

# Laboratory-based Research on the Cognitive Aspects of Survey Methodology: The Goals and Methods of the National Center for Health Statistics Study

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FOR YEARS SURVEY RESEARCHERS HAVE BEEN constructing survey questionnaires and conducting questionnaire design research, but improvements in questionnaire design are less impressive than those in other phases of the survey measurement process such as sampling and data processing. The reason may be that other survey activities are more scientifically based than questionnaire design, which remains essentially an art. Is it possible that the cognitive sciences could provide the underpinning for questionnaire design research comparable to the support provided by the statistical and computing sciences in the development of modern sampling and data processing methods? This is a question being explored in the National Center for Health Statistics (NCHS) study on the Cognitive Aspects of Survey Methodology (CASM). This article describes the NCHS CASM study and indicates how it relates to the NCHS methodological research program for improving the designs of health surveys.

Both survey researchers and cognitive scientists are concerned with the manner in which individuals handle information. However, their approaches to the problem and their methods for dealing with the problem are quite different. Survey researchers wish both to measure and control the errors associated with the survey response task, and

they conduct pretests and quality check studies to evaluate the response error effects of question wording, response categories, ordering of questions, etc. Survey researchers, especially in federal statistical agencies, make relatively little use of controlled laboratory experiments to investigate these problems.

Cognitive scientists, on the other hand, are concerned with the mental systems people use in processing information, and they typically conduct controlled laboratory experiments that strive to eliminate all factors except those relating to the cognitive issues being investigated. Differences between the objectives and approaches of survey and cognitive scientists are illustrated next by comparing two research projects dealing with the issue of temporal dating of past events.

The temporal dating issue is of prime importance to survey researchers because many surveys ask respondents to report retrospectively about events that occurred during a reference period, which is a calendar period of specified length that precedes the interview date. Failure of respondents to recall events and to place them correctly in time are major sources of error in survey statistics. The tendency for survey respondents improperly to date events to either earlier or later periods than those in which they actually occurred is called telescoping.

Survey research findings indicate that when reference periods are not bounded by a previous interview there is a net forward telescoping, that is, more events are erroneously shifted forward into the reference period than are shifted out of the reference period. The importance of the event, the length of the reference period, and the characteristics of respondents all appear to have an effect on the telescoping. When bounded reference periods are used there appears to be telescoping within the reference period itself, with the net forward effect being greatest for more recent events.

A paper by Neter and Waksberg (1964) illustrates the survey researcher's approach to the study of telescoping. Prior to designing a national consumer expenditure survey on household repairs, Neter and Waksberg carried out an extensive field experiment to measure the magnitude and direction of telescoping, and in particular to investigate the effects of length of reference period and whether or not the period was bounded. A large sample of over 5,000 households, randomly selected and interviewed under usual survey conditions, was divided into 30 interview panels in which procedures varied by length of the reference period and whether or not the period was bounded.

In each panel, respondents recalled all repair expenditures within the reference period and designated the month in which the repairs were made. The panels were inducted at different times so that for any particular calendar month estimates of the number of repair jobs and the associated expenditures were available under different procedures. The response effects under study were measured by comparing the estimates for the same calendar period under two or more procedures. The study did not provide estimates of bias since the expenditures reported in the study were not validated. By assuming, however, that a specific type of procedure was less subject to a particular type of response effect, bounds on the size of the effects were obtained.

Neter and Waksberg found that unbounded recall of household repair resulted in considerable forward telescoping, especially for larger repairs. They observed that unbounded recall of household repairs would fail to meet the precision requirements for national statistics, and they therefore concluded that a national panel survey design would be required in which the initial interviews would be used to bound the reference period for succeeding interviews.

Now consider an approach by cognitive psychologists to the temporal dating problem. Brown, Shevell, and Rips (1984) investigated respondents' ability to date natural events such as attempted assassinations or deaths of important persons. They state that when subjects cannot recall the month and year in which an event occurred they assign a date based on approximation. The goal of their study was to investigate the cognitive basis of these approximations. They designed a series of laboratory experiments to investigate what they termed the "accessibility hypothesis" in which they posit that

the subjective time of an event depends in part on the amount you know about it: The more you know, the more recent the event will seem, other things being equal (Brown, Shevell, and Rips 1984, 3).

