National Center for Science and Engineering Statistics

Title: Modular Survey Design and Smartphone Applications: Considerations for the SDR

Date: August 2021
Final Report

Contractor Awardee: University of Michigan with University of Maryland
Contract Number: 49100420C0020

Modular survey design and smartphone applications: considerations for the SDR

Rosalynn Yang, Ai Rene Ong, Yanzhi Shen, Christopher Antoun, Brady T. West

8-25-2021

Table of Contents

I. Introduction

This project used multiple approaches to lay the groundwork for the future use of smartphone apps for data collection by NCSES.

First, our team gathered information about best practices for using smartphone apps in large-scale surveys. We conducted a systematic literature review of research that has evaluated the effects of app design features on survey outcomes (response rates, indicators of response quality) as well as research that has evaluated modular-based surveys.

Second, we investigated participants' reactions to and suggestions for using a smartphone for the Survey of Doctorate Recipients (SDR). Our research questions were as follows:

- What factors would motivate respondents to download the app and keep engaged in responding to survey requests in the app?
- How do respondents like the idea of completing modular surveys? What do they think would be the optimal length and timing of survey modules?
- What design elements or features would respondents like to see in the app?

To address these questions, we gathered information directly from potential respondents. We hosted three participatory design (PD) workshops with a diverse set of 19 participants sampled from the Early Career Doctorates Survey (ECDS). The objective was to engage participants in co-designing a potential data collection app that could issue modularized surveys. In each workshop, participants were asked to identify the design features or functionality that would be most important to them, develop a plan for encouraging respondents to download and use an app, discuss their ideas about the optimal length and timing of survey modules, and work in small groups (via Zoom's "Breakout Rooms") to design their own prototypes of an app and then have them evaluated by other participants. At the conclusion of the workshops, our team reviewed the workshop notes to identify themes that emerged. We use this information to make recommendations about the design of a smartphone app for delivery of NCSES modular questionnaires.

Lastly, our team used insights gained from the first two sets of activities to design experiments that will evaluate a smartphone app for data collection. The main experimental factors include the survey mode (*web-based* vs. *app-based*) and whether the survey uses a modular design (*all questions at once* vs. *modular approach*). In addition, respondents assigned to the modular group could be randomized to receive either a s*ingle incentive* or a series of *"micro" incentives* based on completion of individual survey parts as well as either *more* or *less* frequent reminders to complete the modules.

II. Background

Smartphone App for Survey Research

With the rise of smartphone adoption and usage, survey methodologists and social scientists have been eager to explore the use of smartphone apps to collect survey data. Smartphone apps have been used to administer brief surveys and conduct ecological momentary assessments. For example, the IAB SMART study collected responses via short surveys pushed to the apps and utilized GPS sensors to trigger location-related question modules to collect data relevant to the locations (Kreuter et al., 2020). With smartphone apps, it allows researchers to collect frequent responses in a comparatively long period of time and it is easy for respondents who own smartphones to answer brief survey questions via the apps (Bahr et al., 2020; Miller et al., 2018). In a field test across five European Union countries, Shouten and colleagues collected survey responses about household expenditures via an app for a field period up to 12 months (Schouten et al., 2020). With smartphone apps, surveys are optimized for small screens by design. Respondents can also interact with embedded features provided with the app, such as uploading pictures and recording voice answers. Smartphone apps also allow for sending push and in-app notifications, which makes it easy for researchers to engage respondents and keep motivating respondents to get involved in the study (Shouten et al., 2020). Furthermore, recent research has found that respondents tend to stay engaged in the study once they downloaded and started using the app (Jackle et al., 2019). Given the benefits of this approach, we hypothesize that using smartphone apps which issue modularized surveys will help reduce perceived response burden compared with other online data collection modes.

Despite the advantages of administering surveys via smartphone apps, current research in this area suggests that this approach may suffer from noncoverage and nonresponse issues. Most existing studies using smartphone survey apps recruited volunteers, which introduces self-selection problems (Struminskaya et al., 2020). Studies on noncoverage have found that mobile device users differ from non-users in socio-demographic characteristics (Jackle et al., 2019; Keusch et al., 2020). Before being able to respond to a survey request, a respondent must first download and install the app on their smartphones (Read, 2019). However, not all respondents are willing to download an app. For example, Jacobsen and colleagues (2021) found in a study that roughly 40% of the respondents consented to download a survey app, and among these respondents, only 60% installed the app. A study conducted by Wenz and colleagues (2019) also found that respondents were less willing to participate in tasks that required downloading an app. A recent study by Keusch and colleagues, however, did find the probability to download a research app increased with educational attainment (Keusch, 2021).

To encourage participation, few studies have experimented with the use of incentives and contact strategies and have found mixed evidence. Jackle and colleagues (2019) explored the effect of varying incentive values (£2 vs. £6) for downloading the app and have found no effect on participation outcomes. In a field experiment conducted with web panel members, Revilla and colleagues have found that offering a small incentive significantly increased app installation in Spain (Revilla, 2021). In terms of contact strategies to get respondents sign up for the study and download the research app, Lawes and colleagues (2021) examined the effects of different contact modes among job seekers in Germany and have identified that the best combination that maximized participation was a preannouncement letter and email invitation compared to stand-alone letters and emails. To keep respondents engaged in

continuous survey requests, Miller and colleagues (2018) have found that email notifications worked better than push notifications sent via the app with a college student sample. In a study of refugees, Jacobsen and colleagues (2021) found that interviewers played an important role in convincing respondents to download and use the app. Nevertheless, these findings are subjective to various factors such as study context, type of request (e.g., self-report or passive data collection), and study population.

Overall, current research findings vary by context in terms of what could be effective to encourage participants to download the app and keep engaged in continuous survey requests pushed to the app. Empirical studies are needed to explore motivating factors behind smartphone app survey participation and continuous engagement, as well as the specific design elements (e.g., app features, incentives, contact strategies) that would work most effectively with a certain study population.

Modular Survey Design

Modular survey design and split questionnaire design are two approaches that are similar in that the survey questions are split up but differ in the way the questions are administered to respondents. In modular survey design, the modules are to be taken over time by the same respondent. Meanwhile, split questionnaire design, respondents receive different sets of modules of the survey, and their responses to the modules they do not receive are imputed (Raghunathan & Grizzle, 1995; West, Ghimire and Axinn, 2015; Toepoel and Lugtig, 2018). In this section, we will focus primarily on the literature on modular survey design.

To date, there have been very few studies conducted to examine the best practices for modularizing surveys. The four papers that have studied modular design were varied in their approaches (e.g., varying the number of modules, incentives, and time between modules while examining the impact in different measures of response quality). All four papers used probability samples to test their modular design.

