 0 was cut out, since it was only necessary to use these keys. At the appropriate places above the keys, the hardboard template had both Braille and magnified numbers, enabling the respondents to use the keyboard themselves while answering.

To support the respondent's memory, we also developed paper flash cards with the response-categories used. There were three versions: one with Braille text, one with a very large magnification and one with little magnification.

The questionnaire and the procedure were *pre-tested* extensively, using qualitative pretests and a small-scale pilot study on blind and visually impaired adolescents. Interviewers attended a three-day interviewer course. Topics were standard interviewer training, handling the laptop, the contents of the questionnaire, an introduction in CAPI and CASI, and the structure of the computerized questionnaire. Very important issues in the interviewer training were the special adaptations in the interview and specific interviewer skills needed for our target population. The training included a visit to a special school for the visually impaired.

The questionnaire was implemented on the laptops of the interviewers, together with an automated system for making backups and a virus-scanner, automating as much as possible to reduce respondent and interviewer burden. Before the fieldwork started, each laptop was thoroughly tested, including the interview program and the back-up facilities. A disk-version of the questionnaire was available as stand-by, in case of emergencies. The stand-by version was implemented to run on adequately on a diversity of computers. If the interviewer laptop should break down, the respondents own personal computer could be used. Since a personal computer is a very important tool for visually handicapped persons, we could rely on the availability of the respondents computer. A paper field guide was prepared for the interviewers. It contained the text of the questions for the Audio-CASI part, a summary of basic interviewer rules, and a short manual summarizing the main computer commands and help with problems.

The fieldwork took five months. In this period, sixteen interviewers traveled all over the Netherlands, each approximately interviewing twenty respondents. An interview, including the self-administered part, took on average 90 minutes. During the fieldwork period, both laptops and software proved to be very robust. A field manager could be consulted by phone, even at odd hours in the evening and during the weekend, and acted as technical help-desk and general non-technical support (e.g., to keep up morale, and instruct interviewers in difficult situations).

Data quality

We did have two means to verify the acceptance of the methods used and the internal validity of the data: acceptance of the new method and general data quality. To investigate respondents' *acceptance* and to systematically list any problems that may have occurred during the data collection, we had structured interviewer-debriefing sessions. As the knowledge of interviewers and the information they possess on the past interviews is often rather diffuse and unstructured, we used concept mapping. This is a qualitative, highly structured method specially developed to extract diffuse information and quickly proceed from fuzzy knowledge to an acceptable conceptual framework (Trochim, 1989). In addition we analyzed the results of short evaluations by both respondents and interviewers, completed immediately after the finished interview.
The experiences of the blind and visually impaired adolescents were very positive. In the

Netherlands, almost all visually impaired young persons are very familiar with computers. Many respondents asked a large number of questions about the kind of laptop used and the reasons why we used a computer in this study. Our mixed-mode approach created interest and motivated the respondents. The computer assisted self-administered part (CASI) gave the respondents more privacy and offered more variation in the interview-situation, while the computer assisted face-to-face interview (CAPI) proved an efficient way to deal with the complex network questions. The interviewers substantiated that it was important to clearly verbally state that they were not looking at the screen during the CASI-part, thereby verbally compensating for the missing visual channel. The hardboard Braille template for the keyboard worked well and the respondents had no difficulties typing-in their answers. Some respondents pushed by accident some keys through the hardboard device. Since the questionnaire was programmed to check the responses and to accept only numerical input at this point, this created no problems.

The face-to-face interview (CAPI) and its adaptation to the special population did not give any problem, the special flashcards with response categories in Braille and large letter type worked extremely well. The interviewers mentioned that it was extremely important to verbalize every action. When interviewing visually impaired, only a limited channel capacity of communication is available (audio and touch). Interviewers had to heavily rely on verbal and paralinguistic communication (e.g., humming in stead of nodding as a positive reinforcement).

