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Question evaluation for real-time surveys: Lessons from COVID-19 data collection



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ABSTRACT

The need for high-quality, real-time data has never presented itself as clearly as it did during the COVID-19 pandemic. Responding to the COVID-19 pandemic, from both a policy and a public health perspective, required timely, accurate data about the public's attitudes and behaviors from health surveillance, monitoring, and public opinion surveys. The uniqueness of the COVID-19 pandemic also created particular challenges for survey data collection, specifically, how to develop high quality survey questions on topics that had never been previously fielded. To account for this challenge, the National Center for Health Statistics adopted an iterative, two-component, mixed-method approach to question design and evaluation. The first, a cognitive interviewing study using virtual, online interviews was used to produce interpretative schemata of the response processes underlying the survey questions. The second, a two-round, mixed method survey using a statistically-sampled panel, was designed to further develop the interpretive schemata and to allow for detailed subgroup analyses. To increase the usefulness of the survey's second round, cognitive interview findings and results from the survey's first round were used to develop both open- and close-ended embedded probes. Taken together, the studies reveal the specific problems for question-design during such a novel, quickly-evolving event: 1) a lack of shared understanding of novel concepts and vocabulary, 2) the shifting reference period respondents use to think about attitudes and behaviors during a multi-year event, 3) the pervasive nature of the event that therefore frames how respondents conceptualize and process questions about unrelated topics. This iterative approach to understanding question-design problems not only allowed for the continuing improvement of COVID-19 survey items, going forward, it also provided a methodological foundation for question development for high quality, real-time data collection.

1. Introduction

As the COVID-19 virus spread through the US in early 2020, a new collective reality was ushered in, with closing schools and businesses, growing unemployment, and rising infection and hospitalization rates. In order to understand the magnitude of the pandemic's effect, and to provide actionable data for policymakers, businesses, and individuals, collecting timely and accurate survey data was essential. However, the context of the pandemic created unique question design difficulties, raising the risk that data collected from surveys asking about these novel topics would be subject to high levels of measurement error. In particular, vocabularies and frames of reference emerged and evolved alongside the COVID-19 pandemic. This shifting cultural terrain impacted how survey questions could be best written in order to capture respondents' lived experiences. Additionally, the need for real-time data simply could

not accommodate the type of question design and evaluation methodologies traditionally used for producing high-quality federal data.

To address this challenge, the National Center for Health Statistics (NCHS) implemented an iterative, two-component, mixed-method approach to question design and evaluation. This iterative design allowed for on-going question evaluation, even after the first wave of data collection. And most importantly, it allowed for a much more insightful understanding of item performance than the more customary approach of simply assessing item response and cut-off rates. The first component, a cognitive interviewing qualitative study using virtual, online interviews was used to produce interpretative schemata of the response processes underlying the survey questions. The second, as actual survey data was collected using a statistically sampled panel, a question evaluation study was embedded within the survey questionnaire to further develop the interpretive schemata and to allow for

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detailed subgroup analyses. To increase the usefulness of the survey's second wave of data collection, cognitive interview findings and results from the survey's first round were used to develop both open- and close-ended embedded probes. Taken together, the studies reveal the specific problems for question-design during such a novel, quickly-evolving event: 1) a lack of shared understanding of novel concepts and vocabulary, 2) the shifting reference period respondents use to consider attitudes and behaviors during a multi-year event, 3) the pervasive nature of the event that therefore frames how respondents conceptualize and process questions about unrelated topics. This iterative approach to understanding the question-design problems associated with the COVID-19 pandemic not only allowed for the continuing improvement of COVID-19 survey items going forward, it also provides a methodological foundation for question development in high quality, real-time data collections.

The next section describes the methodology, first of the cognitive interview study and then the RANDS during COVID-19 survey. This is followed by the results section and finally a conclusion about lessons learned.