The findings are mixed regarding the response rates of a multiple-module survey compared to the traditional one-module survey. West, Ghimire and Axinn (2015) and Toepoel and Lugtig (2018) found that unit nonresponse rates were low across the single module and the multiple module versions. Toepoel and Lugtig (2018) found higher initial response rates in the multiple-modules survey version, with the 10-module condition administered every second weekday having a higher initial response rate compared to the 3-module condition which was administered per week. However, after accounting for breakoffs, the overall response rates were similar across the modularized conditions and the single survey condition (i.e., only one module). Meanwhile, Peytchev and colleagues (2020) and Andreadis and Kartsounidou (2020) found that overall response rates were lower for the multiple modular conditions compared to the single module condition. It has to be noted that in Peytchev (2020), the second module was offered immediately after the first while Andreadis and Kartsounidou (2020) administered their second module 15 days after the first module.

As for nonresponse bias, there is evidence that there is very little nonresponse bias when a modular survey is administered compared to a single-module survey. West, Ghimire and Axinn (2015) found that item nonresponse was higher in the modular survey (with questions sent via text messaging) than a

single-module survey via text messaging and a single-module survey via telephone, but the nonresponse bias is relatively small. Toepoel and Lugtig (2018) found that the 10-module condition had the lowest item-missing data compared to a 3-module condition and single-module condition. The 10-module version also has the highest number of partial completes for the key political questions in the survey. This finding is echoed by Peytchev and colleagues (2020), who also found that the modular survey had the lowest item-nonresponse for five items. Meanwhile, Andreadis and Kartsounidou (2020) did not find overall differences in item-nonresponse rates across modularized vs. non-modularized survey conditions.

In terms of other measures of data quality, modularized surveys do not perform worse than single module surveys and might even perform better. However, there were group differences between the respondents given the modular survey compared to those who took it in a single sitting on some sensitive questions such as age of drinking, and ever smoked marijuana (West, Ghimire & Axinn, 2015). Respondents do not seem to differ across conditions in terms of how carefully they answer the questions. Andreadis and Kartsounidou (2020) found no difference in the amount of straightlining or speeding. However, they did find that there are fewer respondents choosing the midpoint answers in the two-module survey than the single module survey. Peytchev and colleagues (2020) did not find any differences in substantive responses to fictitious issues and for reverse-coded items across conditions. Meanwhile, Toepoel and Lugtig (2018) did not find differences in factor loadings for the scales administered in their surveys across the modular conditions and the single-module condition. Finally, respondents reported having a better experience with modular surveys (Toepoel and Lugtig, 2018) and found the modular survey to be much easier (West, Ghimire and Axinn (2015).

Participatory Design Techniques

Most of what is known about smartphone data collection and modular design is derived from experimental studies. Qualitative research can also generate data about how to potentially implement these methods. Participatory Design (PD) techniques provide a way to gather such information directly from potential respondents. We characterize PD methods as a set of activities that engage end-users (respondents) as co-designers in the activities that lead to the development of a product (survey smartphone app). Research suggests that PD techniques, especially when applied to a diverse set of participants, can challenge the assumptions made by designers and generate new insights and plans for a product's design (for further information, see Greenbaum and Kyng, 1991; Muller and Kuhn, 1993; Schuler and Namioka, 1993). In the current project we use qualitative methods, namely focus group discussions and PD techniques, to generate ideas for designing a smartphone survey app.

III. Methodology

Participant Recruitment

Participants were recruited from the Early Career Doctorates Survey (ECDS). ECDS respondents were eligible if they were age 18 or older, with a PhD between 2015 and 2017 in the fields of science, engineering, or health. A stratified random sample of 604 eligible people was selected, equally balanced by sex (female vs. male), race/ethnicity (member of an underrepresented minority group vs. other), age (less than 40 years old vs. 40 years or older) and PhD field (Science and Engineering vs. Health).

Recruiting emails were sent in six batches between 4/8/2021 and 5/3/2021. Among the 604 invitation emails sent, 89 were undeliverable, and 56 completed the online screener survey, resulting in a screener response rate of 11% (for detailed information regarding invitation emails results, please refer to Appendix A). The screener collected participants' demographic information and smartphone usage behaviors and asked participants to indicate their availability on weekdays. Selected participants were then sent emails with consent forms and were requested to email back the signed consent form to be confirmed participants for this study. A total of 19 participants were scheduled to participate in three workshops and all of them participated during the scheduled times. Table 1 lists out the participant characteristics by workshop. Overall, there is not much difference between workshops in terms of participant characteristics.

Table 1. Participant characteristics by workshop

Characteristic	All Workshops	Workshop 1	Workshop 2	Workshop 3
n	19	8	7	4
Sex				
Female	12	5	4	3
Male	7	3	3	1
Age				
30-39 years old	14	6	5	3
40-49 years old	2	1	1	0
50-59 years old	2	0	1	1
60-69 years old	1	1	0	0
Race				
Asian	3	2	0	1
Black/African American	3	0	1	2

White	12	5	6	1
Mixed White/Asian	1	1	0	0
Ethnicity				
Hispanic	4	2	1	1
Non-Hispanic	15	6	6	3

Participatory design workshop discussion guide

To gather recent doctorate recipients' experience with surveys and their ideas for designing a smartphone app for SDR, we developed a discussion guide that consists mainly of two sections. The first section is a focus group, and the second section involves PD activities.

In the focus group section, participants were first encouraged to discuss the following topics (in order): their experience with web surveys in general; their thoughts on using mobile devices and smartphone apps for surveys; and their reaction to the concept of modular survey design. Then participants were given a brief introduction to SDR (including its study goals, questionnaire sections, average completion time, and current contact strategies) and asked for their general reactions to its survey design.

In the PD section, participants were divided into two groups to work on an implementation approach for the survey app using a digital whiteboard ("Google Jamboard"). They were asked to identify the design features or functionalities that would be most important to them, discuss their ideas about the optimal length and timing of survey modules, and design their own prototypes of an app (homepage and survey ending page).

Prior to conducting the workshops, we tested the protocol with an internal dry run involving colleagues working on the project. After the dry run, we simplified the Google Jamboard links and added more instructions to the discussion guide to make sure all components could be covered in the scheduled amount of time.

A copy of the participatory design workshop protocol can be found in appendix B.

IV. Findings

Focus group discussion

Web surveys

To kick off the discussion, participants were first asked to reflect on their experience taking web surveys. They were asked whether they regularly respond to web survey requests, the type of request they usually respond to, and reasons why they would or would not respond to web surveys.

All participants had previous experience completing surveys online. Most indicated that they tended to respond to survey requests that are relevant to their professional fields or are from organizations that they are familiar with. Examples of such surveys include student and faculty research surveys and study requests from other early-career researchers. Some participants explicitly mentioned that they received a large number of requests and normally would ignore consumer surveys unless they were interested in the product or service. An example quote follows:

> "Now we are bombarded with all types of surveys. I think it's important at the outset that the request be made clear and that I know what the purpose of the survey is."

Prior to filling out surveys, participants would consider whether the survey sponsor or organization is a trustworthy one. One participant pointed out that some surveys were linked to hacking and phishing, leading to potential identity theft. Besides security concerns, a few participants would also evaluate whether the request is relevant to them and whether the data collected will benefit the organization. A few participants also paid attention to privacy and anonymity when doing surveys. Example quotes:

> "We want to be very careful with any survey request now. I want to see, is this really legitimate? Do I trust that person? "

> "I have some concerns about privacy. If I get to a certain point and feel like it could be identifiable even if it is not my name, like if it starts narrowing down to my field and location, they could figure out who I am."