To investigate the *internal validity* of the data, we checked missing values, psychometric reliability and interviewer variance. As to the first, no *missing values* occurred at all. To examine the psychometric *reliability* the responses to the multi-item scales were analyzed. For each multi-item scale, Cronbach's coefficient alpha was computed as a reliability index for the whole group of respondents and for subgroups (i.e., blind vs. visually impaired). We expected that it would be somewhat harder for the blind to use the computer assisted self-administered part, which should result in somewhat less consistent answers for the blind compared to the visually impaired. This was not confirmed by the data. In the whole group and in the subgroups the multi-item scales all had sufficient reliability. No significant differences in reliability of scales (Cronbach's alpha) were found between subgroups. Finally, we investigated whether there were any interviewer effects for the difficult question on network size. Again, we analyzed the data for the whole group and for the blind and visually impaired subgroups separately. Although we expected that the blind needed more assistance, resulting in a larger interviewer effect, this was not confirmed by the data. In fact, no interviewer effects on network size were found for the whole group, nor for the subgroups.

Summing up:
1) A mixed CAPI-CASI approach can be successfully used with visually impaired adolescents and young adults.
2) Given the high level of computer sophistication of Dutch young visually impaired and the fact that almost all own a personal computer with Braille adaptations, even a CASI-only survey could be successfully implemented.
3) Acceptance of computer assisted data collection methods is high. Both interviewers and respondents were positive in their reactions.
4) The special adaptations using Braille and Audio-CASI procedures worked well.
5) The combination of computer-assisted data collection and well-trained interviewers results in good data quality.

Case 3: A Pilot Study of Deviant Adolescents and Their Parents

In summer 2000, a pilot study was started to survey adolescents with deviant behavior (e.g., aggressive behavior, delinquency) and their parents (Kef, 2000).[2] The adolescents investigated are between 12 and 19 years old, they all speak the Dutch language, and they all are under professional counseling. For part of the group the counseling is voluntary, the adolescents and their daily caregivers have sought counseling themselves. For others the counseling is mandatory, (e.g., ordered by a judge, or juvenile court). Both the adolescent and the daily caregivers are surveyed at the same time by one interviewer with two or three laptops. The laptops are equipped with special dedicated computer-assisted questionnaires, one questionnaire for the adolescent, and another for their daily caregivers. A mixed mode interview and self-completion (CAPI-CASI) approach was used. Both the adolescent's and the parents' questionnaires contained very sensitive topics. For instance, the questionnaire for daily care givers contained questions on family relations, marriage satisfaction, norms and values, well being, coping, child rearing, counseling experiences. The adolescent questionnaire contained questions on physical and psychological health, friendships, family situation, how they were reared, coping behaviour, norms and values, and deviant behaviour (violence, crime). Both the adolescent's and the parents' questionnaires contained questions on background demographics, including gender, date-of-birth, ethnicity, education, and sources of income. Each questionnaire was rather long (around 300 questions) and contained complex routings. To program the questionnaire CI3 was used, and the customary range and consistency checks were programmed in. After careful analysis of the special needs of the study, a pilot was devised and conducted, followed by a debriefing in which the respondents were asked to comment on the procedure and the questions.

To accommodate this very special population in combination with the sensitive nature of the topic, a mixed-mode CAPI-CASI survey was the best choice. The majority of the questions were asked in a self-administered computer assisted questionnaires (CASI). The task of the interviewer was limited to introducing the survey, start up the questionnaire, ask some introductory questions and than hand over the computer to the respondent. Thus, interviewers acted more like knowledgeable key-persons to make the self-administered procedure accessible and provide technical assistance when needed, than as traditional interviewers. The interviewers carefully explained the self-administered procedure, and made sure that all the individual members of the household could answer the questions in privacy, each using a different laptop. For instance, the mother was installed with a laptop in the family room, the father in the bedroom, and the adolescent in his/her own room. The usual procedure was that after a short general introduction for the whole household, first the daily caregivers were introduced to the questionnaire in all privacy, and than the adolescent.

An important role of the interviewer was to guide and support the respondents both technically and emotionally. To facilitate this, the self-administered part was programmed with a short break in which respondents could consult the interviewer, let of emotional steam, and relax. The results of the pilot suggested that this worked well to relieve the stress of responding and many respondents suggested including a second break. To keep the respondents motivated and again to reduce tension, short supportive texts appeared on the screen between questionnaire modules. These texts thanked the respondents and introduced the next set of questions. The pilot respondents appreciated this because it gave some structure to the questionnaire. In general, the adolescents really appreciated the computerized self-administered (CASI)-procedure; they thought it was 'cool'. The caregivers were more neutral in their reaction, they appreciated the privacy, but the computer did not add anything special for them. One adult respondent commented that she missed the feeling of order and the overview of a paper questionnaire.

