

Improving food frequency questionnaires: A qualitative approach using cognitive interviewing

AMY F. SUBAR, PhD, RD; FRANCES E. THOMPSON, PhD, MPH; ALBERT F. SMITH, PhD; JARED B. JOBE, PhD; REGINA G. ZIEGLER, PhD, MPH; NANCY POTISCHMAN, PhD; ARTHUR SCHATZKIN, MD, PhD; ANNE HARTMAN, MS; CHRISTINE SWANSON, PhD, RD; LAURA KRUSE, MPH, RD; RICHARD B. HAYES, PhD; DENISE RIEDEL LEWIS, PhD; LINDA C. HARLAN, PhD

ABSTRACT

In an attempt to improve data quality and ease of administration of standard self-administered food frequency questionnaires, various alternative approaches were tried for inquiring about frequency of consumption, portion size, seasonal intake, and food preparation. Evaluation consisted of a cognitive interviewing method in which respondents verbalize their thought process while completing several variations of a questionnaire. Interviewers observed and asked follow-up probe questions to evaluate problems or inconsistencies verbalized by respondents. Consensus and judgment by interviewers and observers suggested several problematic features of food frequency questionnaires: formatting of questions about frequency and portion size; computing average frequencies for aggregated food items or for foods eaten seasonally; comprehension of many items; and ordering of foods. These findings led to cognitive refinement and innovations, which included detailed questions regarding preparation or use of low-fat varieties or other alternatives to help better describe specifics of intake for some foods; questions on seasonal intake for several foods; inclusion of portion size ranges; and additional response categories for frequency of intake. Cognitive interviewing is an important step in pinpointing cognitive problems in dietary questionnaires. *J Am Diet Assoc.* 1995; 95:781-788.

Food frequency questionnaires are often used to assess usual dietary intake of people in epidemiologic investigations of diet and chronic disease. Such questionnaires are interviewer-administered or self-administered and assess typical diet quickly and inexpensively compared with multiple daily records of individual food consumption. Although food frequency questionnaires lack precision, there are few practical and economical alternatives to this method for most large population studies. Creating a food frequency questionnaire is an intensive effort requiring development of an appropriate food list, establishment of a nutrient database, design of a questionnaire format, and preparation of software to process the data. Thus, many investigators have relied on the small number of instruments (1,2) that have been developed and validated.

A.F. Subar is a nutritionist, F.E. Thompson and L.C. Harlan are epidemiologists, A. Hartman is a statistician, and A. Schatzkin is a physician in the Division of Cancer Prevention and Control, R.G. Ziegler, N. Potischman, and R.B. Hayes are epidemiologists and C. Swanson is a nutritionist in the Division of Cancer Etiology at the National Cancer Institute, Bethesda, Md. A.F. Smith is a psychologist in the Department of Psychology, Cleveland State University, Cleveland, Ohio. J.B. Jobe is a psychologist with the Behavioral and Social Research Program at the National Institute on Aging, Bethesda, Md. L. Kruse is a nutritionist with the Health Resources and Services Administration, HIV/ Substance Abuse Branch, Rockville, Md. D.R. Lewis is an epidemiologist with the Environmental Protection Agency, Research Triangle Park, NC.

At the time of the study, A.F. Smith was a psychologist in the Department of Psychology, State University of New York at Binghamton; J.B. Jobe was a psychologist at the National Center for Health Statistics, Office of Research and Methodology, Hyattsville, Md; L. Kruse was a nutritionist in the Division of Cancer Prevention and Control, National Cancer Institute; and D.R. Lewis was an epidemiologist with the Nova Research Company, Bethesda, Md.

Address correspondence to: Amy F. Subar, PhD, MPH, National Cancer Institute, Division of Cancer Prevention and Control, EPN 313, 6130 Executive Blvd, MSC 7344, Bethesda, MD 20892-7344.

When nutrient or food group intakes estimated by food frequency questionnaires have been compared with reference data from multiple food records or recalls to evaluate validity, the correlation coefficients have ranged from 0.5 to 0.8 (3-5). Although these observed correlations may underestimate true validity because the reference instrument is itself an imperfect measure of usual diet, the food frequency approach is frequently criticized because it lacks detail (6-8).