When thinking about reasons why they would or would not respond to survey requests, most participants mentioned survey length. It was agreed by many that the longer the survey gets, the less engaged they would be. Participants found 5 to 10 minutes acceptable. If the survey is longer than 15 minutes, some participants indicated that they tended to ignore the request, put off completing it until a later time and perhaps forget about it, or start the survey but drop off before completing it. A few participants mentioned that they would like to see reasonable survey length estimation in the initial request so that they could plan their schedule accordingly. Example quotes:

> “If 5-10 minutes no problem. I had experience of not finishing surveys, if it ended up being a lot more involved than I expected, and then judging from the questions I don't think the information is ultimately going to be that helpful, I'll just stop unfortunately.”

> "The length of the survey matters a lot. If it is 5 to 10 minutes I highly likely to do it, 15 minutes is borderline. Anything over 20-30 minutes then I'm likely to forget."

> "There’s nothing more irritating than starting a survey and finding out their definition of 10 minutes is very different."

Besides survey length, some participants explicitly pointed out that they disliked repeated survey reminders, especially when the request may not be applicable to them. Example quotes:

> "It can be frustrating too sometimes to get reminders of surveys that don't pertain to you."
>
> "It's kind of irritating to keep getting reminders especially when you already decide that you ignored it."

Smartphone surveys

Following the discussion of web surveys, participants were asked to think about their experience using smartphones or other mobile devices to complete surveys. They were encouraged to recall when they typically respond to surveys using their smartphones and how they liked their experience.

We found participants divided as to whether they use their smartphones to fill out surveys. Some participants indicated that they did not use their phones for surveys because they preferred the survey interface when displayed on their computers. Other issues mentioned by participants include small screen size, difficulty scrolling and typing open-ended responses, and low trust in the mobile web browser to capture survey responses. Example quotes:

> "Size does matter. Sometimes the surveys are not designed for phones, too small on my phone screen, and hard to push the button."
>
> "Sometimes if I really want to respond I will do it on a computer; I will be writing it out because I do not trust the system to capture it, and then I paste it over. So, a lot of it is the interface barrier, some of them it's technical or fears that it'd be lost if it's taking a lot to think through."
>
> "If you ever have an open response where you need to type it's so much easier doing it on the computer."
>
> "Scrolling can be painful on a smartphone, so I definitely prefer to use my laptop."

For some participants, their phones are for personal use and that they do not want to mix work and their personal lives. One participant suggested that he liked to minimally use his phone, keeping only basic functions such as text messaging and phone calls. Another participant mentioned security concerns as one of the reasons why she would not want to do more things with her phone. For example:

> "I would not be as comfortable doing things on my phone, because I know there are many apps that tap into information on the phone that can access my personal information."

There were also participants who were more phone-savvy and talked about how they were more comfortable and efficient when completing surveys and work-related tasks on the phone. One participant was involved in a momentary assessment health study during the pandemic, and she mostly enjoyed answering survey questions pushed to her phone to learn more about the context she was in:

> "Phone for me is the platform where I'll be finding everything that I do that is not labor intensive."

When thinking about when they tended to use their smartphones for surveys, a few participants mentioned different contexts of use such as during their commute, in the DMV, and waiting to pick up someone. Completing surveys on their phones in such downtime made them feel more productive. However, they pointed out that in these cases they would be less focused and would fill out surveys that are “flavorless” and “not serious”. They would not fill out surveys with technical content on their phones that required more careful thought.

> "I would maybe give less information or put less consideration when answering questions when you use a mobile device rather than the computer interface."

Doing surveys using smartphone apps

Up to this point, participants had been talking about their experience taking web surveys with their Internet browsers on PCs and smartphones. In this section, participants were directed to think about smartphone applications that would facilitate survey requests and were asked to talk about their motivations and discouragement of using an app to fill out surveys.

On the promising side, many participants were excited about the idea of using a smartphone app to take surveys. Some quickly related the survey app idea to mobile game apps that they had used before and suggested the app incorporating gamification aspects such as giving points and rewards for filling out different sections of the survey (e.g., different incentives for filling out close and open-ended questions). Related to this, two participants would like to see a leaderboard in the survey app listing people doing more surveys at the top:

> “It’s not just taking surveys, and I would expect some fun part to it.”

Some participants mentioned that they liked the app idea because surveys in the app would be optimized for small screens by design. They imagined that smartphone app surveys would be short and concise and would have neat graphics with a smooth user experience. Participants also brainstormed on the possible features, besides gamification elements, that could be added to the app including using voice recording for open-ended responses and sending other media such as images and videos:

> "I compare different things, and if the app is really well designed, I’m much more likely to keep it and respect it, that's an important factor."

> "If the app would really facilitate answering survey questions with functions, like you can record instead of typing, you can also send images perhaps, that would really be nice."

As discussed in the previous sections, participants indicated that they would probably download the app to fill out the survey if it is published from a trusted source. Most participants suggested that trust is a key for research participants and that data security is a primary concern. Fully disclosing what’s being collected will help participants make informed decisions:

> "Why do they make you download an app? Often it feels like that they want more data than what you are planning on sharing and connecting to this broader web. They need to fully disclose what they are collecting in the first place."

However, some participants thought it would be burdensome to download the app just for one-time surveys. Rather, they envisioned the app to be a multi-purpose tool to help facilitate various involvement with the organization using relevant features. For example, one participant discussed her experience with a blood donor app, where besides answering blood donor screening questions, one could schedule appointments and view blood test results in the app. In the context of NSF, one participant suggested that the survey app could be linked with her NSF account to check grant status. In other words, participants expected to regularly use apps downloaded to their phones and not just for one time use:

> "If you receive an email with a link to an app, that means you have to download it on your phone, and if it's a one-time use app, I'm going to have a dis-incentive to install the app to then complete the survey because it's a multi-step process."

> "If I have an app that I only use once a year, every time I go back it's going to have to be updated, my iOS it's probably going to be different, and I don't remember anything about the navigation; the benefit of being able to record responses is totally lost."

> "I wouldn't download an app just to complete surveys, but the fact that it's packaged with other useful things makes a big difference."

> "If I could link it with my other NSF accounts that would be useful, if I could check the status of my grant application, that would be useful. If it's an NSF app that I would use all the time and it has my NSF dashboard."

Some participants raised the concern of phone storage and said that their phones would not have enough space for new apps:

> "Sometimes my phone gets full, and I find myself having to clear up more room for downloading new apps."

> "My motivation to download a survey app that I potentially have to delete another app would be pretty low."

Other motivations of downloading and engaging with a survey app include the capability of creating surveys and collecting data using the app for research purposes and using it because everyone else is using it:

> "If this app can be used by other researchers to share their surveys, can create and submit one's own surveys and invite people to respond to, both answering it and sharing your research that'd be really cool."

