

IS TELEPHONE AUDIO COMPUTER-ASSISTED SELF-INTERVIEWING (T-ACASI) A METHOD WHOSE TIME HAS COME?

David J. Mingay, Department of Anesthesia and Critical Care, University of Chicago
5841 S. Maryland Avenue, MC 4028, Chicago, IL 60637

Keywords: T-ACASI, CAI, Telephone interviewing

1. Introduction

In a telephone audio computer-assisted self-interviewing system (T-ACASI), the respondent answers voice-digitized survey questions by pressing the appropriate keys on a touchtone telephone. Questionable uses of the methodology, e.g., where there is no sample frame or a very low response rate, are common. Examples are the use of 1-800 or 1-900 numbers for people to call to register their opinion on an issue or an entirely automated "dial-out" interview in which the computer dials the telephone numbers in the sample. This paper reviews the studies that have attempted to collect data of high quality.

An extensive literature review identified articles on only five T-ACASI surveys. Some market research companies that have conducted T-ACASI surveys do not publish the results. For example, the Gallup Organization conducts many customer satisfaction surveys using T-ACASI methods (Tortora, personal communication). Many are short call-out surveys in which a human interviewer telephones the respondent and then transfers the call to a T-ACASI system. The maximum response rate is about 30%. Gallup also conducts call-in T-ACASI surveys--e.g., by printing on restaurant receipts a telephone number for the customer to call at any time to be connected directly to an automated interviewing system. Even with incentives for participating, response rates are substantially lower than for the call-out surveys.

There is a more extensive literature on clinical applications of T-ACASI than on survey applications. Although there are significant differences between the typical survey and clinical interview--e.g., in interviewees' motivation for participating, and in the impression they wish to present--clinical studies can provide insight into T-ACASI surveys. The next section describes the design of the T-ACASI surveys and the most relevant clinical studies. The results of these studies are then summarized and the strengths and weaknesses of T-ACASI discussed.

2. Description of Studies Reviewed

Frankovic and Arndt (1994) achieved a 53% response rate in a T-ACASI survey of reactions to President Clinton's 1992 State of the Union Address. A total of 4,578 adults were recruited by random-digit dialing several days before the speech and asked to call a toll-free number to respond to some pre-recorded

questions immediately after the speech whether or not they had watched it.

Using a counterbalanced design, researchers at Research Triangle Institute (RTI) used T-ACASI to administer one of two highly sensitive sections of an AIDS behavioral survey to 142 respondents aged 18 to 49 (Turner et al., 1996). The first part of the questionnaire and the other sensitive section were administered by computer-assisted telephone interviewing (CATI). Respondents were paid \$10 for participating.

A recent T-ACASI survey examined the health-related behavior and health care needs of 2,881 men who have sex with men (Gribble et al., 2000). After the first part of the interview was conducted by CATI, 697 respondents were randomly allocated to T-ACASI and 2,184 continued with CATI. The questions concerned sexual development, anti-gay victimization, sexual coercion, access to medical care, sexual problems, and recent alcohol and drug abuse. Alemagno et al. (1990) conducted an innovative T-ACASI survey on the substance abuse treatment needs of 218 homeless adults in Cleveland, Ohio. Outreach workers visited sites that served homeless adults, offered compensation, and handed cellular telephones to respondents to take the interview. One-week later respondents were reinterviewed on T-ACASI or by the outreach worker on several key items and provided a hair sample for drug testing.

A T-ACASI survey that has been the subject of considerable research and development since 1987 is the Bureau of Labor Statistics' (BLS) Current Employment Statistics Survey (CES). T-ACASI, which BLS calls touchtone data entry (TDE), is used to administer the CES to the majority of the 370,000 business establishments who voluntarily take the survey each month (Clayton and Winter 1992). The interview usually takes less than two minutes. Clayton and Winter (1992) suggested that several characteristics of the CES, including the small number of items, the relative simplicity of contacting businesses, and the participation of the same respondents each month, make automated data collection especially feasible.