To investigate this hypothesis they studied events which had been reported in the news media, thus building into their experiments a means of validating the reported dates.

Four experiments were conducted. In the first, 20 subjects were presented a list of 50 news events that had occurred in the previous five years and asked to date the events. Each event was a member of

a pair of events that had similar content such as assassination attempts on the pope and the president. In general, the pairs were constructed such that the subjects were more likely to have more knowledge about one than the other. As a check on the knowledge ratings, subjects rated the events according to the amount they remembered about them. Although subjects were more accurate in reporting the dates of high-knowledge events, the experiments demonstrated that the temporal dating errors were consistent with the accessibility hypothesis in that the reported dates of high-knowledge events were moved further forward in time than low-knowledge events.

It is evident that Brown, Shevell, and Rips were not concerned with the measurement of temporal dating errors per se but with understanding what the errors revealed about the cognitive processes for recalling and estimating dates of earlier events. The reverse was true for Neter and Waksberg. Their concern was not with the cognitive processes of temporal dating, but with the measurement of survey response errors associated with retrospective reporting of household alteration and repair expenditures. The difference in objectives is reflected in the difference in methodology. The cognitive psychologists conducted controlled laboratory experiments based on small numbers of subjects. On the other hand, the survey researchers conducted field experiments under simulated survey conditions using relatively large numbers of randomly selected respondents.

The NCHS CASM project is designed to combine the survey researchers and cognitive scientists in a common effort to improve the design of survey questionnaires. Neter and Waksberg (1964, 48) noted that their study

was concerned with investigating the existence of telescoping and recall loss and measuring their magnitudes rather than learning their causes. One important factor to be investigated with respect to telescoping is the effect of the type and wording of questions.

The additional research requested by them is indicative of the type of research being investigated by the NCHS study. More particularly, this study is investigating the feasibility and utility of conducting survey questionnaire research in a laboratory setting that makes maximum use of the theory and methods of the cognitive sciences.

## Research Plan

### *Background*

The National Center for Health Statistics is the federal statistical agency responsible for producing national health statistics, and serves as the principal statistical arm of the United States Public Health Service. The center's mission is:

- To maintain a set of data systems capable of meeting the broad needs for accurate national health statistics;
- To make data readily available for data users; and
- To conduct analyses on selected health and epidemiological issues.

A subsidiary mission is:

- To maintain a vigorous methodological research program to improve the design efficiency of health data systems and the quality of health statistics.

The NCHS CASM project is an integral part of the center's methodological research program. It focuses on one phase of the health survey measurement process, namely questionnaire design. Since the Center has never before conducted questionnaire research in a laboratory setting, one objective of this study is to demonstrate the potential utility of this research mode for discharging the Center's ongoing responsibility to understand, measure, and ultimately control response errors in health surveys. Another related objective is to investigate relevant design issues and methods for conducting laboratory-based research on questionnaire design.

This project is being conducted within the framework of one of the major NCHS health surveys, the National Health Interview Survey (NHIS). The NHIS is the main source of information on the health of the civilian, noninstitutionalized United States population. It is an annual survey based on a national sample of about 50,000 households. The United States Census Bureau serves as the NHIS field agent and collects the data in household interviews. An adult household member 17 years of age or older is encouraged to report for him or herself. Proxy responses are obtained for children and members of the household who are infirm or absent during the interview.

The survey aims to provide national data on the incidence of acute illness, the prevalence of chronic conditions and impairments, the extent of disability, the use of health care services, and other health-related topics. The NHIS questionnaire consists of two basic parts: a core set of health, socioeconomic, and demographic items; and one or more sets of supplementary health items. The core items are repeated each year. The supplementary items change yearly in response to changing needs for data. Core items include:

- Demographic information on age, sex, race, education, and family income;
- Disability days during the two-week period preceding the interview week;
- Physician visits during the two-week period;
- Health conditions responsible for disability days and/or doctor visits;
- Long-term activity limitations associated with chronic conditions and impairments; health conditions responsible for the disability;
- Number of hospitalizations during the year preceding the interview; reasons for hospitalization;
- Interval since last doctor visit.