> "I would not be an early adopter, but if everyone else is using it I'll use it."

Modular design

As mentioned by some participants, they would not want to install an app just to complete one-off surveys. Following this line of thought, participants were introduced to the idea of modular design, which is to divide a questionnaire into smaller parts that respondents could complete at their convenience. Participants were asked to react to this type of design and brainstorm factors that would motivate or discourage them to opt for this approach.

A few participants liked the idea of using modular design to administer surveys with a smartphone app. They thought the notifications would be particularly helpful. Some participants associated the idea with ecological momentary assessment studies and thought it would be more efficient to conduct such studies with smartphone apps.

> "Using an app that gives new questions from time to time would facilitate tremendously to respond every time. If I get a request in mail, I may leave it behind and I will just lose the follow up of the survey. The app will notify me like you have a new part of the survey to complete and it is small and easy to respond to."

In terms of the implementation of the design, participants brainstormed some things that they would like to see. Some mentioned that they liked how longitudinal studies could track one's performance over a period of time. They expected to receive personalized feedback after completing a survey regularly, such as a graphic presentation of performance over the time. They were also interested in comparing themselves with other people who had responded to the survey. Two participants also mentioned that they liked to be able to set preferences to only receive things (e.g., survey part) that interested them and to fill out the small sections of the survey based on their schedule.

However, some participants were skeptical and felt like it would be interruptive to receive surveys from time to time. They compared the idea to robocalls where they had negative experience with. One participant insisted that the hurdle would be to download the app and get onboard, despite the interesting modular design survey app idea. To many participants, whether they liked the idea of a modular survey app seemed to be dependent on the task and content of the survey app.

When asked whether providing an incentive would help with downloading the app, participants' reactions were somewhat mixed. A few participants wanted to have some rewards for downloading the app and participating in the survey. They discussed some options ranging from cash incentives to lotteries.

> "Financial incentive is really motivating; if it's a survey that I really believed in that I shall invest in the outcome, that's my incentive. But most surveys are not like that for me. the cheapest would be to enter you into some sort of drawing, but I like those combinations of modest guaranteed incentive and chance for much larger incentives."

However, a few participants were skeptical of how effective the incentive could be.

> "I don't think an incentive could be big enough, and it's not like it's a huge hassle, but it's enough of a hassle, so it's like offering me 99 cents probably wouldn't do it."

SDR reactions

Finally, participants were shown a slide with some information about SDR, including a brief description of the study, questionnaire sections, contact strategies, and two screenshots of the 2019 SDR web survey. Participants talked about their thoughts about the study and discussed features that they would like to have for the survey, regardless of whether it is in the format of a web survey or a survey app.

Some participants said that they remembered participating in SDR before while some others had experience with similar surveys. They did not report having any issues responding to the request mostly because they trusted the survey sponsor and would like to support NSF. One participant related back to the modular survey app idea and thought it would be easier to fill out surveys in that way to not miss the deadline:

> "I remember doing this. It is important so I do not care about the time as much. It's also coming from a very important group so I would pay special attention and really craft all my open-ended answers for it."

Participants were interested to know more about the mission of the SDR. They would consider participating if the research goal was clarified in the study invitation. Participants indicated that the purpose of the research would influence how much time and effort they would put into answering surveys. It was also important for these participants to know how their data are going to be used:

> "A factor when I try to decide (whether to fill out a survey or not) is what is its mission of this research; I don't have any sense of it (SDR) and I could only make some assumptions, and I'll think why I should do it, what's the point of it."

When looking at the different question sections of SDR, some participants felt that it might be difficult for them to retrieve answers to some of the questions. One participant thought it would be difficult to answer SDR questions using a mobile app, given that some questions would require referring to and pasting information from their CV. She then suggested possible linkage to other records (e.g., LinkedIn profile, ResearchGate profile) to save them time and energy answering some fact-based questions:

> "I looked at these questions that you are going to ask me, the first thing I wonder if do I know these answers, and how hard it's going to be how much time it's going to take to go back, it kind of remind me of the time when I had to do my performance evaluation; so if the app would help me remember those things that would be kind of motivating."

> "I'm just wondering if a lot of this information is already out there on individuals, and maybe there's something that can be done to auto-populate based on LinkedIn profiles or ResearchGate or something like that. Otherwise, it's like you are filling out information that's already out there."

Some participants commented on the design elements of the SDR web survey referring to the question screenshots. Features liked by participants include the “back” button allowing them to navigate back and change their answers, as well as the “save and exit” function giving them a chance to return to the survey at their convenience. There were also a few things mentioned by participants that the SDR web survey could improve on, such as showing a progress bar, adding a side tab that allows participants to choose from sections that they want to work on, and listing the estimated time in a range (e.g., 15 to 20 minutes) instead of an estimate of the average (e.g., 18 minutes precisely):

> "Knowing ahead of time my itinerary would help; having a navigation tab for different sections for the survey, for me that would be helpful."

A few participants also commented on the contact strategy listed on the slide. It was quite universal that they did not like any materials going through postal mail. Participants would prefer electronic invitations with a direct link to the survey website:

> "Most of the time what I get from postal mail are bills or junk, bills are easy to identify based on the size of the envelope and you just kind of hang on to it, and the rest just junk, and it doesn't get much attention."

When probed if there were other things that would motivate them to participate in SDR, participants mentioned that they would like to see feedback from research in various format, including visible data points shown in invitations, results and findings based on historical data, as well as personalized data results informing how participants compare with each other and where they stand relative to overall trends:

> "You could say like hey we hope you recruit 1000 people, and you are 852, and here are some graphs of some rough statistics so far and we'll follow up with you and send you a report which is designed intriguingly, that might be enough to pique my interest."

> "It's nice to know where you stand."

Co-design activities

After the focus group section, participants were assigned into breakout rooms and were asked to work among themselves through the tasks listed on Google Jamboard. The first two tasks were related to the operation of modular design, and tasks three to five were design-based tasks where participants could brainstorm desired app features and sketch out the app landing page and ending page. Please refer to appendix C for the description of the five Jamboard tasks.

Task 1: Splitting the questionnaire

In task 1, the groups were asked if they would split the questionnaire and how they would prefer to split the questionnaire if they think it should be divided. There was no consensus among the groups, but one clear theme that emerged was the preference for more control. Some groups prefer not to split the questionnaire. They would mainly prefer to decide on their own when to stop and continue later rather than follow preset modules. Those who said that they would prefer the questions split prefer the questions grouped into modules based on themes or topics. They also asked for the ability to take the modules out of order; or to go back to an earlier module or earlier questions. One participant commented that different questions take a different amount of time, so splitting it by time will make the number of questions in each module inconsistent. One group suggested ten questions per module.

Everyone agreed that an option to save and continue is important to them. Even the groups that prefer to split up the questions want the option to do several modules at once. A few participants brought up that they would appreciate a limited number of reminders (e.g., two) to complete the modules,

although they prefer to decide by themselves when to continue the survey. Some quotes from the different groups are as follows:

> "Personally, I wouldn't split it up. I would make it so that you can save and come back if you don't have time."
>
> "Each section will only take a few minutes, and if the questions are related that would be good […] saving progress should be a necessity."
>
> "I like modules to direct your thoughts of what you should be thinking about and what to expect."