2. Methods

The research described here involves two separate data collections: a qualitative cognitive interviewing study (Willson, 2020) and a quantitative study with embedded cognitive probes using the first two rounds of NCHS' Research and Development Survey (RANDS) during COVID-19.¹ Across both the cognitive interviewing study and the RANDS during COVID-19 survey, question topics included COVID-19-related work interruption, access to healthcare and telehealth (telemedicine), general symptoms of illness, COVID-19 testing, quarantine behavior, and psycho-social effects of the pandemic. Many of the questions overlapped in the two studies and were either identical in wording or were variations, given the iterative nature of the work.² The cognitive interviewing study occurred prior to the RANDS study so that the qualitative work could inform the quantitative component. Specifically, cognitive interview findings informed revisions of RANDS survey questions as well as helped to develop the embedded construct and error probes.

2.1. Cognitive interview study

In order to reach the goal of theoretical saturation (where additional data yield no further information), NCHS conducted 50 cognitive interviews virtually, using the Zoom platform. The study, including the method for interviewing and analysis, is consistent with that described in Miller, Willson, Chepp, and Padilla (2014). These one-on-one, hour-long cognitive interviews took place between September and November of 2020. Respondents were recruited via Facebook and Craigslist, with the only geographic limitation being that they lived in the United States. Respondents were chosen on the basis of qualitative purposive sampling. The goal was to achieve diversity and inclusion in terms of gender, age, race and ethnicity, and educational attainment in order to account for different types of experiences. Additionally, because the questions in this study included topics on COVID-19 testing and experiences with COVID-19 (such as symptoms and quarantining), the main goal of recruitment was to obtain respondents who 1) had never been tested for COVID-19, 2) had tested negative, and 3) had tested positive. Table 1 details the demographic composition of those sampled.

Data collection for the cognitive interviews employed unstructured retrospective probing. Interviewers first administered the survey questions, obtained an answer, then asked probes to ascertain the nature of respondents' experiences in relation to the questions. The ultimate goal of interviewers was to gather information about the question-response process, response error, and patterns of interpretation.

Table 1

Cognitive interview sample characteristics (n = 50).

Variable	Description	Cases	Percent of Sample
Gender	Male	18	36.0
	Female	30	60.0
	Non-Identified	2	4.0
Age (in years)	18–30	12	24.0
	31–40	10	20.0
	41–50	11	22.0
	51–60	4	8.0
	Over 60	13	26.0
Race/Ethnicity	Non-Hispanic White	22	44.0
	Non-Hispanic Black	21	42.0
	Hispanic	3	6.0
	Non-Hispanic Other	3	6.0
	Missing	1	2.0
Education	High School Diploma or Less	8	16.0
	Some College, No Degree	11	22.0
	Associate Degree or Higher	31	62.0

Notes: Age and education categories collected for the cognitive interviewing sample do not match the categories used to collect age and education in the RANDS samples shown below in Table 2. Geographic region was not collected for the cognitive interviewing sample.

2.2. Panel survey study

RANDS is NCHS' experimental survey data collection system, ordinarily used for methodological research and question evaluation studies (National Center for Health Statistics Centers for Disease Control and Prevention, 2021a). At the onset of the COVID-19 pandemic, the agency began a special series, called RANDS during COVID-19, that focused on COVID-19-related topics and was used not only for methodological research, but also to provide the public with timely estimates of selected COVID-19-related variables (National Center for Health Statistics Centers for Disease Control and Prevention, 2021b). The findings described in this paper are derived from the first two rounds of this series, which were conducted in the summer of 2020. These rounds both used NORC at the University of Chicago's AmeriSpeak survey panel as their sample sources. AmeriSpeak is a panel of survey respondents sampled from an Address Based Frame representative of the United States and recruited into the panel via a mail-back survey (with a sub sample of non-response follow-up conducted via in-person interviews) (NORC, 2021). Table 2 provides the characteristics of these two rounds' complete cases.