Among clinical studies, Kobak et al. (1997a) recruited 205 subjects who were patients at local primary care clinics or specialty treatment centers, recent participants in a drug study, or nonpatients who responded to a newspaper advertisement. Subjects, who were paid \$25 or \$50, completed the Primary Care Evaluation of Mental Disorders (PRIME-MD) by T-

ACASI from home. A clinician also administered part of the Structured Clinical Interview for DSM-IV Diagnosis (SCID) in a telephone interview. PRIME-MD was administered by a clinician to 51 percent of the subjects in a face-to-face interview. In another clinical study, PRIME-MD and a subscale of the SCID were administered to 51 outpatients of a community mental health clinic (Kobak et al., 1997b). In counterbalanced order the SCID-IV was administered by a clinician over the telephone and the PRIME-MD by T-ACASI and on a desktop computer in the clinic. All interviews were 24 to 72 hours apart and subjects were paid \$50 for participation.

In a recent study, the Short Form-12 Health Status Survey (SF-12) was administered to 288 patients with low back pain who did not have speech, hearing, or cognitive impairment (Millard and Carver, 1999). Subjects were telephoned by an interviewer and randomly allocated to either continuing with the interviewer or being switched to T-ACASI. Subjects in the T-ACASI condition could choose to return to a live interviewer at any time and were automatically returned if they failed to answer two questions. Mahoney et al. (1999) evaluated a T-ACASI system for assessing changes in the functional status of disabled elderly adults living in the community. The respondents, 20 adults aged over 60 years, received over a 72-hour period, in random order, two T-ACASI functional assessments, one personal functional assessment by telephone, and a home visit assessment by a case manager. During an initial home visit, the project field coordinator gave the respondent approximately 15 minutes practice with the T-ACASI system.

Finally, Mingay et al. (2000) investigated patients' performance in completing a detailed preoperative assessment questionnaire, HealthQuiz, by touchtone telephone from their homes. Fifty orthopedic patients were asked to take the questionnaire by their surgeon's nurse and given written instructions. An additional 30 patients were given oral instructions by telephone. A small number were not asked to participate because they seemed confused by the task or were aged 85 years or older. Patients spent an average of 25.5 minutes answering between 112 and 152 questions.

3. Evaluating T-ACASI

3.1. Reliability and Validity of Non-sensitive Information

Extensive research by BLS has shown that T-ACASI collects high quality data on the CES. For example, in several record check studies the average error rate for data items was less than 1.8% (Phipps and Tupek 1990). Kobak et al. (1997a) found that there were no significant differences in responses between T-ACASI and the in-person clinician interview on PRIME-MD. Millard and Carver (1999) reported that

internal consistencies, and the scores for each item, were similar for CATI- and T-ACASI-administered questions on the Physical Component Scale of the SF-12. Compared with patients in the CATI condition, patients taking T-ACASI indicated that their overall health was poorer. Mahoney et al. (1999) found excellent test-retest reliability for T-ACASI administration. T-ACASI showed a good agreement with CATI on the Activity of Daily Living (ADL) and Independent Activity of Daily Living (IADL) items (weighted kappa of 0.68 and 0.80, respectively). The mean impairment rates for the T-ACASI and CATI interviews were not significantly different on either item.

Although more studies are needed, in particular using record check procedures, these results suggest that the reliability and validity of reporting non-sensitive information on T-ACASI is similar to that of face-to-face or telephone interviews by live interviewers.