Even though the food frequency approach plays a pivotal role in chronic disease epidemiology, methodologic research focused on its improvement has been limited (9-11). Studies have addressed the accuracy of frequency reports (12-14), the effect of aggregating individual foods in a single question (15), and the effect of using ascending vs descending frequency response categories (16). Whether or not to include questions about portion size in food frequency questionnaires (3,17-24) and the accuracy of portion size estimation (25,26) have also been investigated.

In the past decade, research using cognitive psychology has led to increased validity of self-report data in surveys and in epidemiologic research (27,28). A key feature of these methods is an intensive interviewing procedure for improving questionnaires (29-32). Respondents are encouraged to verbalize their thought processes as they comprehend the question, retrieve information from long-term memory, and use decision processes to provide estimates and responses. Follow-up probe questions are also used extensively to clarify the respondent's thought processes.

Our collaborative group used cognitive interviewing to improve methods for assessing usual dietary intake. We modified various aspects of the previously developed National Cancer Institute-Block Health Habits and History Questionnaire (HHHQ) (1,33) and cognitively tested these modifications on a small nonrepresentative group of participants. We were interested in determining the cognitive strategies people use to formulate responses to food frequency questions, and identifying consistent problems in comprehension, interpretation, or formulation of answers to either specific questions or to general classes of questions. Our intent was to design a user-friendly, self-administered, computer-scannable questionnaire that could be completed using paper and pencil and that might yield more valid and complete dietary intake data with less frustration to respondents than currently available food frequency instruments.

GENERAL METHODS

In each of two iterative phases, conducted 2 months apart, 24 different participants between 50 and 70 years of age were recruited by a community newspaper advertisement and word of mouth to participate in a 2-hour interview. Each participant was paid \$50. We attempted to recruit equal numbers of men and women, but made no attempt to stratify by or collect data on other demographic characteristics. For phase 1, 11 men (mean age=61.3 years; range=51 to 73 years) and 13 women (mean age=63.6 years; range=54 to 70 years) were enrolled; one person canceled. For phase 2, 12 men (mean age=61.8 years; range=50 to 71 years) and 12 women (mean age=58.4 years; range=50 to 68 years) were enrolled; two persons canceled.

At the interview, participants were given one or more versions of a food frequency questionnaire (described later) to complete. Standard instructions and examples were provided for each questionnaire. The interviews were conducted by A.F.S, F.E.T, A.F.S, J.B.J, often with one or two observers present. Using a concurrent think-aloud protocol (34), participants were instructed to verbalize their thought processes as

they comprehended questions and formulated responses. As respondents completed questions about individual food items, interviewers noted when they were having difficulty with any aspect of answering, either in comprehension or completion. If necessary, interviewers probed to further assess the reason for the difficulties. All interviews were audiotaped with informed consent.

As the intent of this work was to evaluate the feasibility of new methods of inquiring about usual diet and to assess any general aspects of questionnaires that could be improved, the setting was of a pretesting, exploratory nature. The interviewers used judgment and consensus to assess which methods or questions were problematic. The results serve as a first step in developing future questionnaires and represent what the interviewers and observers judged to be reasonable difficulties in this small sample in the interpretation and response to questions. We recorded all problems in detail, but report here only those encountered by many respondents.

PHASE 1: DESIGN

Questionnaires developed for phase 1 contained an abbreviated 43-item food frequency questionnaire based on the HHHQ (1,33). Eight variants of the questionnaire were designed to test different approaches, which we describe later. Each respondent was asked to complete three of these questionnaires in the 2-hour period.

Portion Size

We tested the standard HHHQ approach (Figure 1, Example 1) and two alternative methods of asking about usual portion size. One alternative was to replace the "small," "medium," and "large" columns (appearing as "S," "M," and "L" on the standard questionnaire) with ranges of portion size (Figure 1, Example 2). A second alternative used the word "helping(s)" in describing portion sizes (Figure 1, Example 3).