Task 2: Timing between modules

When it comes to the time between modules, which was Task 2, similar comments about the importance of the ability to save and continue emerged. The groups mentioned that they want to move at their own pace instead of having a schedule for completing modules imposed on them and want the ability to choose the order of completing the modules:

> "It totally depends. I could see like, If I am sitting there, my train just came, I need the option to save it and continue until I get to my next spot. But there are going to be times where I'm sitting there and want to blast through the whole thing."
>
> "I wouldn't want to wait. I just want the flexibility to move through them."
>
> "Sometimes it bothers me to wait because filling the survey, I do sometimes forget. When I am filling out the survey, I want to finish it, so I don't forget it anymore. If I can do it in one sitting, then that will be good."

Tasks 3-5: Designing the app

The design concerns of the groups were mainly on accessibility, user experience, background information about the survey, the presence of extra features, and security. In terms of accessibility, all the groups mentioned that they would appreciate the function to change the font size and turn on text-to-speech and speech-to-text (i.e., the app will read the questions to the respondents and respondents can record their answers to open-ended questions by speaking into the microphone). One group mentioned they would like to have a dark mode option.

As for user experience, the commonly mentioned design requests are easy navigation, a survey progress bar, navigational buttons such as forward and backward to different sections of the survey (either module or question), and a user guide or FAQ on the app. Other extra features that they had mentioned would be good are the function to set up reminders for themselves to complete the surveys, the ability to give feedback or ask questions about the survey, and finally the ability to assign nicknames to the surveys to remember the survey context.

In terms of the background information about the survey, the home screen should describe the type of questions, the number of questions, and how “easy” the questions are to answer, along with the average time needed for the module. The participants also mentioned that the app needs to have features that incentivize its use. A few groups mentioned that the app should be able to field other surveys as well from other institutions; it should not be limited to only one survey or one institution. One group suggested adding a dashboard that links to the user’s account in the National Science Foundation. Besides that, one group mentioned virtual rewards and providing feedback to the respondents (e.g., comparing their responses to other respondents, past year statistics) to incentivize app usage:

> “I think especially for the question, that one where you have to describe your current job. To try and type that out on a smartphone, I'm going to give you a two-word answer vs. if I can just do a quick speech-to-text."
>
> "I think a reminder is helpful for questionnaires with multiple modules since you won’t complete them at once."
>
> " -- and the reminder should have the clickable link that leads you directly to the section you stopped at last time."

Table 2 below lists out the example features mentioned by participants across three workshops.

Table 2. Summary of the features mentioned

Theme	Examples
Accessibility	Font size, save progress, text-to-voice, voice-to-text
User experience	Easy navigation; good designs, voice dictation or other design to avoid texting; well-designed user guide; save button; reopen last module, progress bar; tab to move back and forward different sections; even within a module to go back to a certain questions; have more short videos and good pic, convert questions to more suitable for smartphone app and avoid using text for ease of use e.g. using scale
Security	Worries about the data fidelity of the app*; Have a “Data Privacy” button on the landing page that navigates to a separate page with information about privacy and confidentiality*.

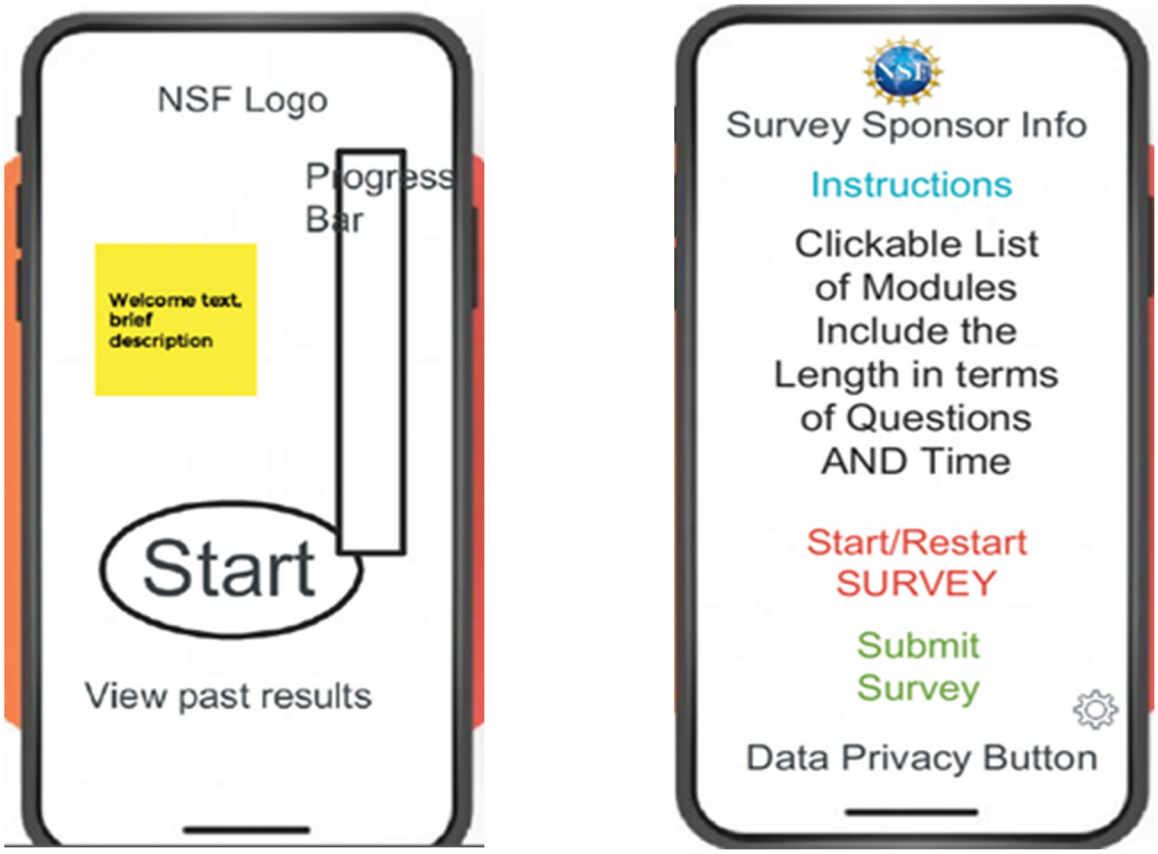
User incentives	Being able to publish surveys (a platform for publishing and responding to surveys, not just for only one institution; smart app - suggest sending surveys to them based on their respondent profile*; link to their NSF dashboard*; a snapshot of survey results; comparing responses to past responses/other respondents
Extra features	Have a survey management portal, and give each recurring survey a short nickname to help remember the survey context*; set up the reminder for unfinished/interested surveys so that could go back to the app; give feedback or comments for the app in case there are concerns/questions
Information on the survey	Research and publication info; tell respondents the average time range of completing a specific module and don't be deceitful about the actual time range for completion otherwise will quit the survey; home screen modules describe question types (whether the module contains “easy” questions or open questions); a symbol to show whether text answers are needed; all modules presented simultaneously (allowing respondents to choose which ones to answer); in the header, give info about how many questions are within a module