3.2. Reliability and Validity of Sensitive Information

In general, the findings are consistent with the literature showing that self-reporting by computer often results in less socially desirable responses than other interviewing methods (e.g., Tourangeau and Smith 1996). Turner et al. (1996) reported that on 7 of 15 sensitive questions there was significantly greater disclosure with T-ACASI. Respondents' perceptions of the interviewing modes were consistent with these findings. T-ACASI was rated as best for protecting privacy, for asking about sensitive topics such as sexual behavior, and for making respondents feel comfortable answering the survey questions. Gribble et al. (2000) found that respondents in the T-ACASI condition answered 3 questions in ways that suggested greater drug use than respondents in the CATI condition. Respondents in the T-ACASI condition also reported significantly greater use of 4 of 11 recreational drugs. This may be attributed to a difference in how the questions were asked, however. Only CATI respondents were initially asked whether they had used any drugs in the last 6 months. If they said no, the questions about individual drugs were omitted.

Miller and Carver (1999) found that on the Mental Component Scale of the SF-12, greater overall mental interference, greater general emotional concerns, and poorer mood and overall health were reported with T-ACASI than with CATI. In the Alemagno et al. (1996) study, there was higher self-reported drug use for all illicit drugs on the T-ACASI interview than on the in-person interview, although analysis of hair clippings indicated that drug use was still significantly underreported. There was no significant difference in test-retest reliability when the second interview was administered by T-ACASI or CATI.

Patients in the study by Kobak et al. (1997a) gave answers to PRIME-MD by T-ACASI and to the SCID by CATI that indicated similar prevalence rates for all psychiatric disorders, with the exception of higher rates of dysthymia reported on T-ACASI. Primary care patients reported twice the rate of alcohol abuse on T-ACASI than to the clinician. Computer-administered and clinician-administered PRIME-MD demonstrated high and approximately equivalent levels of sensitivity and specificity. Kobak et al. (1997b) found few differences across interviewing methods, although dysthymia and obsessive compulsive disorder were more prevalent on the telephone and computer-administered PRIME-MD and panic disorder was more prevalent on the clinician-administered SCID-IV.

These results indicate that often, but not invariably, more sensitive information is disclosed with T-ACASI than to a live interviewer. In most instances, the live interview was conducted by CATI. Future research is needed to determine whether T-ACASI results in more disclosure than other self-completion methods, e.g., paper-and-pencil, computer-assisted self-interviewing (CASI), and Internet administration. These methods also tend to elicit more reporting of sensitive information than does an interviewer (e.g., Tourangeau and Smith 1996).

3.3. Response Rates and Completion Rates

Failure to begin an interview is the most frequent reason for non-completion of call-in surveys in which the respondent must initiate the call. In the CBS study (Frankovic and Arndt 1994), although most received a reminder telephone call one or two days before Clinton's speech, on the night of the broadcast only 67% of those who had agreed to participate called the number. Mingay et al. (2000) reported that 79% of patients completed the preoperative questionnaire. Reasons given by the 16% who did not start the questionnaire were forgetting, unwillingness to make a long distance call, inability to do the task, or illness. On the CES, with the use of an advance notice by facsimile or postcard, and a telephone call or facsimile prompt as the deadline approached, response rates averaged a little above 80% (O'Connell, Rosen and Clayton 1996). This rate compares favorably with 55% for mail administration of the CES but is lower than the completion rate of 90% or more for CATI administration. An additional advantage of T-ACASI over mail is a lower attrition rate.

These studies required respondents to call-in to take the interview. A call-out procedure in which an interviewer initiates the call and switches the respondent to T-ACASI is more costly than a call-in procedure. In addition, respondents do not have the convenience of taking the questionnaire when they choose. Response rates are likely to be higher with a

call-out methodology, however, as it eliminates forgetting and procrastination as reasons for non-participation. In most studies, few respondents who were willing to be interviewed refused to be switched to an automated interview. For example, Turner et al. (1996) reported that none of the 142 respondents refused. An even better response rate than with a call-out procedure may be achieved with face-to-face contact but at high cost (e.g., Alemagno et al. 1996). Supplementing a call-in procedure with reminders should also improve response rates. Forty percent of completions on the CES occur only after a reminder by telephone, facsimile, or mail (O'Connell, Rosen and Clayton 1996).