Frequency and Time Frame

We explored several methods of reporting frequency of consumption for various time frames. First, similar to the earliest HHHQ questionnaire, we asked some people to report frequency in an open-ended format, writing a value for frequency in a designated space and then checking the appropriate column for day, week, month, or year time frame. Second, we asked some people to report intake over the past 4 weeks and some to report intake over the past year using the closed-ended response categories currently used in the computer-scannable HHHQ. For the 4-week reference period only, we asked some people to report counts (ie, exactly how many times a food was consumed in the past 4-week period) and some to report rates (ie, times per day, week, or month).

Embedded Questions

We tested whether embedding questions that asked for more detailed information about preparation and/or use of low-fat or other versions after specific food items would aid in better eliciting and defining the food as consumed. Embedded questions were asked for several foods using two different response categories, one with three categories ("almost never or never," "sometimes," "almost always or always") and one with five categories (Figure 2).

Anchoring

We tested whether having respondents "anchor" their frequency responses to a food or foods for which they were confident would aid in completing frequency responses for other foods about which they were less sure. We tried several

Example 1: Standard method

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	MEDIUM SERVING	YOUR SERVING SIZE		
											S	M	L
Peas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	1/2 cup	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Example 2: Range method

TYPE OF FOOD	HOW OFTEN									HOW MUCH		
	Never or less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	YOUR SERVING SIZE		
										Less than 1/4 cup	1/4-3/4 cup	More than 3/4 cup
Peas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Example 3: Helpings method

TYPE OF FOOD	HOW OFTEN									HOW MUCH		
	Never or less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	YOUR SERVING SIZE		
										Less than 1 helping	1 helping	More than 1 helping
Peas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

FIG 1. Examples of methods used to query portion size in phase 1.

ways of anchoring respondents: (a) thinking of a food, recording frequency of consumption in an open-ended manner, and then using it as an anchor, or point of reference, in responding to frequency for other foods in the same food group; (b) choosing one food already on the food list as an anchor, reporting its frequency, and then using it as an anchor in responding to other foods in the same food group; and (c) choosing any number of foods from the food group list as anchors and using them for the remainder of the foods.

PHASE 1: FINDINGS

Portion Size

In all cases, people tended to skip portion size questions after completing frequency. Of the three approaches to portion size (Figure 1), the one providing ranges of portion size within the columns for small, medium, and large appeared easiest for respondents to understand and complete. The meaning of the word, "helpings," to describe portion size was unclear to respondents.

In the standard HHHQ format, the reference medium portion size is placed to the left of the "S," "M," and "L" columns (for "small," "medium," and "large"). Several respondents did not comprehend the purpose of the reference portion size column. Some checked the "S" column to indicate a medium portion size because it was directly adjacent to the reference medium portion size column.

The reference medium portion size was purposefully disregarded by some respondents because the reference amount did not represent a "medium" portion size as perceived by the respondent.

Frequency and Time Frame

The open-ended response format, while allowing participants to report frequency at a level that suited their cognitive preferences, appeared to be conducive to error, especially with the format and instructions we used. Although respondents recorded a value representing frequency of consumption, they often failed to check a time-frame category for day, week, month, or year as appropriate. The open-ended format may be

PERSPECTIVES IN PRACTICE

TYPE OF FOOD	HOW OFTEN										HOW MUCH		
	Never or less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	MEDIUM SERVING	YOUR SERVING SIZE		
											S	M	L
Cold breakfast cereal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	1/2 cup	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
HOW OFTEN													
How often is your cereal:	Almost never or never	Infrequently	Sometimes	Frequently	Almost always or always	Don't know							
High fiber, bran, or granola cereals, shredded wheat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Highly fortified cereals, such as Total, Just Flight, or Product 19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Other cold cereals, such as corn flakes, Rice Crispies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
How often do you put sugar on your cereal?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
How often do you put milk on your cereal?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
HOW OFTEN													
HOW MUCH													
TYPE OF FOOD	HOW OFTEN										HOW MUCH		
	Never or less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	MEDIUM SERVING	YOUR SERVING SIZE		
											S	M	L
Spaghetti, lasagna, other pasta	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	1 cup	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
HOW OFTEN													
How often do you add the following things to your pasta?	Almost never or never	Infrequently	Sometimes	Frequently	Almost always or always	Don't know							
Cheese sauce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Cream sauce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Oil	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Margarine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Tomato/spaghetti sauce with meat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Tomato/spaghetti sauce without meat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
HOW OFTEN													
HOW MUCH													
TYPE OF FOOD	HOW OFTEN										HOW MUCH		
	Never or less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	MEDIUM SERVING	YOUR SERVING SIZE		
											S	M	L
Cottage cheese	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	1 cup	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
HOW OFTEN													
How often is your cottage cheese:	Almost never or never	Infrequently	Sometimes	Frequently	Almost always or always	Don't know							
Regular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
Low-fat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							