*Suggestion is from only one group

Design of the app landing and ending page

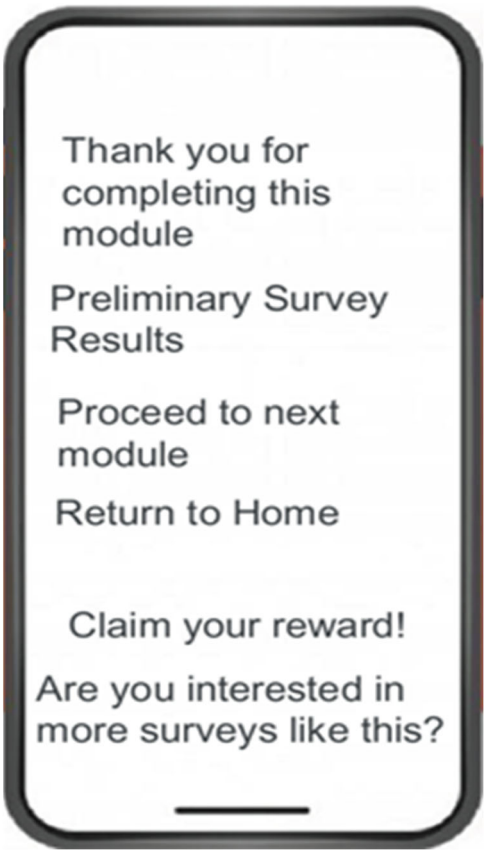
From the designs provided by the groups, clean design with intuitive navigation is important to them. The button to start the survey is featured prominently in many of their designs (see Figure 1).

Figure 1. Examples of app landing page design



A few groups included the sponsor information and information and instructions on the survey. As for the survey ending page, the groups generally included a “thank you” statement, some preliminary results or past survey results and easy access to the next module (see Figure 2).

Figure 2. Examples of module ending screen design



Additional Jamboard files available upon request.

V. Preliminary recommendations and next steps

Based on the literature review and the PD workshop results described above, we make preliminary recommendations for the design of a smartphone app that could issue modular surveys.

Recommendations

We recommend pursuing the development of a smartphone app for administration of the SDR. This approach would address several of the design requests made by participants in the PD workshops.

1. Short surveys. Participants requested surveys that are short in length (e.g., 5 minutes). However, the most recent SDR took approximately 20 minutes to complete on average. An app would provide a vehicle for administering SDR in a set of relatively short modules. Under this approach, we think the modules could contain conceptually related questions and be about the same length for consistency.
2. Flexible pace of survey completion. PD workshop participants generally wanted control over the timing and pace in which they complete surveys. When asked about modular surveys, they wanted the ability to complete the modules on their own schedule (rather than a preset schedule) and the ability to complete more than one module at one time (i.e., no predetermined breaks between modules). An app interface could use a navigation structure that enables this go-at-your-own-pace approach -- e.g., by displaying the full list of selectable modules on a navigation page.
3. Reducing response burden. Participants expressed a preference for features that make completing surveys easier. Specifically, they mentioned voice input as a way to quickly record answers. An app could support this functionality for the SDR items that involve text entry. Participants also expressed the desire to control the way the questionnaire design elements (text, colors) are displayed on their screens to improve accessibility. An SDR app could feature customizable settings and provide respondents with a way to increase the size of fonts used for question text.

However, the PD workshop participants also cited potential challenges with an app-based approach that would need to be overcome.

1. Data privacy and security. Some participants voiced concern that a survey app could collect additional data about their activities without asking for permission. To be effective, invitation materials for an SDR app-based survey would therefore need to address these concerns, for example, by providing information about which types of data are collected and how data are protected. The app itself could also feature relevant information (e.g., accessed through a button labeled “privacy”).
2. Extra step of downloading the app. Some participants expressed concern about the effort involved in downloading an app to their phones. Given this, successful implementation of an SDR app may require special efforts to encourage participation. For example, making convincing arguments that using the app will reduce respondent burden (Schouten et al. 2020) or providing an upfront incentive to motivate respondents to participate (Jäckle et al, 2019; Keusch, 2019; Lugtig et al., 2020).

Other topics emerged in the PD workshop that do not yield a clear set of design recommendations.

1. Frequency of reminders. The optimal frequency of reminders is unclear. Reminders to complete survey modules via email or app notifications are likely to encourage participation. However, some PD workshop participants viewed reminders as disruptive because they interrupt their other activities. Frequent reminders therefore could backfire if respondents decide to delete a survey app from the devices to avoid receiving them.
2. Incentives for completing modules. PD workshop participants had mixed views about the effectiveness of incentives for completing individual survey modules (i.e., "micro incentives"). Some participants did not think this type of incentive would motivate them to participate. However, previous research suggests that these incentives can increase participation rates (Bell et al. 2016).

Future Research

Our overall view on the development of an app is that the advantages outweigh the potential challenges, but more research is warranted to determine its optimal design. In this vein we propose two avenues for future research.

1. Participatory Design Workshops with App Prototype. We propose to design an SDR app prototype (paper or interactive) that can be evaluated in a second round of PD workshops.

   The prototype may include screens that enable respondents to participate in methodological studies (e.g., responding to open-ended cognitive interviewing probes after a closed question). The app prototype may also provide feedback to the respondents (e.g., on which surveys they have completed over the time or how their answers compare to the answers provided by other respondents).

   In each PD workshop, participants would be asked to view the app, provide their reactions to it, and work in small groups to generate design recommendations. We will use this information to make improvements to the design of the app.

2. Experimental Testing of Design Features. Our next step would be to finish programming an interactive app prototype and carry out experimental testing of it. Our preliminary proposal is to test specific design features that could impact response quality or response burden (e.g., voice vs. text input of open questions; use of progress indicators). These experiments could be conducted with subsamples of ECDS participants.

All of this work would lay the groundwork for a future phase of the project involving a large-scale experiment. For example, that experiment could use a 2 x 2 design to investigate the effect of survey mode (app vs. web) and the effect of modular design (multiple-module vs. single-module). This work would also test data collection procedures aimed at reducing nonresponse error, such as the use of micro incentives (rather than a single incentive) and the use of more frequent reminders (rather than less frequent reminders). Estimates produced by the app-based approach could be compared to benchmark values to determine whether it is viable for producing accurate population estimates.

We hope to work with NCSES on these experimental designs and related app development in future research.