Discontinuing a T-ACASI interview is usually less common than failing to start it. Turner et al. (1996) reported that only 1 of 158 respondents broke off completely. Mingay et al. (2000) reported that none of the 63 patients who started the interview intentionally broke it off. Two studies had relatively high break-off rates. Gribble et al. (2000) reported that of those respondents who were randomly allocated to T-ACASI, 24% broke off during the interview compared to only 2% of respondents in the CATI condition. Seventy percent of those breaking off T-ACASI went on to complete a CATI interview. The authors suggested that some of the break-offs in the T-ACASI condition might have been caused by undiagnosed technical failure or the automatic "time-out" feature used to terminate calls after a period of inactivity. Millard and Carver (1999) reported that 7% of patients who started the T-ACASI interview were automatically switched back to the interviewer because they failed to answer two questions. Among the reasons suggested for the automatic switching was answering before the beep to give a response. Another 20% of patients elected to return to the CATI interview, perhaps because they found talking to a live interviewer easier and more enjoyable (cf. Turner et al., 1996).

Because of the many differences between the studies, it is not possible to determine the reason for the different break-off rates. A high break-off rate is likely to be reduced substantially by allowing respondents to switch to a live interviewer, although this increases costs.

3.4. Length of Interview

In most of the studies, the T-ACASI interviews were short, averaging from less than 2 minutes (Clayton and Winter 1992) to between 10 and 11 minutes (Kobak et al., 1997a,b; Millard and Carver 1999). However, relatively long questionnaires averaging 25 minutes were successfully administered by Alemagno et al. (1996) and Mingay et al. (2000). No one intentionally broke off the interview in either study, although in the Mingay et al. study the length of the questionnaire was

often criticized during debriefings. It may be that the compensation offered in one study, and the desire for an excellent preoperative assessment in the other, made respondents willing to complete a lengthy interview.

Research is needed to determine how long interviews can be when respondents have low motivation for participation. It is much easier to hang up during an interview administered by a computer than a human. However, careful attention to such factors as the information provided about the study, incentives for participation, and the simplicity of the task and instructions, should enable the researcher to field a longer questionnaire than would otherwise be possible.

3.5. Respondent Characteristics Associated with Non-response and Reporting Accuracy

Older age and lower socioeconomic status were associated with greater difficulty in taking the survey on the State of the Union Address (Frankovic and Arnedt, 1994). Respondents with lower education and income levels were also less likely to call in to participate after having agreed to do so. This refusal may have been prompted by less experience with, and greater suspicion of, touchtone applications. Nevertheless, Frankovic and Arnedt (1994) and Mingay et al. (2000) found that the large majority of respondents who were elderly or had low educational attainment were willing and able to complete the T-ACASI questionnaire. Alemagno et al. (1996) provided evidence that almost all individuals with low income and educational levels can complete a user-friendly T-ACASI interview. Only 1% of respondents were unable to complete a T-ACASI interview lasting an average of 25 minutes even though 56% had income of less than \$10,000 per year and 43% had not completed high school.

4. Potential Limitations to Use of T-ACASI

4.1. Touchtone Telephone Availability

In a 1993 national random digit dial survey, 20% of U.S. households contacted had rotary telephones (Turner et al. 1998). Respondents aged 65 years or older and those with less than a high school education or living in a rural area were significantly more likely to have rotary telephones (36%, 34%, and 41% respectively). Although penetration has probably risen since 1993, coverage problems may still be significant for surveys of the elderly and people of lower socioeconomic status. Unless the ownership rate of touchtone telephones in the sampled population is known to be very high, the best procedure may be to identify telephone users who have rotary service and assign them to a different interview method, such as CATI or voice recognition entry. Alternatively, all non-responders could be followed up using a different interview method.