FIG 2. Examples of embedding methods in phase 1.

more suitable for an interview-administered than for a self-administered questionnaire.

Although respondents easily reported frequency of consumption in a closed-ended fashion, they often complained or were confused about the lowest frequency category, "never or less than once per month." Many simply missed the word "never" in the category. Others, attempting to be accurate, were searching for a way to report an unqualified "never" in the response categories.

Reporting in counts rather than rates appeared easier for infrequently consumed foods. For items eaten fairly regularly, counts tended to be difficult; some respondents struggled in formulating an exact count by trying to remember each discrete event of eating the food over the past 4 weeks.

For food items eaten seasonally, like corn-on-the-cob, cooked cereal, and some fruits, respondents had difficulty reporting a composite frequency over the past year. The challenge of mathematical computation over four seasons in an effort to report one yearly frequency caused frustration, leading to extra time spent in responding or to inaccuracies as revealed by probe questions. In some cases, people just reported their most current intake or their intake in season only.

Reporting usual intake over the past 4 weeks (as a rate) compared with the past year was an easier task for many respondents, though some expressed discomfort that the past 4-week period was atypical of their usual intake. Although it is not surprising that reporting intake over the past 4 weeks is easier than over the past year, part of the ease appeared to stem from not having to confront seasonal intake of many food items.

Embedded Questions

Embedding appeared to be less frustrating for respondents because it allowed for more flexibility in describing possible ways a food could be consumed. A common problem, however, was that respondents answered only one of several embedded items despite instructions to answer all.

Anchoring

The various methods of anchoring frequency responses to foods about which people felt sure of their intake were generally confusing and unsuccessful with the format and instructions we used. Few respondents seemed to understand the task or to actually use anchors. We concluded that this method required further development and might require interviewer assistance to be useful.

Level of Aggregation of Food Items

For two separate items that we queried, "apples, applesauce, and pears" and "tomatoes, tomato juice," the aggregation of food items caused many respondents difficulty and, thus, increased time to answer. Respondents tended to think of the items listed as separate foods rather than variations of the same food, so they attempted to compute an aggregate frequency response. Many respondents also had difficulty reporting an aggregate usual portion size (eg, "one apple or 1/2 c" or "one tomato or 6 oz") when each of the aggregated items might be eaten with different usual portion sizes.

Three line items pertained to intake of cold breakfast cereal in the HHHQ ("highly fortified," "high fiber," "others"). This presented cognitive difficulties because people did not know to which category their cereal belonged; bought various types of cereals, but consumed them one at a time; substituted cereals on a regular basis in a single week; and mixed cereals in a single bowl. Although the standard HHHQ questionnaire allows people to report their complex behaviors through appropriate averag-

ing over a time period, or through adjustment of portion size, such strategies were difficult for respondents, leading to answers on the questionnaire that were inconsistent with their answers to probe questions.

Food Reported in Units

Many respondents reported number of eggs instead of how frequently eggs were eaten. (For example, probing revealed that people reported "two times per week" when they were thinking "two eggs per week.") This would not be problematic if these same respondents reported a portion size of "small" (one egg) rather than "medium" (two eggs). This kind of mathematical manipulation often did not occur, however, causing frequent misrepresentation of intake. Further, a few people confused "small," "medium" and "large" portion sizes with small-, medium-, and large-sized eggs. People who usually consumed egg substitutes or egg whites in place of whole eggs were not sure how to respond to this question.

Comprehension and Ordering

We found numerous small problems with comprehension on the questionnaire, which are illustrated in the following examples.