The NHIS supplements are designed to meet the topical needs for national health statistics. Supplement topics have included immunizations, home health care, health insurance, alcohol consumption, dental visits, health maintenance behavior, and so on. For example, the dental care section of the 1983 supplement collected data that are used by public, private, and voluntary agencies to evaluate the success and failure of dental care delivery services and to plan health education and health promotion programs. The respondent reported the number of dental visits and types of services received during the past two weeks, as well as the number of dental visits during the preceding twelve months and the interval since the last visit. Use of fluorides and number of missing teeth were also assessed.

The respondent to the dental supplement was faced with a number of difficult response problems. A judgment about the number of visits during the past year must be made. The respondent must understand the difference between partial bridges, partial dentures, crowns, and caps in order to provide good information on the type of services received. He must recall the date of the last dental visit and calculate the interval between that date and the interview date. This last task was made somewhat easier by allowing the respondent to report in

calendar intervals. The reporting tasks were even more difficult for respondents who served as proxies for children and for absent family members. Imagine, for example, the task of a parent who must report for three children, one of whom is undergoing orthodontia, and for the spouse.

The NHIS was chosen as the subject survey for CASM from among 20 Center surveys and data systems because there was a long history of research on various aspects of the survey methodology and because it had been the subject survey that was reviewed by the Committee on National Statistics seminar on the Cognitive Aspects of Survey Methodology (CNSTAT/CASM). The many studies on measurement methods in the NHIS have included: investigation of different interviewing techniques; studies of interviewer and respondent behavioral and psychological variables; interviewer variance studies; effects of reinforcement, question length, and reinterviews; and several studies of the differences between interview data and data contained in medical records.

None of these prior studies were laboratory based, though one study by Laurent, Cannell, and Marquis (1972) made explicit use of cognitive theories to guide the development of alternate questioning techniques. Three questioning strategies were investigated. One was an intensive interview that was designed to stimulate recall by using multiple recall cues, additional probes, and the use of recognition rather than recall. The second procedure consisted of a diary with a followup interview. It was hypothesized that the diary would improve the reporting of acute illness by minimizing the length of recall and would increase reporting of chronic conditions in the followup interview by sensitizing the respondent to the reporting of health events. The third procedure was the then current NHIS interview. The results showed that the extensive interview did increase the reporting of health events and that acute conditions were more fully reported using the diary. It was recommended, however, that the findings be validated with reliable medical information in order to determine what part of the increased reporting represents better reporting and what part represents overreporting.

### *Work Plan*

The NCHS/CASM project is in its beginning stages and few results are available. Two types of studies are being carried out as collaborative efforts between NCHS staff and cognitive psychologists at research

institutes and universities. The first has the practical goals of evaluating the use of the cognitive research laboratory for designing and testing supplements to the NHIS questionnaire. The second will investigate some intractable cognitive issues associated with specific survey response tasks.

*Development of the 1986 NHIS Supplement.* The supplement to the 1986 NHIS supplement questionnaire will be developed and tested simultaneously by field pretests and in the laboratory, and the results obtained by the two methods will be compared and evaluated. The three components of the 1986 supplement are: dental care, use of vitamin and mineral supplements, and availability of medical insurance.

The current procedure for developing NHIS questionnaire supplements has remained unchanged for many years. It involves two pretests each based on about 400 or 300 households that are located in two selected sites (one for each pretest). The Census Bureau's data collection staff carries out the pretesting under conditions that simulate the regular NHIS interviewing conditions. The NCHS CASM study will be the first systematic evaluation of the NHIS questionnaire development and testing process.

The study is being carried out under a collaborative contract with the National Opinion Research Center and its subcontractor Bolt, Beranek, and Newman. The work has been divided into three phases. At the beginning of the study, NHIS provided the contractor with draft questionnaires for each of the three topics (dental, vitamin and mineral, and medical insurance) covered by the 1986 supplement. After examining various issues concerning the respondent's ability to answer these questions, two cognitive issues were chosen for more detailed investigation in the first phase:

- (1) Recall and estimation strategies used by respondents when trying to determine the number of events in a reference period, for example, the number of dental visits during the past twelve months.
- (2) Judgments by respondents when asked about unfamiliar items. For example, a number of items ask if the respondent has used a certain dental care product. In many cases the respondents would not be expected to know what these products are unless they have used them. How do the respondents answer these questions if the products are unfamiliar to them?