Summing up:
The computer assisted data collection methods worked well. Based on the results of the pilot and the debriefing, the following adaptations are proposed for this special survey: (1) include several short breaks to relieve stress and give the interviewer an opportunity to offer (emotional) support; (2) add even more introductory texts between the modules to guide the respondents through the questionnaire; (3) have a summary card with a description of the modules and its contents to give the respondents a feeling of control and familiarity with the structure of the questionnaire. This is analogous to the summary-lists often given to interviewers during training.

CONCLUSION, SOFTWARE AND INTERNET RESOURCES AND SUGGESTED READINGS

Computer assisted self-administered questionnaires have definitely advantages for data quality, especially when sensitive topics are investigated and/or complicated questionnaires are used. The high potential and flexibility of computer assisted data collection is well suited for surveying special populations. Most important is a systematic approach to data collection. The research problem should be carefully analyzed and the design should be adjusted to the special group as we described in general above and illustrated with the case studies.

New developments in multi-media systems, using sound and video, increase the power of the tools available for surveying special groups. We are confident that everyone, even low educated or risk groups, can be surveyed using computer assisted (self) interviewing, provided that time and effort is taken to tailor the research design to the specific needs of the respondent and the special group of interest.

We want to stress that using computer assisted interviewing does not require enormous resources. The cases presented above were carried out by a small research team, and the largest investment was the software and the laptops, which were written of on two different research projects.

It is not necessary to develop special software; quality standard software is available to accommodate your special survey. The question which software is the best is impossible to answer, because software is continually improved, and because different investigators may have very different needs. In our case, we used the commercially available software *CI3* by Sawtooth Inc. (http://www.sawtooth.com). This survey software is directed at large scale application of large and complex questionnaires. We should stress that despite its power and flexibility we found *CI3* relatively easy to use. Since developing survey software is obviously computer related, it is no surprise that all major survey software makers maintain well-designed and informative websites for their product. Directing a search engine to search on 'survey software' turns up dozens of hits. A website documenting a number of survey packages available on different computers can be found at http://www.researchinfo.com/dosc/software. The survey software *Blaise*, developed by Statistics Netherlands (http://www.cbs.nl), stands out because it is actually a survey system with many different and highly programmable modules. These can be used to create management systems, metafiles that describe the data, and a number of analyses. *Blaise* is clearly intended for experienced research teams in large organizations. But, Blaise is not easy to implement for inexperienced users.

A recent review in *Field Methods* (Crawford, 2002) compared three programs for conducting Web surveys: *SurveySolutions* for the web (http://www.perseus.com), *Ztelligence* (http://www.markettools.com) and *MrInterview* (http://www.spssmr.com). Crawford (2002)

concludes that the more powerful systems come at a price, not only in money but also in difficulty of use. For researchers who are *not* part of a large and wealthy organization, *Infopoll Designer* (http://www.infopoll.com) is interesting, because the entry-level package is *free*. It can be used to develop relatively simple web surveys. By putting the questionnaire on a laptop and using a browser offline, this product can also be used for CAPI and CASI interviews. Researchers who need to use the highly portable palmtops should consider Entryware (http://www.techneos.com). A recent review of this product in *Field Methods* (Gravlee, 2002) found this a very useful product for field research.

Most software makers maintain a page with papers and other information on their website. These are of course partial to their own product, but in some cases genuinely informative.

Two academic sources of information containing research papers and articles are Don Dillman's homepage at Washington State University, USA (http://survey.sesrc.wsu.edu/dillman/), and the homepage of the Internet research group at the University of Ljubljana in Slovenia (http://www.ris.org/group.html).