The first round of RANDS during COVID-19 had a completion rate of 78.5% and a weighted cumulative response rate of 23.0% (which takes into account the panel recruitment and retention rates) whereas for the second round these metrics were 69.1% and 20.3%, respectively. These sample sizes were targeted in order to satisfy NCHS' various data needs from the RANDS during COVID-19 series, including not only the methodological research reported on here, but also the production and dissemination of COVID-19-related variables. Full documentation of these surveys, including the questionnaires and public use data files, are available on NCHS' RANDS web page.³

A series of embedded cognitive probes (Behr, Meitinger, Braun, & Kaczmirek, 2017; Scanlon, 2020) were developed by NCHS staff and included in the two rounds' questionnaires. Embedded cognitive probes, often referred as "web probes" can collect either open-ended or categorical data, depending on the probe wording, which can be used to evaluate the response process for survey questions. In the first round of RANDS during COVID-19, open-ended probes were used to collect qualitative information that, when analyzed alongside the findings from the cognitive interviews, allowed NCHS staff to develop close-ended probes in the second round. The categorical data from the close ended probes was then used to estimate the prevalence of specific patterns of interpretation and response.

¹ <https://www.cdc.gov/nchs/covid19/rands.htm>.

² The relevant questions are presented in the findings section.

³ <https://www.cdc.gov/nchs/rands/data.htm>.

Table 2
RANDS during COVID-19 sample characteristics.

Variable	Description	Round 1		Round 2	
		Complete Cases	Percent	Complete Cases	Percent
Gender	Male	2969	43.7	2592	43.3
	Female	3831	56.3	3389	56.7
Age (in years)	18–29	1470	21.6	1208	20.2
	30–44	1624	23.9	1434	24.0
	45–59	1900	27.9	1657	27.7
	60+	1806	26.6	1682	28.1
Race/Ethnicity	Non-Hispanic White	4515	66.4	4078	68.2
	Non-Hispanic Black	813	12.0	691	11.6
	Hispanic	529	7.7	462	7.7
	Non-Hispanic Other	943	13.9	750	12.5
	Education	High School Diploma or Less	1296	19.1	1104
	Some College or Associate Degree	2557	37.6	2229	37.3
	Bachelors Degree or Higher	2947	43.3	2648	44.2
Census Region	Northeast	1023	15.0	876	14.7
	Midwest	1837	27.0	1640	27.4
	South	2325	34.2	2029	33.9
	West	1615	23.8	1436	24.0
Total Complete Cases		6800	–	5981	–

NOTES: Cases and percents are unweighted. Age and education categories collected for the cognitive interviewing sample do not match the categories used to collect age and education in the RANDS samples shown in this table.

SOURCE: National Center for Health Statistics, 2020. RANDS during COVID-19, Rounds 1 and 2.

Qualitative analysis of the open text data in the RANDS during COVID-19 surveys used the constant comparative method, whereby NCHS researchers used a collaborative, emergent, and iterative process to develop a schema for each open-ended probe. Once these schemata were finalized, the researchers used them to code the individual open-ended responses in a collaborative manner in order to ensure inter-coder agreement. The codes for each open-ended item were then appended to their respective round's data file for future quantitative analysis. Quantitative analyses of the RANDS data presented here are weighted and were conducted using the Survey package in R in order to account for the complex sampling design (Lumly, 2020). Chi square tests of independence were conducted with a second-order Rao-Scott test.

3. Results and discussion

Three major question-design problems relating to measurement of COVID-19 pandemic-related phenomenon emerged. First, new vocabulary and shifting social contexts resulted in inconsistent understandings of terms among respondents. Second, time frame references pertaining to the start of the COVID-19 pandemic were not consistently conceptualized, thereby creating differences in respondent reporting. And finally, the pervasive context of the COVID-19 pandemic influenced respondents' interpretations of questions, even when such interpretations were not called for. Each of these problems is discussed next.

3.1. Shifting vocabulary

Due to the COVID-19 pandemic, new terminology lacking widespread or shared understandings appeared. Additionally, some previously existing, more common terms took on new understandings with

increased public health and political discourse. When used in survey questions, these terms produced inconsistent and sometimes unintended interpretations among respondents. Two examples from the cognitive interviews are 'telemedicine' and 'quarantine.'