During the first phase, volunteer subjects were brought into the laboratory and interviewed using protocol analysis. This type of analysis involves asking the respondents to think out loud as they respond to the NHIS draft questionnaire. The results of these exploratory studies are being used to develop hypotheses for more formal experiments that will be conducted during the second phase of the study.

During the second phase, the laboratory subjects will be tested using alternative questionnaire versions, and alternative methods of validating their responses will be investigated. Considerable attention will be given to the criteria for selecting about 100 subjects that participate in this phase of the study. Simultaneously, the NHIS staff will conduct its first field pretest of the 1986 NHIS supplement. The laboratory findings and the results of the first NHIS field test pretest will be compared and used to develop at least two questionnaire versions for the final testing.

In the last phase of the study, the questionnaire versions developed in phase 2 will be simultaneously tested in the field and the laboratory, and the lessons learned will be compared to determine if the tests revealed similar questionnaire problems.

A goal of the study is to determine if the laboratory approach is a cost- and time-effective alternative or could serve as an adjunct to the current NHIS questionnaire development process. This assessment will consider which components of the questionnaire design process can be most effectively studied in the laboratory and which components require field testing. Questions of time, cost, response burden, and quality of the final product will all be addressed.

*Experiments on Cognitive Issues.* The second component of the study entails carrying out basic research on specific cognitive issues that are important in survey research. The NCHS will be funding a series of studies with researchers in universities and research institutes with laboratory facilities where there are ongoing programs in the cognitive sciences. Although two particular topics were chosen for these studies, researchers that respond to the "request for proposal" (RFP) are being given fairly wide latitude in proposing specific experiments. In one case, the researchers will focus on problems in survey reporting of chronic health conditions, including physical impairments. In the other case, researchers will investigate the cognitive processes used by NHIS respondents to retrieve health information from memory and the associated error patterns.

To assist responders to the RFP on chronic conditions, the Center commissioned Thomas Jabine (1985) to write a background paper on the findings from previous research studies of the reporting of chronic conditions. The paper reviews the goals and survey operating procedures for collecting chronic conditions in NHIS and summarizes findings from the survey research literature. For example, Jabine notes that:

- Previous studies showed high levels of measurement variance for reports of chronic conditions.
- High levels of underreporting occur; smaller but significant levels of overreporting also occur, and these vary by type of condition.
- Methods of collecting the data such as probes, check lists, extensive interviewing, increase reporting.
- Respondents who feel they are generally healthy may underreport chronic conditions.

As a guide, the RFP listed the following as topics suitable for study:

- Respondents' understanding of the NHIS questions, including the terms "impairment," "health problem" and the condition-list terminology, and the impact of current survey procedures on this understanding.
- Sensitivity to reporting certain conditions.
- Respondents' cognitions related to labeling themselves as impaired or chronically ill.
- Schema related to recalling and reporting chronic conditions.
- The circumstances under which respondents consider the conditions salient.
- The manner in which the original information or their chronic conditions was encoded by the respondents, and cues for stimulating recall of the conditions.
- Proxy versus self-reporting.

A background paper was not prepared for responders to the RFP on recall and estimation strategies. Again, the researchers are free to choose from a large variety of issues that could be considered. These include issues related to the length of the reference period, relative frequency of the health event, and the salience or impact of the health event, etc.

## Potential Benefits of the Cognitive Research Laboratory

When implementing a survey data system, the Center must specify the data requirements, decide on the population to be surveyed, design and select a sample, develop a measurement design which entails designing questionnaires and specifying data collection protocols, locate the sample members and secure their cooperation, collect the data, process and analyze the data, and provide data tapes and summaries to the public. Each component of this complex survey process is subject to error, and each must be considered when evaluating the quality of a survey-based data system. The Center currently maintains a vigorous program of methods research directed at evaluating and improving the quality of each component of its surveys. An ongoing research program that employed the cognitive sciences and/or laboratory methods may be a valuable addition in this continuing effort to evaluate and improve survey design. One of the goals of the current CASM project is to judge the place of such a research program within the Center's ongoing research and evaluation activities. In making this judgment, we will be thinking about the multiple components of surveys and considering the role that laboratory research and the cognitive sciences could play in assessing and enhancing the quality of each component, but by far the principal area of concern will be the questionnaire design component.