- *"Fruit drinks with added vitamin C"* Respondents tended to ignore the phrase, "with added vitamin C," and there was general lack of knowledge regarding types of drinks to include.

- *"Mixed dishes with cheese, such as macaroni and cheese"* Frequently, confusion arose about the types of food to include. Respondents included foods like veal parmesan, cheese sandwiches, and pizza, which had already been asked. When "other cheese" was asked subsequently, double-counting often occurred. Others thought only of macaroni and cheese and did not consider other types of mixed dishes.

- *"Breakfast foods" as a heading on the questionnaire* This made several people uncomfortable because they ate some foods in this grouping, such as eggs or cold cereal, at times other than at breakfast.

- *"Green salad"* Several people were confused by this terminology because their salads included items that were not green, such as tomatoes.

- *"Spaghetti, lasagna, other pasta with tomato sauce"* Respondents were confused about whether to include only pasta with tomato sauce or all other kinds of pasta.

The order in which foods were asked was important. For example, in our brief questionnaire, "oranges" was asked before "orange juice or grapefruit juice." Several respondents included orange juice when reporting frequency of orange intake.

PHASE 2: DESIGN

The intent of phase 2 was to develop a questionnaire incorporating the most successful approaches from phase 1 and to continue experimenting with format and wording. We developed two questionnaires, each with a complete list of foods (100 items based primarily on the HHHQ questionnaire) intended to capture intake of most nutrients and commonly consumed foods in the United States from 1976 to 1980. Each respondent was asked to complete one questionnaire in the cognitive interview.

Findings from phase 1 and other approaches tested in phase 2 included:

- *Portion size* We decided to use a portion size format that would put the reference value in the same column as the "M" response category (Figure 3, Examples 1 and 2).

- *Frequency and time frame* Although respondents found it easier to use a reference period of the past 4 weeks than the

past year, past month was deemed unsatisfactory because investigators needed to assess usual diet over a longer period. Questions related to seasonal variation in intake over the past year were added (Figure 3, Example 1). We tested use of the time frame "typical month" to help respondents think of a short time interval without losing information about usual long-term intake. We added a "never" response category for frequency and tested expanded frequency response categories (Figure 3, Example 2) to accommodate intakes lower and higher than those found on the standard questionnaire. Open-ended response categories for frequency were not tested further.

- *Embedded questions* Embedding was revised and expanded to additional foods by using five qualitative response categories and a "don't know" category (Figure 3, Example 3).

- *Anchoring* No further methods were pursued.

- *Comprehension and ordering* Several changes in wording, ordering of food items, and disaggregating foods from a single line item to multiple lines were incorporated into phase 2 questionnaires. The food item "eggs" was placed at the end of the questionnaire and reformatted as "how many" eggs were eaten vs "how often" (Figure 3, Example 3).

Comprehension and ease of administration of dietary assessment methods currently in use can be improved through cognitive interviewing of respondents

PHASE 2: FINDINGS

Portion Size

Portion sizes in ranges appeared to be preferable to approaches that used a reference medium portion size. Although wordier, this method allowed respondents to select a portion size disassociated with the terminology "small," "medium," or "large." The reference medium portion size approach with the portion size in the "M" column was also satisfactory; respondents were able to choose a portion size and did not confuse the reference with "S" as in the standard HHHQ approach. As in phase 1, many respondents skipped portion size questions after completing frequency questions, regardless of approach.

Frequency and Time Frame

Respondents were generally comfortable with both the expanded and the more standard versions of the response categories for frequency. In the expanded version, the lower frequency categories ("1-6 per year" or "7-11 per year") were used frequently, and the higher frequency categories ("4+ per day") were used rarely. Therefore, it may not be useful to expand the frequency categories to beyond "2+ per day" for nonbeverage items. (The standard questionnaire extended to "6+ per day" for beverages like coffee, tea, and milk.)

In phase 2 we found that "past year" was preferable to "typical month," especially when questions asked about seasonal intake. The meaning of "typical month" was unclear to respondents and was especially confusing when they were asked about seasonal intake in a typical month.