4.2. Difficulties Taking a T-ACASI Questionnaire

As discussed above, break-offs in the majority of T-ACASI studies were minimal. Difficulty severe enough to affect data quality may be more common, however. Taking a T-ACASI interview is a novel task for most respondents and there is usually no interviewer to assist. Respondents in the study by Turner et al. (1996) rated interviewer administration as easier than T-ACASI by a 2:1 margin. They also reported that it was easier to change their answers with an interviewer. Respondents may also be unaware that they misunderstand aspects of the task. Mingay and Kim (1998) observed patients taking the T-ACASI interview and then asked detailed follow-up questions in their small scale usability study. Many patients apparently did not know how to have a question repeated or change an answer, despite reporting that they understood all aspects of the automated interview.

One potential source of difficulty is the questions asked. Their length is limited because the respondent must remember the question and response categories while formulating an answer. The design of the telephone keypad makes some questions more difficult to answer. For example, selecting the number 10 on a 10-point scale requires pressing a non-numerical key such as the * key, or pressing two keys (1 and 0). Thus, a scale of 10 or more points may be more difficult to respond to than a scale consisting entirely of one-digit responses. Apart from some demographic questions that require numerical values to be entered, most T-ACASI studies have principally used response categories of between 2 and 4 items.

The design of some telephones may be another potential source of error. Many households have telephones with the keys on the handset rather than the base, such as trimline and many cordless telephones. Patients with these telephones reported greater difficulty answering the questions because they had to move the handset away from the ear to see the keys to press and then move it back to hear the next question (Mingay and Kim, 1998). Finally, if the interview is less engaging than a live one, as reported by Turner et al. (1996), respondents may be less motivated to make the necessary cognitive effort to answer the questions well. Research—including usability studies, record check studies, and respondent debriefings—is needed to investigate the extent of these problems and identify ways to minimize them.

Careful attention to the design of the T-ACASI system should improve the ease with which respondents can take the interview. Some of the design principles suggested by Schumacher, Hardzinski and Schwartz (1995) for building telephony menu systems, as well as certain principles from the usability testing literature on human-computer interaction (Rubin 1994) offer guidance. For example, as much as possible, responses

should require a single key press, a key should have the same function across different questions, and feedback about errors should be in simple, non-technical language. Mundt et al. (1997) offered recommendations for the design of T-ACASI systems in longitudinal research that seem relevant to one-time surveys as well. Their recommendations include: repeating a respondent's answer to critical questions before the next question is read and requiring that the answer is verified so that errors can be corrected; permitting respondents to return to previous questions to correct a response by pressing the * key; and not allowing responses before key words have been read out. There are likely to be tradeoffs, however. For example, requiring verification of every answer may reduce errors at the cost of lengthening the interview and irritating the respondent.

5. Voice Recognition Entry

Voice recognition entry (VRE) permits automated telephone interviews to be conducted via a rotary telephone. The accuracy and sophistication of the systems are improving rapidly while costs are going down (Clayton and Winter 1992). VRE has already become sufficiently accurate for use in some surveys with limited responses without the need to first "train" the system to recognize the speaker's voice. For example, on the CES, which only uses the digits 0 through 9 and *yes* and *no*, the error rate is acceptably low at between 0.5% and 0.6% (Clayton and Winter 1992). Because of these and other findings, the CES now uses a voice recognition system for businesses without touchtone service (O'Connell, Rosen and Clayton 1996).

VRE may also benefit respondents with touchtone telephones because the problems of using a keypad to enter answers are avoided. In addition, most respondents may prefer to answer verbally: about 60% of respondents preferred VRE over T-ACASI for taking the CES, with most citing that VRE is easier to use and more natural (Clayton and Winter 1992). Of the 32% who preferred T-ACASI, most had experienced a recognition or procedural problem during their first use of the VRE system. Another advantage of VRE was that the majority of respondents felt that it took less time than T-ACASI, although it actually took about 20 seconds longer because of lengthier instructions and prompts.