Each survey is unique, has its own design and its own concomitant error structure. It is possible, however, to provide a general classification of the types of activities that are part of a survey data system and of the kinds of errors that can occur within the survey data system. In table 1, a survey data system is divided into three stages—the presurvey stage, the survey stage, and the postsurvey stage. The presurvey stage involves assessing the needs for the information and deciding what, if any, statistical system can meet these needs. The survey stage includes all activities associated with the actual design and execution of the survey including sample design, data collection, and analysis. The postsurvey stage occurs after the survey is completed and encompasses evaluating and using the survey results to assist in making policy decisions. Errors can occur at each stage.

Some of the errors that can occur in each stage of the survey process are listed in table 1. The Center conducts ongoing evaluations in each of these areas. For example, in the late 1970s a technical consultant panel evaluated how well NHIS was meeting its legislative mandate.

TABLE 1  
Potential Sources of Error in a Sample Data System

Presurvey activities and decisions	Errors associated with the decision to do a survey: failure to consider alternative sources of information; doing a survey on a topic for which an appropriate survey methodology is not available; lack of well-specified goals.		
Survey activities and decisions	<i>Sampling Errors</i>	<i>Nonsampling Errors</i>	<i>Measurement</i>
	Errors associated with the sample design. Includes the impact of stratification, sample size clustering, weighting, estimation of population parameters and of standard error.	Errors due to missing data for sample members. Includes errors due to failure to locate the sample members, refusals to be included in the survey, and refusals to answer specific questions.	Errors due to developing and executing a measurement method. Includes questionnaire development, mode of interview, interviewer training and actions. Respondent problems of understanding, recall, judgment, motivation, and reporting. Reactions to the response task, the interviewer, problems of self-presentation.
Postsurvey activities and decisions	Errors associated with the use of the results in formulating policy decisions: Drawing conclusions unsupported by the data due to failure to consider all the results, ignorance of sampling and measurement errors, assuming real differences between subgroups or overtime when the results do not support the conclusion; Assuming results are incorrect when they do verify preexisting expectations and vice versa.		

A major emphasis of that evaluation was the relevance of the survey content and its usefulness to federal, state, and local health programs. The Center routinely calculates sampling errors of NHIS statistics, and decennially evaluates the NHIS sample design and redesigns it accordingly. Numerous studies of the NHIS measurement methods have also been conducted, and some of these were mentioned earlier in the article.

How can a research program employing the cognitive sciences and laboratory methods be used in this evaluation process? The cognitive sciences are concerned with studies of memory, thinking, awareness, learning, problem solving, judgment, and decision making. We expect that laboratory methods and the knowledge of the cognitive sciences will be useful in developing survey instruments and studying the errors associated with them. Numerous problems of recall, judgment, and understanding arise during the development and administration of questionnaires. Many anomalous effects have been demonstrated—variation across interviewers, the mode of interview (mail, telephone, face-to-face), context of question, ordering of response alternatives, sensitivity, saliency, reference period, number of times interviewed, and so on. Traditional survey research methods for investigating these problems depend heavily on field studies which have limited control over the interview environment, place strict demands on respondents and interviewers, and do not permit a close intense working relationship between researchers, interviewers, and respondents. Furthermore, the field experiment cannot manipulate the full range of important variables likely to influence survey response, and cannot take full advantage of the knowledge and techniques of the cognitive sciences and the kinds of technology currently available for laboratory use.

It may be easier to examine the cognitive components of survey tasks and to learn which response errors are caused by laboratory experimentation and which by field studies. Greater control over types of subjects, questioning strategies, and validation methods may make questionnaire design experiments easier to design and interpret, and less costly and time consuming to execute in the laboratory than in the field setting.

The knowledge of error structure gained from laboratory experiments may be helpful in developing statistical models to estimate survey measurement errors. It may be possible in some cases to substitute laboratory studies for elaborate and costly field experiments. Even if

only partially successful, these laboratory-based models would provide an alternate or complement to the traditional methods of estimating survey measurement errors, and would have potential benefits of major proportions in improving the design of survey instruments and the quality of survey statistics. Examples of cognitive laboratory findings that might be incorporated in response error models are the robustness of survey response to changes in questionnaire design and confidence ratings that respondents attach to their survey responses.