Asking about seasonal intake of many foods generally worked well in conjunction with a "past year" time frame. Respondents

did not seem to mind being asked about the same food twice, once in season and once the rest of the year, though this increased questionnaire length. We found that increased page length did not necessarily translate to increased time in completing the questionnaire if the longer version allowed the respondent to answer more quickly. However, there was some confusion, regarding whether or how to include frozen and canned items when asking about intake in season.

Embedded Questions

The general consensus among the interviewers was that embedding should continue to be used and refined. Without greatly increasing respondent burden, embedding allowed for more detail in low-fat food options, and in eliciting food choices and food preparation techniques. Problems still existed with respondents not answering embedded items (though instructed to do so). We noticed that the qualitative response categories were not understood similarly among respondents. In the future, we hope to test a more quantitative format.

Comprehension and Ordering

Changes based on findings from phase 1 made it easier to respond in phase 2. For example, disaggregating "apples, applesauce, and pears" and "tomatoes and tomato juice" facilitated responses without adding inordinate time delays and computations. In phase 2, we tested a longer list of food items that included new wording for embedded questions. This provided new opportunities for improving wording and ordering as illustrated by the following examples.

- *Coffee* For most people, responses about coffee intake are cognitively thought of as cups per day and not times per day; questions about coffee intake should be worded in that way.

- *Hamburgers, cheeseburgers, and meatloaf* Several respondents wanted to include burger products made with ground poultry. Therefore, inclusion of the word "beef" would be necessary to clearly assess intake of beef products. A separate item for ground poultry, listed before ground beef, is warranted.

DISCUSSION

Our findings suggest that, among the many tasks required to develop a food frequency instrument, focusing on the respondent's perceptions of the meaning of the questions is fundamental to good questionnaire design. Listening to and then probing respondents as they verbalize their thought processes while completing a food frequency-type questionnaire is a sobering experience. We were forced to reconsider fundamental issues in questionnaire design to obtain the best data from the most people. This project suggests that comprehension and ease of administration of dietary assessment methods currently in use can be improved through cognitive interviewing of respondents. In the future we hope to show that, by better addressing the concerns of the respondents, more accurate dietary intake data can be collected. Although widely used food frequency questionnaires have been pre-tested, we are unaware of any intensive cognitive interviewing conducted during their development.

In this project we conducted two rounds of cognitive interviews in an iterative process to compare standard and new approaches of asking about usual food intake. In addition to our findings suggesting many wording and ordering changes that would improve the comprehensibility of the questionnaire, the results indicated that the following new approaches appeared to result in fewer comprehension problems, less frustration, and answers that were more consistent with respondents' answers to follow-up probe questions: embedded questions, ranges for portion size, questions about seasonal intake, inclu-

Example 1: Seasonal intake and modified reference medium size

TYPE OF FOOD	HOW OFTEN										HOW MUCH			
	Never	Less than once per month	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	YOUR SERVING SIZE			
											S	M	L	
Peas (fresh, canned, or frozen) (IN SEASON)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1/2 cup	<input type="checkbox"/>
Peas (fresh, canned, or frozen) (REST OF THE YEAR)	Same as in season <input type="checkbox"/>	<input type="checkbox"/>	1/2 cup											

Example 2: Expanded frequency categories

TYPE OF FOOD	HOW OFTEN											HOW MUCH			
	Never	1-6 per year	7-11 per year	1 per month	2-3 per month	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2-3 per day	4+ per day	YOUR SERVING SIZE		
Peas	<input type="checkbox"/>	Less than 1/4 cup <input type="checkbox"/>	1/4-3/4 cup <input type="checkbox"/>	More than 3/4 cup <input type="checkbox"/>											

Example 3: Eggs

TYPE OF FOOD	HOW OFTEN								
	Never eat eggs	Less than 1 egg per month	1-3 eggs per week	1 egg per week	2 eggs per week	3-4 eggs per week	5-6 eggs per week	1 egg per day	2-3 eggs per day
How many eggs, egg whites, or egg substitutes do you eat NOT counting in baked goods and desserts?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	SKIP								
How often are your eggs:	HOW OFTEN								
	Almost never or never	Infrequently	Sometimes	Frequently	Almost always or always	Don't know			
Egg substitutes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Eaten as egg whites only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Regular	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Cooked in oil, butter, or margarine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Boiled or poached	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			

FIG 3. Examples of formatting in phase 2.

sion of a "never" response category for frequency, disaggregation of foods with dissimilar eating patterns as single items (eg, tomatoes and tomato juice), and addition of unit-specific response categories for foods for which intake is thought of primarily as units (eg, eggs per week). Our results concur with those of others (29-32) in demonstrating that the cognitive interview is an effective technique for improving health survey data about such topics as functional status in the elderly, dental health, radon exposure, and use of assistive devices.