We end with some suggestions for further reading. The reference list contains many specialized references to articles on different aspects of computer-assisted data collection. In addition the 1998 monograph edited by Couper,.et al on *Computer-assisted survey information collection*. (New York: Wiley), contains many helpful reviews and a thorough bibliography on the topic. For a general introduction into the advantages and disadvantages of computer assisted data collection, including computer assisted telephone, and face-to-face interviews, we recommend De Leeuw, Hox, and Snijkers, (1995). 'The effect of computer-assisted interviewing on data quality ,' in *Journal of the Market Research Society, 37*, 4, 325-344. A thorough summary of empirical findings on data quality is the chapter by Nicholls, Baker, & Martin, 'The effect of new data collection technologies on survey data quality,' in the 1997 monograph edited by L. Lyberg, et al. on *Survey Measurement and Proces Quality*. (New York: Wiley). An excellent critical introduction to internet surveys is Couper, (2000). 'Web surveys: A review of issues and approaches' in *Public Opinion Quarterly*, *64*, 464-494.

Regarding writing and testing questions in general, we recommend Fowler' book (first edition 1995). *Improving Survey Questions.* (Thousand Oaks, CA: Sage). Finally, Don Dillman has written many articles and two well-known books on self-administered questionnaires. For interesting articles on visual design of questionnaires and websurveys we refer to his home page (http://survey.sesrc.wsu.edu/dillman/).

REFERENCES

Aquilino, W. 1994. Interview mode effects in surveys of drug and alcohol use. *Public Opinion Quarterly* 58: 210-240.

Baker, R.P. (1998). The CASI future. In*Computer-assisted survey information collection,* edited by M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly, 583-604. New York: Wiley.

Beckenbach, A. 1995. Computer assisted questioning: the new survey methods in the perception of the respondent. *Bulletin de Méthodologie Sociologique* 48: 82-100.

Catania, J.A., Gibson, D.R., Chitwood, D.D., Coates, T.J. 1990. Methodological problems in AIDS behavioral research: Influences on measurement error and participation bias in

studies of sexual behavior. *Psychological Bulletin* 108: 339-362.

Clayton, R.L., & Werking, G.S. 1998. Business surveys of the future: The world wide web as a data collection methodology. In *Computer-assisted survey information collection.*, edited by : M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly, 543-62. New York: Wiley.

Couper, M.P. 2000. Web surveys: A review of issues and approaches. *Public Opinion Quarterly* 64: 464-494.

- - , M.P., Blair, J., & Triplett, T. 1999. A comparison of mail and e-mail for a survey of employees in Federal statistical agencies. *Journal of Official Statistics* 15: 39-56. (www.jos.nu)

- - , & Nicholls, W.L.II. 1998. The history and development of computer assisted survey information collection methods. In *Computer-assisted survey information collection.*, edited by : M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly, 1-22. New York: Wiley.

Crawford, S. 2002. Evaluation of web survey data collection systems. *Field Methods* 14 (3): 307-321.

De Leeuw, E.D. 1992. *Data Quality in Mail, Telephone and Face to Face Surveys* (chap. 3). Amsterdam: TT-publikaties.

- - 2002. The effect of computer-assisted interviewing on data quality. A review of the evidence. In *Social Science Methodology in the New Millennium*, edited by J.Blasius, J.Hox, E. De Leeuw, & P. Schmidt. FRG: Leske + Budrich [CD-ROM].

- - , Nicholls, W.L.II, Andrews, S.H., Mesenbourg, T.L. 2000. The use of old and new data collection methods in establishment surveys. The use of old and new data collection methods in establishment surveys. Proceedings of the 4th International Conference on methodological issues in Official statistics. Stockholm: SCB (http://www.scb.se/omscb/off_stat/conference.asp)

- - & Collins, M. 1997. Data collection method and survey quality: An overview. In *Survey Measurement and Process Quality*, edited by L. Lyberg, P. Biemer, M. Collins, C. Dippo, E. de Leeuw, N. Schwarz, & D. Trewin, 199-220. New York: Wiley.

- - , Nicholls, W.L.II. 1996. Technological innovations in data collection: Acceptance, data quality, and costs. *Sociological Research Online*, 1 (4) (http://www.socresonline.org.uk/socresonline/1/4/leeuw.html)

- - , Hox, J.J., & Snijkers, G. 1995. The effect of computer-assisted interviewing on data quality. A review. *Journal of the Market Research Society* 37 (4): 325-344.

Dippo, C.S. 1997. Survey measurement and process improvement: Concepts and integration. In *Measurement Errors in Surveys*, edited by P.P. Biemer, R.M. Groves, L.E. Lyberg, N.A. Mathiowetz & S. Sudman 457-74. New York: Wiley.