Appendix A. Invitations emails by batch

Batch number	Date emails sent	Sample size	Undeliverable	Out of office
1	4/8	101	18	2
2	4/12	100	15	2
3	4/21	100	14	1
4	4/30	101	13	2
5	5/3 (morning)	101	14	3
6	5/3 (afternoon)	101	15	1
Total		604	89	11

Appendix B. Participatory design workshop discussion guide

I. Introduction (10 minutes)

Hello, welcome and thank you for joining us today. Today we'll be talking about your experience taking surveys and your thoughts on using a smartphone app to take surveys. In particular, we're interested in getting your thoughts on how to best redesign the Survey of Doctorate Recipients or SDR. We will tell you a little bit more about that survey later in the session.

This session will have three parts. The format of the first part is a focus group. If you've never done one of these before, it's pretty straightforward, I just have a set of questions and I'd like to open those up for discussion. There's no formal method for answering. I encourage everyone to share their thoughts. My role is merely to facilitate the conversation; you all will be guiding it.

The second part will involve working in small groups. I will divide you into two groups, and ask you to discuss ways of redesigning the survey I mentioned earlier. My colleagues will each join a group to help take notes and you'll be working on the design tasks among yourselves.

Finally, we will get together after the small group activity and discuss the design implementations that you came up with. There are no right or wrong answers, and we encourage everyone to share their thoughts.

I'll be recording the session today, but I want to assure you that whatever that is being shared in this Zoom session stays with us, and anything we use from this conversation today to help develop resources or publications will not be connected to your name.

This session is scheduled to last approximately 90 minutes and we will take a 5-minute break halfway through the session.

Did you receive and have a chance to review the consent form we sent earlier?

> *[If no]* That's ok, we are required to provide this information before the workshop. So let me just reiterate some points mentioned on the consent form. This is a research study and your participation is voluntary, there are no direct benefits or risks associated with participating in this study. Upon completion of this workshop, you will receive a $50 electronic debit card via email. We would like to record our session today, the recording helps us make sure we hear everything you say correctly. Only the people who work on this research project will be able to view the recordings and see our notes. *[Read information sheet aloud]*
>
> *[If yes]* Ok, I would like to remind you that participating in this workshop is voluntary, there are no penalties for refusing to participate, and you can end the session at any time. Do you have any questions? *[Answer questions]*

Do you agree to participate in this workshop? *[If yes, continue. If no, stop now]*

Do you agree for the workshop to be video recorded? *[If yes, continue. If no, do not record or end participation]*

[Questions and answers]

[Moderator starts recording]

Great. To begin, I would like each of you to tell us a little bit about yourselves. Please tell us your name and where you are located, and maybe in what field you are working in right now… I am going to call people's names and you can unmute and introduce yourself very briefly.

II. Focus group (35 minutes)

(1) Now we are going to talk about your experience taking Web surveys. I'd like to hear whether you regularly respond to Web survey requests, what kind of requests you usually respond to? For those who don't regularly respond to Web surveys, are there reasons why not?

Feel free to unmute and start the discussion with others in the room. Anyone can go first, there is no order.

> Prompts: what kinds of Web surveys are you more or less likely to complete? How has your overall experience been with taking Web surveys? Do you generally prefer to be invited to participate with mailed letters, emails, or text messages?

[Discussion]

(2) Now let's move on to your experience using smartphones, mobile devices to complete surveys, other than with your computers. For those who actually have used their phones to do a survey, I'd like to hear when, what situation, and why you've used it. For those who haven't had this type of experience, are there any reasons why not?

Feel free to discuss anything relevant based on your experience, or just talk about observations and any thoughts related to this.

> Prompts: How has your experience been with using your phone to complete Web surveys? In general, which device do you prefer to use to complete Web surveys?

[Discussion]

(3) Now let's shift our conversation to a newer method of administering survey questions. This is to use a smartphone app. What are some of your thoughts on using an app on your phone to complete a survey?

> Prompts: If an incentive is provided for downloading a survey app, how much seems acceptable to you? What would make you keep an app on your phone? What features or functions would you expect a survey app to have? Would you prefer using a smartphone app rather than a smartphone browser to access a survey?

[Discussion]

(4) We're interested in how we might use a smartphone app to improve people's experience with surveys. One idea is to divide a questionnaire into smaller parts and allow respondents to complete various small parts at their convenience. What are your thoughts on this approach?

> Prompts: How long would you want each part to be? How often would you want to be willing to answer a new part of the survey – monthly, weekly, daily – or at some other frequency? Would this be more convenient than completing the full questionnaire all at once? With this approach, would you prefer to be reminded to answer questions with email, text messages, or app notifications? If we are to offer an incentive, would you want a small incentive after each small section or a large incentive after completing all the sections?

[Discussion]

(5) Now I want to shift our conversation to focus on the survey I mentioned earlier, the Survey of Doctorate Recipients or SDR. I will share my screen and show a slide that contains information about this survey. After I describe it, I'd like to get your opinions and feedback on what you think of certain aspects of the survey. *[Moderator shares screen showing a slide with descriptions of current SDR design, including the study description, question topics, and sample question screenshots.]*

Now I'd like to hear what you think of the design of this survey. Is there anything you particularly like or dislike?

> Prompts: Do you think you would respond to this survey? What do you think of the incentive provided? What do you think about their approach for contacting people and sending reminders?

[Take a 5-minute break here] Let's take a 5-minute break and come back at [*Time*].

III. Group work (35 minutes)

Welcome back. Let's start the second part of our session. As I mentioned in the beginning, we will divide you into two groups and you'll be working with your group members on a series of tasks using Google Jamboard. My colleagues will send links to the Jamboard in the chat once you are all in the breakout rooms, but before we do that, I'll share my screen now and give a quick tutorial of how Google Jamboard works.

[Moderator gives a quick tutorial of how Jamboard works]

Now I will break you into two groups. My colleagues will join you to help take notes. You will have 25-30 minutes for this activity. Please read instructions on the first page of the Jamboard and start working on the task among yourselves. Please record your answers directly on the Jamboard. After you are done, we'll invite one person from each group to quickly go over their design and we can react to it.

[Start of the participatory design breakout rooms]

IV. Debriefing (10 minutes)

[Participants and moderators join the main Zoom session]

Thanks so much for thinking through different design options and working on an actual implementation of the survey app. We're coming to the final part of today's session. Now we are going to have a group member discuss their ideas in 2-3 mins sharing their screen. I can share my screen with your jamboard and just let me know if you want to go to the next page.

[Moderator invites participants (one from each group) to go over their Jamboards and talk about specific design considerations]

Now suppose we have to make decisions on the specific design parameters mentioned in the boards, let's talk about our favorite design elements. Group 1, what are some features that you like about Group 2's design?

Now I'll pose the same question to Group 2. What are some features that you like about Group 1's design?

Is there anything else you wanted to talk about today that we didn't ask?

Finally, I'm curious how you like the format of today's workshop. What do you think of doing focus groups at first and then design activities? What about the co-design activities working on the Jamboard? Any changes you prefer to see on the Jamboard? Would you prefer other discussion formats?

Thank you again for your valuable time today. We appreciate your contributions. Please feel free to share any comments or feedback if you think of any. We will email you the incentive after this meeting. If you don't have other questions or comments, you can leave the meeting now. Thank you.