Results from the cognitive interviews suggest that at the start of the COVID-19 pandemic, 'telemedicine' was a term not widely used or consistently understood by those outside the healthcare profession. For example, although some cognitive interview respondents did have a reasonably accurate understanding of the term (i.e., of video, email, or phone call appointments), others had no familiarity with the term. These respondents, therefore, had to infer its meaning to formulate their answer. For respondents not familiar with the term, the most common inference approach was to break the word into its two components, 'tele' and 'medicine,' incorrectly understanding the question to be asking about phone calls ('tele') made by health providers to pharmacies to fill drug prescriptions ('medicine').

While telemedicine was an unfamiliar term to some, words such as 'isolate' and 'quarantine' were more common. These terms, however, took on different meanings within the context of the COVID-19 pandemic. For example, one survey question aimed to capture behavior associated with a medical directive to isolate a sick person (or potentially sick person) from the rest of society (including a cohabiting family) to prevent the spread of COVID-19. It read, "Have you isolated or quarantined yourself because of the Coronavirus?" Some respondents did interpret 'quarantine' in the manner intended. However, others did not. Rather than the intended meaning, many respondents in the cognitive interviews understood the question to be asking about new patterns of social interaction. That is, rather than the medical directive for those directly exposed to COVID-19, respondents considered the emergent norms of COVID-19 pandemic-appropriate behavior for *all* individuals, including mask wearing, hand washing, staying home when possible, and maximizing distance between people in public.

Analysis of RANDS during COVID-19 data corroborates these findings. Half of the sample in the first round of RANDS during COVID-19 were asked an open-ended probe about their interpretation of the quarantine question. The question read "When answering the previous question about isolating or quarantining because of the Coronavirus, what were you thinking about?" NCHS researchers coded this data and arrived at a similarly wide set of interpretations as those found in the cognitive interviews. These ranged from thinking about an actual 14-day medical quarantine to the general changes in personal (hand washing, limiting social interactions with friends, social distancing) and societal (working from home, limitations of commercial establishments) behaviors, to the impetuses behind (i.e., keeping others safe, limiting the spread of the virus) and the outcomes (feelings of anger, isolation, and worry) of these behaviors.

These findings from the first round of RANDS during COVID-19 allowed NCHS to refine a close-ended probe for the second round designed to evaluate the prevalence of these interpretations and examine subgroup differences.⁴ As an example, Table 3 shows the weighted percentage of Round 2 respondents who interpreted the quarantine question by thinking about staying six feet away from others differed significantly across age and race/ethnicity groups.

These differences, as well as others observed across subgroups for the other patterns of interpretation included on the close-ended probe,

⁴ The probe read: "When answering the previous question about isolating or quarantining because of the Coronavirus, which of the following, if any, were you thinking about [Select all that apply]? (Staying inside your house and not leaving at all; Staying in one room in your house as much as possible; Limiting interactions with members of your household as much as possible; Limiting interactions with people outside your household as much as possible; Leaving your house for essential purposes only, such as grocery shopping, healthcare appointments, and exercise; Staying six feet away from other people as much as possible; Something else, please specify).

Table 3
Interpretations of “quarantine” by selected characteristics in the second round of RANDS during COVID-19.

Variable	Description	Eligible Sample Size	Percent Interpreting as Physical Isolation	Standard Error	Rao-Scott Chi Square	p-value
Age (in years)	18–29	1208	67.6	2.8	$\chi^2_{(3)} = 197.5$	<0.001
	30–44	1434	62.7	2.2		
	45–59	1657	52.8	2.2		
	60+	1682	43.6	2.4		
Gender	Male	2592	57.0	2.3	$\chi^2_{(1)} = 2.4$	0.510
	Female	3389	59.0	2.0		
Race/Ethnicity	Non-Hispanic White	4078	53.4	1.4	$\chi^2_{(3)} = 105.2$	<0.001
	Non-Hispanic Black	691	61.0	4.3		
	Hispanic	462	71.5	4.1		
	Non-Hispanic Other	750	67.1	3.3		
Education	High School Diploma or Less	1104	57.0	3.3	$\chi^2_{(2)} = 1.8$	0.808
	Some College or Associate Degree	2229	59.1	1.8		
	Bachelors Degree or Higher	2648	58.1	1.5		
Income	\$0-\$49,999	2279	60.1	2.3	$\chi^2_{(2)} = 12.4$	0.249
	\$50,000-\$99,999	2060	54.7	2.3		
	\$100,000+	1642	58.6	2.6		
Region	Northeast	876	59.7	4.1	$\chi^2_{(3)} = 8.9$	0.620
	Midwest	1640	59.6	1.9		
	South	2029	55.6	3.0		
	West	1436	59.2	2.3		

NOTES: Cases and percents are weighted. “Physical isolation” was defined in the probe answer categories as “Staying six feet away from other people as much as possible.”