6. Conclusions

Drawing conclusions about the effectiveness of T-ACASI methods is difficult because of the limited number of studies and the diverse methods, subject matter, and populations. Research is needed to determine what methods are most appropriate for particular types of surveys and populations. Little is known about whether non-response bias among those

with touchtone telephones is a significant problem. Future studies should investigate the demographic characteristics of individuals who refuse to participate. Most of the studies were conducted in the U.S. In countries with a lower penetration of touchtone telephones, T-ACASI may still be appropriate if those without touchtone service are identified and interviewed by other methods.

In the clinical studies, non-sensitive questions on T-ACASI were answered similarly in CATI and face-to-face interviews. Thus, levels of reliability and validity were similar. While it is reasonable to expect that these results will hold for surveys as well, more studies are needed to confirm this. Another concern is that most of the studies only measured reliability. Only two studies assessed the validity of respondents' answers; indeed, most concerned subjective phenomena for which a "gold standard" is not available. Future studies should include questions on objective phenomena and obtain data to validate key responses.

The clinical studies and surveys that asked sensitive questions had higher levels of reporting on some but not all of the sensitive questions when administered by T-ACASI rather than by an interviewer face-to-face or on the telephone. This result is consistent with the literature showing that self-administration by computer is often associated with high levels of disclosure. Thus, T-ACASI methods may be especially useful for administering questions that have a strong social desirability component.

Although a short questionnaire, relatively few response categories, and a non-elderly population of high socioeconomic status may be desirable for T-ACASI surveys, lengthy questionnaires have been successfully administered to individuals of low socioeconomic status (Alemagno et al. 1996) and advanced age (Mahoney et al. 1999; Mingay et al. 2000).

In general, the studies paint a largely positive picture of T-ACASI as a method of administering questionnaires, although breakoffs and low completion rates have been a significant problem in several studies. Most studies have been clinical in nature. A definitive evaluation requires more methodological research on T-ACASI surveys, including research on non-response bias, response validity, reporting of sensitive information, the relative merits of call-in and call-out surveys, and the appropriate interview length. If these studies show similarly positive results, survey organizations are likely to make increasing use of T-ACASI due to its convenience, flexibility, and low cost.

ACKNOWLEDGMENT

The author is grateful to Charles Turner and James Mundt for their comments on an earlier draft.

The author is now at the Statistical Research Division, U.S. Bureau of the Census, Washington, D.C. 20233-9150.