Appendix C. Jamboard tasks

Task 1. Dividing the Questionnaire into Modules

Imagine that you are invited to complete the Survey of Doctorate Recipients (SDR) using a smartphone app. The SDR has approximately 61 questions and takes 18 minutes to complete on average.

Imagining that you are an SDR survey respondent, would you like to divide the survey into shorter parts (or "modules")? If so, how long would you want each part to take in minutes? If not, why wouldn't you want to split the survey?

Task 2. Determining the Time Between Modules

Imagine that you are an SDR survey respondent, and the survey has been split into modules and that you have already completed the first module using a smartphone app.

Would you like to wait before starting the next module? If so, how long would you want to wait? If not, why wouldn't you want to wait to start the next module?

Task 3. Identifying Features for the Smartphone App

Imagine that you are an SDR survey respondent and will be using the SDR smartphone app to complete different modules over time. Please brainstorm what features you would you want the smartphone app to have.

Task 4. Designing the Smartphone App: Home Screen

Imagine that you are an SDR survey respondent. Suppose that the SDR smartphone app has a home screen that you see when first opening the app.

Use the tools (pens, shapes, text boxes) in the Jamboard to draw on the smartphone to sketch out how you would want the home screen of the app to look.

Try to show how some of its important features could be displayed.

Task 5. Designing the Smartphone App: Module Ending Screen

As an SDR survey respondent, now suppose the SDR smartphone app has ending screens that you would see after completing each survey module and closing the questionnaire window.

This screen is designed to encourage you to keep using the app to complete the rest of the questions in future modules.

Use the tools (pens, shapes, text boxes) in the Jamboard to draw on the smartphone to sketch out how you would want this screen of the app to look. Try to show how some of its important features could be displayed.

Works Cited

Andreadis, I., & Kartsounidou, E. (2020). The impact of splitting a long online questionnaire on data quality. In *Survey Research Methods* (Vol. 14, No. 1, pp. 31-42)

Bahr, S., Haas, G.-H., Keusch, F., Kreuter, F., & Trappmann, M. (2020). Missing Data and Other Measurement Quality Issues in Mobile Geolocation Sensor Data. *Social Science Computer Review*. First published online August 6. https://doi.org/10.1177/0894439320944118

Bell, A. R., Ward, P. S., Killilea, M. E., & Tamal, M. E. H. (2016). Real-time social data collection in rural bangladesh via a 'microtasks for micropayments' platform on android smartphones. *PloS one*, 11(11), e0165924.

Greenbaum, J. and Kyng, M. (1991). The book, Design at Work: Cooperative design of computer systems, Lawrence Erlbaum Associates

Jäckle, A., Burton, J., Couper, M.P., & Lessof, C. (2019). Participation in a mobile app survey to collect expenditure data as part of a large-scale probability household panel: coverage and participation rates and biases. *Survey Research Methods*, 13(1), 23-44

Jacobsen, J., & Kühne, S. (2021). Using a Mobile App When Surveying Highly Mobile Populations: Panel Attrition, Consent, and Interviewer Effects in a Survey of Refugees. *Social Science Computer Review*. https://doi.org/10.1177/0894439320985250

Keusch, F., Bähr, S., Haas, G.C., Kreuter, F., & Trappmann, M. (2020). Coverage error in data collection combining mobile surveys with passive measurement using apps: Data from a German national survey. *Sociological Methods & Research*, 0049124120914924

Keusch, F., Bähr, S., Haas, G.C., Kreuter, F., Trappmann, M., and Eckman, S. (2021). Nonparticipation in Smartphone Data Collection Using Research Apps [Unpublished manuscript]. University of Mannheim, Germany

Kreuter, F., Haas, G.-C., Keusch, F., Bähr, S., & Trappmann, M. (2020). Collecting Survey and Smartphone Sensor Data With an App: Opportunities and Challenges Around Privacy and Informed Consent. *Social Science Computer Review*, 38(5), 533–549. https://doi.org/10.1177/0894439318816389

Lawes, M., Hetschko, C., Sakshaug, J. W., & Grießemer, S. (2021). Contact Modes and Participation in App-Based Smartphone Surveys: Evidence from a Large-Scale Experiment. *Social Science Computer Review*. https://doi.org/10.1177/0894439321993832

Lugtig, P., McCool, D., Roth, K. (2020, June 11-12). Nonresponse rates and bias in a Smartphone-app Travel Study conducted in the Netherlands. Results from experiments in recruitment strategies. Paper presented at American Association for Public Opinion Research (AAPOR) annual conference.

Miller, Y., DiCiccio, C., Lavista, J., Gore-Felton, C., Acle, C., Hancock, J., ... & Oakley-Girvan, I. (2018). Smart(phone) Approaches to Mobile App Data Collection. *Survey Practice*, 11(2).

Muller, M.J., and Kuhn, S. (Eds.) (1993). Communications of the ACM special issue on participatory design, 36(6), June 1993.

Peytchev, A., Peytcheva, E., Conzelmann, J. G., Wilson, A., & Wine, J. (2020). Modular survey design: Experimental manipulation of survey length and monetary incentive structure. *Journal of Survey Statistics and Methodology*, 8(2), 370-384

Raghunathan, T. E., & Grizzle, J. E. (1995). A Split Questionnaire Survey Design. Journal of the American Statistical Association, 90:429, 54-63, DOI: 10.1080/01621459.1995.10476488

Read, B. (2019). Respondent burden in a mobile app: Evidence from a shopping receipt scanning study. *Survey Research Methods*, 13(1), 45–71. https://doi.org/10.18148/srm/2019.v13i1.7379

Revilla, M., Paura, E., & Ochoa, C. (2021). Use of a research app in an online opt-in panel: The Netquest case. *Methodological Innovations*. https://doi.org/10.1177/2059799120985373

Schouten, B., Bulman, J., Jarvensivu, M., Plate, M., & Vrabic-kek, B. (2020). An app assisted approach for the Household Budget Survey. Report retrieved from https://ec.europa.eu/eurostat/documents/54431/11489222/1+Report+on+the+action.pdf

Schuler, D., & Namioka, A. (Eds.). (1993). Participatory design: Principles and practices. Lawrence Erlbaum Associates, Inc.

Struminskaya, B., Lugtig, P., Keusch, F., & Höhne, J. K. (2020). Augmenting Surveys with Data from Sensors and Apps: Opportunities and Challenges. *Social Science Computer Review*. https://doi.org/10.1177/0894439320979951

Toepoel, V., & Lugtig, P. (2018). Modularization in an era of mobile web: investigating the effects of cutting a survey into smaller pieces on data quality. *Social Science Computer Review*, 0894439318784882

Wenz, A., Jäckle, A., & Couper, M.P. (2019). Willingness to use mobile technologies for data collection in a probability household panel. *Survey Research Methods*, 13(1), 1-22.

West, B. T., Ghimire, D., & Axinn, W. G. (2015). Evaluating a modular design approach to collecting survey data using text messages. *Survey research methods,* (Vol. 9, No. 2, p. 111). NIH Public Access