SOURCE: National Center for Health Statistics, 2020. RANDS during COVID-19, Round 2

indicate that interpretations are not randomly distributed across the population and that the shifting meanings of terms such as “quarantine” did not happen evenly across cultural or geographic groups.

3.2. Evolving timeframe

As of this writing, the COVID-19 pandemic has affected life in the US for two years. During this time respondents’ experiences and understandings of the COVID-19 pandemic evolved, creating question response difficulties related to timeframe. Table 4 lists examples of questions from the cognitive interviews that were sensitive to the evolving nature of the pandemic and, therefore, were difficult to answer.

In answering the first question, cognitive interview respondents who suspected they had the COVID-19 virus and were tested but received a negative result, based their answer on either their belief prior to testing or after obtaining test results. Indeed, some respondents prior to testing did suspect they had COVID-19, but a negative test result changed their suspicions at the time of the interview, so they answered ‘no.’ Other respondents based their response on their original belief (which prompted them to get tested in the first place), so they answered ‘yes.’

Question 2 elicited a similar pattern. Some respondents who sought medical care were not thinking of COVID-19 at the time they became ill,

Table 4
Cognitive interview questions sensitive to evolving pandemic.

Question	Response Options
1. Do you suspect that you have ever had the Coronavirus or Covid-19?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2. Did you seek medical care for Coronavirus or Covid-19?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3. [If ‘no’ to question 2] Why did you not seek this medical care? [CHECK ALL THAT APPLY]	<input type="checkbox"/> Too expensive <input type="checkbox"/> Not available <input type="checkbox"/> Symptoms were not severe enough <input type="checkbox"/> Something else, please specify
4. Since the Coronavirus pandemic began, have you felt more lonely or sad, less lonely or sad, or about the same?	<input type="checkbox"/> More lonely or sad <input type="checkbox"/> Less lonely or sad <input type="checkbox"/> About the same
5. Since the Coronavirus pandemic began, have you felt more socially connected to family and friends, less socially connected to family and friends, or about the same?	<input type="checkbox"/> More socially connected <input type="checkbox"/> Less socially connected <input type="checkbox"/> About the same

especially when this occurred early in the COVID-19 pandemic when they were less aware of the virus and its symptoms. They may have sought medical care, but at the time they did not think it was for COVID-19, so they answered ‘no.’ On the other hand, some respondents did think about what they believed later in the COVID-19 pandemic, so they answered ‘yes.’

As a follow-up to those who answered ‘no’ in question 2, question 3 asks respondents why they did not seek medical care. For this group, it was difficult to choose a category because, when they first felt symptoms, having COVID-19 did not occur to them – they thought their symptoms were the result of more common maladies, such as allergies, colds, or the flu. It was only later (with increased knowledge of COVID-19) that they suspected COVID-19.

Questions 4 and 5 attempt to measure different psycho-social impacts of the COVID-19 pandemic by asking about levels of sadness and social connections. Like the previous examples, these questions also demonstrate the fluid nature of respondent experience during the COVID-19 pandemic. The wording of the questions implicitly assumes a consistent level of emotion during the COVID-19 pandemic that was often not experienced by respondents. Instead, they mentioned that their feelings of sadness and connectedness have ebbed and flowed over the course of the COVID-19 pandemic. As such, it was difficult, if not impossible, to provide a single answer.

3.3. Context effect of the pandemic

Results from the cognitive interviews also demonstrated how the unprecedented nature of the COVID-19 pandemic created a lens through which all questions were understood, regardless of intent. The four items shown in Table 5 provide the clearest examples of this phenomenon during the cognitive interviews.