The use of the cognitive research laboratory for the design and evaluation of survey questionnaires is the main focus of the current NCHS CASM project. However, when considering future long-term benefits of a research program employing the cognitive sciences, it is important to note that other areas of the whole process of developing a data system may benefit from study by the methods of the cognitive sciences. One of the continuing concerns of statisticians who are involved in establishing and evaluating statistical data systems that aim to provide information that will guide policy is to develop methods for determining the usefulness of the statistical systems. Kruskal and Mosteller (1980, 183) comment that there is "no general method of appraising the value of statistical information" and that "the lack of this methodology is a shameful gap that economists, statisticians, and information scientists ought to fill." Perhaps cognitive psychology could be helpful in this task.

Studies of judgment and decision making have attempted to identify and evaluate decision-making strategies and the role that information plays in the process. For example, Wallsten (1981) reported on the results of an experiment that examined the use of diagnostic information by physicians and medical students in arriving at a diagnosis. Several cognitive biases (incorrect assessments of the information) were demonstrated in the study. He comments, as do others (Tversky 1974; Tversky and Kahneman 1974), that these biases arise because people have a limited ability to store and consider information and thus develop less than optimal, but usually adequate, strategies for making judgments when facing a complex decision. He suggests that steps can be taken to reduce these cognitive limitations and cites the success of the use of decision aids in medical diagnosis.

Analogously, deciding whether or not to commission a survey is a complex task, and a study of this process would undoubtedly reveal cognitive biases. Perhaps studies of judgment and decision making

would be very helpful in appraising the usefulness of the survey information in guiding policy decisions. One goal of such studies might be to develop decision aids that would assist the policy maker in the correct use of factual information when either deciding to do a survey or when formulating policy after reviewing the survey results.

Another area in which the cognitive sciences are likely to be useful is in the understanding and control of nonresponse. Some nonresponse results from the failure of the survey staff to locate some respondents, but a more important source of nonresponse is refusal by the respondents to participate in the survey or to answer particular questions. The cognitive issues relating to survey participation, such as the degree to which the respondent understands what is being asked of him, what the confidentiality assurances mean, etc., are fruitful areas for laboratory study. By gaining a better understanding of the cognitive factors that influence survey participation it may be possible to develop survey techniques that would enhance response rates.

Although the approach being used by NCHS is defined by survey research problems, the long-term benefits of this project could benefit the cognitive sciences as well as survey research. The NCHS CASM project will hopefully stimulate ideas for basic research in the cognitive sciences. Consider, for example, the opportunities for laboratory-based research offered by the following cognitive problems in surveys:

- Effects of bounded and unbounded reference periods on the temporal judgments of survey respondents;
- Effects of complex concepts (*viz.*, chronic disease, disability, unemployment, etc.) on the comprehension of survey questions;
- Effects of conditioning on responses to survey questions;
- Effects of survey strategies for desensitizing sensitive survey questions (*viz.*, illicit drug use, drinking behavior, abortion, etc.) on respondents' perceptions of data confidentiality.

This project may also work to the benefit of cognitive psychologists by increasing their awareness of modes of conducting cognitive research outside the laboratory. For example, the population survey accesses persons that are outside the range of those ordinarily available to the cognitive scientist, and thus the survey could serve as a tool for testing and verifying laboratory-based findings.

Since the NHIS will serve as the survey vehicle for the laboratory experiments, it has the most to gain in the short run from the project even though the findings will have a broad applicability to scientific surveys. The project could result in substantial improvements in the existing NHIS methods of constructing and field testing the annual supplements to the NHIS questionnaire, and of researching a variety of NHIS design features which have important cognitive components. Applying laboratory methods and cognitive theory could lead, over the long term, to improved NHIS respondent rules, counting rules, data collection modes, and survey instruments, and ultimately to better quality national health statistics.

In summary, NCHS is conducting a demonstration project using laboratory methods and the theories of cognitive science to design and evaluate questionnaires; is studying specific sources of error using these methods; is examining the statistical and experimental approaches of the two fields (cognitive science and survey research); and will be evaluating the results with the goal of determining the place of cognitive science and laboratory methods in the study and reduction of survey errors.

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