REFERENCES

- Alemagno, S.A., Cochran, D., Feucht, T.E., Stephens, R.C., Butts, J.M. and Wolfe, S.A. (1996). "Assessing Substance Abuse Treatment Needs among the Homeless: A Telephone-based Interactive Voice Response System," *American Journal of Public Health*, 86, pp. 1626-1628.
- Clayton, R.L. and Winter, D.L.S. (1992). "Speech Data Entry: Results of a Test of Voice Recognition for Survey Data Collection," *Journal of Official Statistics*, 8, pp. 377-378.
- Frankovic, K.A. and Arnedt, C.M. (1994). "Interactive Polling and Americans' Comfort Level with Technology," *Proceedings of the Survey Research Methods Section, American Statistical Association*, 2, pp. 1316-1321.
- Greist, J.H., Marks, I.M., Baer, L. et al. (1998). "Self-treatment for Obsessive Compulsive Disorder using a Manual and a Computerized Telephone Interview: A U.S.-U.K. Study," *M.D. Computing*, 15, pp. 149-157.
- Gribble, J.N., Miller, H.G., Cowley PC, Catania, J.A., Pollack, L. and Turner, C.F. (2000). "The Impact of T-ACASI Interviewing on Reported Drug Use Among Men Who Have Sex With Men," *Substance Use and Misuse*, 35, pp. 869-890.
- Groves, R.M. (1989). *Survey Measurement and Survey Costs*, New York: Wiley.
- Havice, M.J. (1989). "How Response Rates Compare for Human and Digitized Phone Surveys," *Journalism Quarterly*, 66, pp. 137-142.
- Kobak, K.A., Taylor, L.vH., Dottl, S. et al. (1997a). "A Computer-administered Telephone Interview to Identify Mental Disorders," *JAMA*, 278, pp. 905-910.
- Kobak, K.A., Taylor, L.vH., Dottl, S. et al. (1997b). "Computerized Screening for Psychiatric Disorders in an Outpatient Community Mental Health Clinic," *Psychiatric Services*, 48, pp. 1048-1057.
- Mahoney, D., Tennstedt, S., Friedman, R. and Heeren, T. (1999). "An Automated Telephone System for Monitoring the Functional Status of Community-residing Elders," *Gerontologist*, 39, pp. 229-234.
- Marks, I.M., Baer, L., Greist, J.H. et al. (1998). "Home Self-assessment of Obsessive-Compulsive Disorder. Use of a Manual and a Computer-conducted Telephone Interview: Two UK-US Studies," *British Journal of Psychiatry*, 172, pp. 406-412.
- Millard, R.W. and Carver, J.R. (1999). "Cross-sectional Comparison of Live and Interactive Voice Recognition Administration of the SF-12 Health Status Survey," *American Journal of Managed Care*, 5, pp. 153-159.
- Mingay, D.J. and Kim, R. (1998). "Using Cognitive and Traditional Methods to Develop an Automated Telephone-administered Questionnaire," *Paper presented at the Annual Meeting of the American Association for Public Opinion Research*, St. Louis, MO, U.S.A.
- Mingay, D.J., Roizen, M.F., Belkin, M., Headley, L. and Foss, J.F. (2000). "Evaluation of Touchtone Telephone for In-home Completion of HealthQuiz Preoperative Assessment Questionnaire," *The Internet Journal of Anesthesiology*, 4 (1): <http://www.ispub.com/journals/IJA/Vol4N1/healthquiz.htm>.
- Mundt, J.C., Searles, J.S., Perrine, M.W. and Walter, D. (1997). "Conducting Longitudinal Studies of Behavior using Interactive Voice Response Technology," *International Journal of Speech Technology*, 2, pp. 21-31.
- O'Connell, D., Rosen, R.J. and Clayton, R.L. (1996). "Long-term Results of Touchtone Data Entry in the Current Employment Statistics Survey Program," *Proceedings of the Section on Survey Methods Research, American Statistical Association*, 2, pp. 764-767.
- Phipps, P.A. and Tupek, A.R. (1990). "Assessing Measurement Errors in a Touchtone Recognition Survey," *Paper presented at the International Conference on Measurement Errors in Surveys*, Tucson, AZ, U.S.A.
- Rubin, J. (1994). *Handbook of Usability Testing*, New York: Wiley.
- Schumacher, R.M., Hardzinski, M.L. and Schwartz, A.L. (1995). "Increasing the Usability of Interactive Voice Response Systems: Research and Guidelines for Phone-based Interfaces," *Human Factors*, 37, pp. 251-264.
- Tourangeau, R. and Smith, T.W. (1996). "Asking Sensitive Questions: The Impact of Data Collection Mode, Question Format, and Question Context," *Public Opinion Quarterly*, 60, pp. 275-304.
- Turner, C.F., Forsyth, B.H., O'Reilly, J. et al. (1998). Automated "Self-interviewing and the Survey Measurement of Sensitive Behaviors," In *Computer-Assisted Survey Interviewing Collection*, ed. M. Cooper, New York: Wiley.
- Turner, C.F., Miller, H.G., Smith, T.K., Cooley, P.C. and Rogers, S.M. (1996). "Telephone Audio Computer-assisted Self-interviewing (T-ACASI) and Survey Measurements of Sensitive Behaviors: Preliminary Results," In *Survey and Statistical Computing*, eds. R. Banks, J. Fairgrieve, L. Gerrard, et al. Chesham, Bucks, U.K.: Association for Survey Computing.