The intent of Question 1 was to capture any symptom respondents experienced irrespective of cause. However, many respondents in the cognitive interviews understood the question as asking about symptoms specifically associated with COVID-19. For example, some respondents experienced ‘red/itchy eyes’ but did not associate this with a COVID-19 symptom and, therefore, did not report it. Other respondents drew an even stronger connection between this question and COVID-19. They understood it as asking whether they ever had COVID-19 and, if so, which symptoms they personally experienced. In other words, some respondents thought the question was a prevalence measure to ascertain

Table 5
Cognitive interview questions sensitive to context effects of the pandemic.

Question	Response categories
1. Which of the following symptoms have you had at any point in time since March 1, 2020? [CHECK ALL THAT APPLY]	<input type="checkbox"/> Fever or chills <input type="checkbox"/> Cough <input type="checkbox"/> Shortness of breath <input type="checkbox"/> Sore throat <input type="checkbox"/> Headache <input type="checkbox"/> Muscle or body aches <input type="checkbox"/> Runny nose <input type="checkbox"/> Fatigue or excessive sleepiness <input type="checkbox"/> Diarrhea, nausea, or vomiting <input type="checkbox"/> Loss of sense of smell or taste <input type="checkbox"/> Itchy/red eyes <input type="checkbox"/> None of the above
2. Were you unable to work because you or a family member was sick with the Coronavirus?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3. At any time in the last 4 weeks, did you need medical care for something other than Coronavirus, but not get it because of the Coronavirus pandemic?	<input type="checkbox"/> Yes <input type="checkbox"/> No
4. Since the Coronavirus pandemic began, have you been able, unable, or have not needed to get a doctor's appointment or some other kind of healthcare?	<input type="checkbox"/> Able <input type="checkbox"/> Unable <input type="checkbox"/> Have not needed

rates of COVID-19 infection. Those who never had COVID-19 sometimes failed to report any symptoms they had that corresponded to COVID-19 because reporting those symptoms might be misconstrued as having had COVID-19.

The intent of question 2 is to capture people who missed work because they contracted COVID-19. However, some respondents also answered 'yes' when they missed work due to *any* reason associated with the pandemic (not just when they were sick). For example, some respondents included missed work due to lay-offs associated with temporary business closings.

Finally, questions 3 and 4 intend to capture unmet medical needs. However, the concept of 'need,' as it was assessed in the context of the COVID-19 pandemic, created some false negative reports. Specifically, respondents interpreted certain types of medical care that were judged as essential prior to the COVID-19 pandemic to be care that should be delayed during the COVID-19 pandemic. Routine visits, check-ups, dental care, and preventative care and screenings often fell into this category and were, therefore, often missed by this question. Instead, respondents associated 'needing' medical care with critical conditions that could not be postponed, such as acute illness or injury.

4. Conclusion

The COVID-19 pandemic illustrated the need for high-quality, real-time data. However, survey data collection, itself, has been – and continues to be – impacted by the pandemic. More specifically, measurement error is affected to the extent that respondents understand survey questions differently than they may have prior to the COVID-19 pandemic. Therefore, it is essential to reevaluate even those questions that have been previously validated or used for trend data when society undergoes significant social change or historic events.

This paper summarized specific question design problems arising from the unique circumstances of the COVID-19 pandemic. Some lessons learned from this experience include the need for both an iterative and mixed-method design for question evaluation studies on emerging topics, such as those related to the COVID-19 pandemic. By using a combination of cognitive interviewing and embedded probing, potential sources of measurement error, particularly those relating to one's lived experience with the pandemic, and the public health response to the pandemic, were discovered early—allowing organizations and researchers to collect more

reliable and valid survey data in a timely manner.

Ethical Statement

Hereby, I/insert author name/consciously assure that for the manuscript/insert title/the following is fulfilled:

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
- 2) The paper is not currently being considered for publication elsewhere.
- 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
- 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
- 5) The results are appropriately placed in the context of prior and existing research.
- 6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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