Our complete questionnaire was long (35 pages). We found, however, that modifications that increased the page length of the questionnaire often appeared to decrease the total time of the interview because of better comprehension, easier retrieval, and less computation in forming a response. Further development is ongoing to increase ease of use through modifying print size and appearance, clarifying skip patterns, and maximizing the use of paper space. The user-friendly nature of a questionnaire may be an important factor in designing a successful final version. Nevertheless, a longer instrument will need to be carefully evaluated with respect to response rates. We also plan to use nationally representative dietary intake data collected from 1989 to 1991 (35) to create a food list and nutrient database that reflect the current food supply and consumption practices.

APPLICATIONS

Researchers who design new dietary instruments should conduct cognitive interviewing to pinpoint problems encountered by respondents. Our findings suggest approaches that we believe may facilitate the collection of more useful dietary data from older men and women. We did not, however, examine validity of the portion size or frequency estimates. Thus, we plan to conduct a validation study of the final version of this cognitively designed food frequency questionnaire using multiple days of food records or recalls. Further development and validation will also be required to assess utility among other age, race/ethnic, and socioeconomic subgroups. Our goal is to design a frequency-type questionnaire that is appealing and comprehensible to respondents, and that provides accurate data and high participation rates for investigators.

References

1. Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnaire design and testing. *Am J Epidemiol.* 1986; 124:453-469.
2. Willett WC, Sampson L, Stampfer MJ, Rosner B, Bain C, Witschi J, Hennekens CH, Speizer FE. Reproducibility and validity of a semiquantitative food frequency questionnaire. *Am J Epidemiol.* 1985; 122:51-65.
3. Hartman AM, Block G. Dietary assessment methods for macronutrients. In: Micozzi MS, Moon TE, eds. *Macronutrients: Investigating Their Role in Cancer.* New York, NY: Marcel Dekker; 1992:87-124.
4. Feskanich D, Rimm EB, Giovannucci EL, Colditz GA, Stampfer MJ, Litin LB, Willett WC. Reproducibility and validity of food intake measurements from a semiquantitative food frequency questionnaire. *J Am Diet Assoc.* 1993;93:790-796.
5. Salvini S, Hunter DJ, Sampson L, Stampfer MJ, Colditz GA, Rosner B, Willett WC. Food based validation of a dietary questionnaire: the effects of week-to-week variation in food consumption. *Int J Epidemiol.* 1989; 18:858-67.
6. Sempos CT. Invited commentary: some limitations of semiquantitative food frequency questionnaires. *Am J Epidemiol.* 1992; 135:1127-1132.
7. Briefel RR, Flegal KM, Winn DM, Loria CM, Johnson CL, Sempos CT. Assessing the nation's diet: limitations of the food frequency questionnaire. *J Am Diet Assoc.* 1992; 92:959-962.
8. Liu K. Statistical issues related to semiquantitative food-frequency questionnaires. *Am J Clin Nutr.* 1994; 59 (suppl):262S-265S.
9. Friedenreich CM. Improving long-term recall in epidemiologic stud-