Dillman, D.A. 1978. *Mail and Telephone Surveys; The Total Design Method.* New York: Wiley.

- - 2000. *Mail and Internet Surveys; The Tailored Design Method.* New York: Wiley.

Dumas, J.S., & Redish, J.C. 1994. A practical guide to usability testing. Series in human/computer interaction, American Institute for Research. Norwood: Ablex Publishing Corporation.

Fowler, F.J. 1995. *Improving Survey Questions.* Thousand Oaks, CA: Sage.

Gravlee, C.C. 2002. Mobile computer-assisted personal interviewing with handheld computers: the Entryware system 3.0. *Field Methods* 14 (3): 322-36.

Forsyth, B.H. & Lessler, J.T. 1991. Cognitive laboratory methods: A taxonomy. In *Measurement Errors in Surveys*, edited by P.P. Biemer, R.M. Groves, L.E. Lyberg, N.A. Mathiowetz & S. Sudman 393-418. New York: Wiley.

Harrel, T. H. & Lombardo, T. A. 1984. Validation of an automated 16PF administration procedure. *Journal of Personality Assessment* 48: 216-27.

Heberlein, T A & Baumgartner, R. 1978. Factors affecting response rates to mailed questionnaires; A quantitative analysis of the published literature. *American Sociological Review* 43: 447-62.

Higgins, C.A., Dimnik, T.P., & Greenwood, H.P. 1987. The DISQ survey method. *Journal of the Market Research Society* 29: 437-45.

Hochstim, J.R. 1967. A critical comparison of three strategies of collecting data from households. *Journal of the American Statistical Association 62*: 976-89.

Johnston, J. & Walton, C. 1995. Reducing response effects for sensitive questions: A computer assisted self interview with audio. *Social Science Computer Review* 13: 304-19.

Kef, S. 1999. *Outlook on relations. Personal Networks and Psychosocial Characteristics of Visually Impaired Adolescents.* Amsterdam: Thela Thesis.

- - 2000 Report on pilot study: deviant adolescents and their parents. Amsterdam: University of Amsterdam.

Kinsey, S.H. & Jewell, D.M. 1998. A systematic approach to instrument development in CAI. In *Computer-assisted survey information collection*, edited by M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly 105-123.. New York: Wiley.

Kwak, N. & Radler, B. 2002. A comparison between mail and web surveys: response pattern, respondent profile, and data quality. *Journal of Official Statistics* 18: 257-73. (www.jos.nu)

Lee, R.M. 1993. *Doing research on sensitive topics.* London: Sage.

Mead, A D & Drasgow, F. 1993. Equivalence of computerized and paper-and-pencil cognitive ability tests: a meta-analysis. *Psychological Bulletin*,114: 449-58.

Nicholls, W.L.II, Baker, R.P., & Martin, J. 1997. The effect of new data collection technologies on survey data quality. In *Survey Measurement and Proces Quality*, edited by L. Lyberg, P. Biemer, M. Collins, C. Dippo, E. de Leeuw, N. Schwarz, & D. Trewin, 221-48. New York: Wiley.

O'Reilly, J.M., Hubbard, M.L., Lessler, J.T., Biemer, P.P., & Turner, C.F. 1994. Audio and video computer assisted self-interviewing: Preliminary tests of new technologies for data collection. *Journal of Official Statistics* 10: 197-214. (www.jos.nu)

Parks, B. T, Mead, D. E., & Johnson, B. L. 1985. Validation of a computer administered marital adjustment test. *Journal of Marital and Family Therapy* 11: 207-10.

Ramos, M., Sedivi, B.M., & Sweet, Computerized self-administered questionnaires. In *Computer-assisted survey information collection.*, edited by : M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly, 389-408. New York: Wiley.

Richman, W.L., Kiesler, S., Weisband, S., & Drasgow. 1999. A meta-analytic study of social desirability distortion in computer administered questionnaires, traditional questionnaires, and interviews. Journal of applied Psychology, 84 (5): 754-75.