- ies. *Epidemiology.* 1994; 5:1-4.
10. Kohlmeier L. Gaps in dietary assessment methodology: meal- vs list-based methods. *Am J Clin Nutr.* 1994; 59(suppl):175S-179S.
11. Baranowski T, Domel SB. A cognitive model of children's reporting of food intake. *Am J Clin Nutr.* 1994; 59(suppl):212S-217S.
12. Smith AF. Cognitive processes in long-term dietary recall. National Center for Health Statistics. *Vital Health Stat.* 1991; 6(4).
13. Smith AF, Jobe JB, Mingay DJ. Retrieval from memory of dietary information. *Appl Cogn Psychol.* 1991; 5:269-296.
14. Smith AF, Jobe JB, Mingay DJ. Question-induced cognitive biases in reports of dietary intake by college men and women. *Health Psychol.* 1991; 10:244-251.
15. Serdula M, Byers T, Coates R, Mokdad A, Simoes EJ, Eldridge L. Assessing consumption of high-fat foods: the effect of grouping foods into single questions. *Epidemiology.* 1992; 3:503-508.
16. Kuskowska-Wolk A, Holte S, Ohlander EM, Bruce A, Holmberg L, Adami HO, Bergstrom R. Effects of different designs and extension of a food frequency questionnaire on response rate, completeness of data and food frequency responses. *Int J Epidemiol.* 1992; 21:1144-1150.
17. Willett W. *Nutritional Epidemiology.* New York, NY: Oxford University Press; 1990.
18. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol.* 1990; 43:1327-1335.
19. Hankin JH, Rhoads GG, Guber GA. A dietary method for an epidemiologic study of gastrointestinal cancer. *Am J Clin Nutr.* 1975; 28:1055-1061.
20. Cummings SR, Block G, McHenry K, Baron RB. Evaluation of two food frequency methods of measuring dietary calcium intake. *Am J Epidemiol.* 1987; 126:796-802.
21. Sobell J, Block G, Koslowe P, Tobin J, Andres R. Validation of a retrospective questionnaire assessing diet 10-15 years ago. *Am J Epidemiol.* 1989; 130:173-187.
22. Block G, Thompson FE, Hartman AM, Larkin FA, Guire KE. Comparison of two diet questionnaires validated against multiple dietary records collected during a 1-year period. *J Am Diet Assoc.* 1992; 92:686-693.
23. Hernandez-Avila M, Master C, Hunter DJ, Buring J, Phillips J, Willett WC, Hennekens CH. Influence of additional portion size data on the validity of a semi-quantitative food frequency questionnaire. *Am J Epidemiol.* 1988; 128:891. Abstract.
24. Clapp JA, McPherson RS, Reed DB, Hsi BP. Comparison of a food frequency questionnaire using reported vs standard portion sizes for classifying individuals according to nutrient intake. *J Am Diet Assoc.* 1991;91:316-320.
25. Faggiano F, Vineis P, Cravanzola D, Pisani P, Xompero G, Riboli E, Kaaks R. Validation of a method for the estimation of food portion size. *Epidemiology.* 1992; 3:379-382.
26. Guthrie HA. Selection and quantification of typical food portions by young adults. *J Am Diet Assoc.* 1984; 84:1440-1444.
27. Jobe JB, Mingay DJ. Cognition and survey measurement: history and overview. *Appl Cogn Psychol.* 1991; 5:175-192.
28. Jobe JB, Tourangeau R, Smith AF. Contributions of survey research to the understanding of memory. *Appl Cogn Psychol.* 1993; 7:567-584.
29. Jobe JB, Mingay DJ. Cognitive laboratory approach to designing questionnaires for surveys of the elderly. *Public Health Rep.* 1990; 105:518-524.
30. Keller DM, Kovar MG, Jobe JG, Branch LG. Problems eliciting elders' reports of functional status. *J Aging Health.* 1993; 5:306-318.
31. Lessler J, Tourangeau R, Salter W. Questionnaire design in the cognitive research laboratory. National Center for Health Statistics. *Vital Health Stat.* 1989; 6(1).
32. Willis GB, Royston P, Bercini D. The use of verbal report methods in the development and testing of survey questionnaires. *Appl Cogn Psychol.* 1991; 5:251-267.
33. Smucker R, Block G, Coyle L, Harvin A, Kessler L. A dietary and risk factor questionnaire and analysis system for personal computers. *Am J Epidemiol.* 1989; 129:445-449.
34. Ericsson KA, Simon HA. *Protocol Analysis: Verbal Reports as Data.* Cambridge, Mass: MIT Press; 1984.
35. US Dept of Agriculture Human Nutrition Information Service. Continuing survey of food intakes by individuals, 1989-1991. [Public Use Data Tape]. Washington, DC: US Department of Agriculture; 1994.