Samuels, J. 1994. from CAPI to HAPPI: A scenario for the future and its implications for research. *Proceedings of the 1994 ESOMAR congress, Applications of new technologies.*

Saris, W.E. 1998. Ten years of interviewing without interviewers: The telepanel. In *Computer-assisted survey information collection.*, edited by : M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly, 409-429. New York: Wiley.

Saltzman, A. 1993. Improving response rates in Disk-by-Mail surveys. *Marketing Research* 5:

32-9.
Sawtooth, 1994. *CI3 User Manual,* edited by Harla Hutchinson & Margo Metegrano. Evanstone: Sawtooth Software
Schwarz, N., Strack, F., Hippler, H-J, & Bishop, G. 1991. The impact of administration mode on response effects in survey measurement. *Applied Cognitive Psychology* 5: 193-212.
Schaeffer, D.R. & Dillman, D.A. 1998. Development of a standard e-mail methodology: results from an experiment. *Public Opinion Quarterly* 62: 378-97.
Scott, J. 1997. Children as respondents: Methods for improving data quality. In *Survey Measurement and Process Quality,* edited by L. Lyberg, P. Biemer, M. Collins, C. Dippo, E. de Leeuw, N. Schwarz, & D. Trewin, 331-50. New York: Wiley.
Siemiatycki, J. 1979. A comparison of mail, telephone, and home interview strategies for household health surveys. *American Journal of Public Health* 69: 238-45.
Sikkel, D. 1998. The individual interview. In *Computer-assisted survey information collection.*, edited by : M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly, 147-66. New York: Wiley.
Snijkers, G. J.M.E. 2002. *Cognitive laboratory experiences: On pretesting, computerised questionnaires and data quality.* Utrecht: University of Utrecht [Ph.D. thesis].
Sudman, S. & Bradburn, N.M. 1974. *Response Effects in Surveys: A Review and Synthesis.* Chicago: Aldine.
Thornberry, J., Bhaskar, B., Wesley, B., Krulewitch, C.J., Wesley, B., Hubbard, M.L., Das, A., Foudin, L., Adamson, M. 2002. Audio computerized self-report interview use in prenatal clinics: Audio computer assisted self interview with touch screen to detect alcohol consumption in pregnant women application of a new technology to an old problem. *Computer Information Nursing 20*: 46-52.(also presented at the Fifth International Conference on Logic and Methodology, Cologne, 2-6 October, 2000).
Tourangeau, R., & Smith, T.W. 1996. Asking sensitive questions; the impact of data collection, question format, and question context. *Public Opinion Quarterly* 60: 275-304.
Trochim, W.M.K. 1989. An introduction to concept mapping for planning and evaluation. *Evaluation and Program Planning,* 12: 1-16.
Turner, C.F., Forsyth, B.H., O'Reilly, J.M., Cooley, P.C., Smith, T.K., Rogers, S.M., & Miller, H.G. 1998. Automated self-interviewing and the survey measurement of sensitive behaviour. In *Computer-assisted survey information collection,* edited M.P. Couper, R.P. Baker, J. Bethlehem, C.Z. Clark, J. Martin, W.L. Nicholls II, J.M. O'Reilly,.455-73. New York: Wiley.
- - , Lessler, J.T., & Devore, J.W. 1992. Effects of mode of administration and wording on reporting of drug use. In *Survey Measurement of Drug Use: Methodological Studies,* edited by C.F. Turner, J.T. Lessler, & J.C. Gfroerer, 177-220. Washington DC: Government printing office.
Van Hattum, M.J.C & De Leeuw, E.D. 1999. A Disk by Mail survey of pupils in primary schools; data quality and logistics. *Journal of Official Statistics* 15: 413-29. (www.jos.nu)
Weisband, S., & Kiesler, S. 1996. Self disclosure on computer forms: Meta analysis and implications. *CHI '96* (http://www.al.arizona.edu/~weisband/chi/chi96.html).
Witt, K.J., & Bernstein, S. 1992. Best practices in Disk-by-Mail surveys. *Proceedings of the 1992 Sawtooth Conference,* Sawtooth software: Evanston, Illinois.
Zandan, P., & Frost, L. 1989. Customer satisfaction research using disk-by-mail. *Proceedings of the 1989 Sawtooth Conference,* Sawtooth software: Evanston, Illinois.

NOTES

[1] For more details see Van Hattum & De Leeuw (1999)

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