Mobile as Survey Mode

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October 1, 2016

Abstract

Survey researchers regularly trade-off the costs and benefits of different modes: face-to-face, mail, telephone, and web surveys. This paper presents the case that conducting surveys via applications installed on mobile devices such as smartphones and tablets is a new mode altogether. The mobile mode shares many characteristics of the web mode, but also has unique advantages and disadvantages. We discuss the attributes that make mobile surveys different from web surveys. In the data collection phase this includes differences in: coverage, non-response, and measurement error, as well as costs and design. When we take full advantage of the mobile mode, we can collect survey responses as well as unique passive data from the device itself. We detail what forms of passive data are available via the mobile mode and how they can be used to increase the utility of survey data.

Keywords— Modes, Web surveys, Mobile devices

1 Introduction

The internet offers inexpensive survey data collection via browser-based questionnaires. Many vendors offer offer platforms where anyone can design such a survey and collect responses. We refer to these as *web surveys*. Many web surveys are in fact completed via a mobile device (Callegaro, 2010). Approximately 68% of American adults own a smartphone and nearly 33% of them have no other regular means of getting online (Anderson, 2015). However, mobile completion of web surveys can introduce coverage, nonresponse, and measurement error (Couper, Antoun and Mavletove, forthcoming; Peterson et al.,

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forthcoming). Rather than designing web surveys that try to cater to both desktop and mobile browsers, another option is to develop an application that runs on a smartphone or tablet and serves up survey questions. We call these *mobile surveys*. In this paper, we argue that mobile surveys are a new mode of survey data collection, with their own advantages and disadvantages. We demonstrate the value the mobile surveys provide beyond what web surveys can provide. Survey researchers who recognize and take advantage of the benefits offered by the new mobile mode can realize substantial benefits.

2 Background on Mode Differences

The survey industry has been at this cross-roads before as surveys moved from face-to-face or mail, to telephone, to web. Each of the modes offered different benefits and costs. Modes differ in how well they cover the target population, what fraction of the selected cases will respond, and the amount of measurement error in the provided responses. Furthermore, they vary in their fixed and marginal costs (both time and money), flexibility, and scalability.

Face-to-face and mail can cover most of the US population. Telephone's coverage is still strong, but complicated by a shifting mix between cell phones and landlines. Web coverage continues to grow, with 84% of of adults using the internet by June 2015 (Perrin and Duggan, 2015).

Response rates vary greatly by mode. Face-to-face surveys achieve high response rates in the U.S. but are the mst expensive choice. Mail surveys have lower response rates. Telephone response rates are falling fast, from 36% in 1996 to less than 10% in 2012 (Kohut et al., 2012). Web surveys are often opt-in, so response rates are not appropriate.

Measurement error is also varied; all four established modes suffer from known mode effects. In face-to-face survey, interviewers can introduce measurement error, for example when the race or gender of interviewer influences respondents (Huddy et al., 1997; Davis and Silver, 2003). Telephone suffers from interviewer effects to a lesser extent as the surveyor is a voice, without known physical characteristics (Hornik, 1982). Due to the absence of an interviewer, both mail and web surveys avoid interviewer-introduced measurement error. However, without an interviewer to provide motivation, surveys in mail and web should be kept short. Respondents answer the same questions differently in different modes, and researchers will seldom know which mode comes closest to capturing the true value.

The modes also differ in the data that can be collected in addition to the survey responses. The telephone and face-to-face modes often generate records of data sets of the outcome of each attempt on each case. These data are useful in responsive design and non-response adjustment (Wagner et al., 2014). In face-to-face surveys, interviewers can make observations about selected households or persons that can be useful in developing nonresponse weighting adjustments (Eckman, Sinibaldi and Moentmann-Hertz, 2013; West, Kreuter and Trappmann, 2014; Sinibaldi and Eckman, 2015). When the addresses of

selected cases are available, Census variables can be merged in and used for weighting adjustments (Biemer and Peytchev, 2013).

3 Previous Comparisons of Online and Mobile Surveys

Due to the recent introduction of mobile surveys, only a few studies have explicitly compared them. Buskirk and Andrus (2012) detailed the relative advantages and disadvantages of web and mobile surveys. They note that mobile surveys can continue to work even when a device looses a connection to the internet, storing the data for transmission later. They also discuss the possibilities opened up by passive data, and the need for additional permissions from users to gather such data.

The only experimental comparison of web and mobile application surveys that we are aware of is by PEW (2015*a*). This study found that response rates to the mobile application survey were lower, but the two sets of respondents showed only small demographic differences. Younger respondents (18-29) were more likely to respond in the mobile mode and older respondents (65+) in the web mode. There were no significant differences in gender, race, and education. However, participation and response rates among those who were registered to vote were lower in the mobile mode than in the web mode. Only a few substantive variables, relating to how mobile devices were used, differed between the two groups.

4 Data

To demonstrate the unique capabilities of mobile surveys, we launched a survey using the Pollfish application. The application is embedded into third-party applications both on the Android platform and the iOS platform, though as we shall see, nearly all users are on the Android platform.

When users install those third party applications, the application can then choose to deliver advertisements to users that ask them to complete a poll. If they click the advertisement, the Pollfish application launches and renders a few survey questions.

In the US, Pollfish has 10 million monthly active users in its network of third party applications. The third party applications have a potential reach of over 40 million respondents. Globally, the number of active users is greater than 300 million.[1]

The first time a user takes a Pollfish survey, the application asks a few background questions such as age and gender, in addition to the questions in the survey itself. Pollfish can then build up a database of user attributes and use these to target certain users for later surveys. For example, a client may want to complete surveys only with persons aged 18 to 25. Pollfish can draw on its database to identify the users who meet the client's

[1] `http://www.pollfish.com`.

criteria and send the survey request only to eligible persons. It can also target on both historical and current location of the respondents.

The Pollfish application also collects passive data from the mobile device, which we discuss in more detail in Section 4.2. The Terms of Service of the Pollfish application detail the data collected.[2]

Pollfish is not the only mobile survey application, but it is the one we chose to work with for this paper. Alternatives which may offer similar survey and passive data collection include Confirmit SODA and Unomer.

4.1 Survey Data

The survey ran November 6th to 10th, 2015 and collected data from 2,257 respondents. The instrument contained 14 questions: education, race, age, location, three items on news consumption, four on news knowledge, income, and party identification. The text of the questions is given in the Appendix. Age and gender were known for all respondents due to participation in previous surveys. All respondents who clicked on the advertisement were eligible for the survey: we did not use any targeting or quota sampling.

No response rate calculation is possible for this type of survey. We do not know how many times an advertisement for a survey was shown on the third-party apps Pollfish works with during these dates, how many people saw the advertisement and what other surveys were running during the same time. All respondents were eligible for random drawings of $10 Amazon gift cards.

The respondent sample overrepresents women and the young. Women are 64% of the respondents and are the majority in each age category. The modal age category for women is 25-34 and for men it is 18-24. Twelve percent of the respondents report their age as 14-18.

4.2 Passive Data

One of the great strengths of the mobile mode is that it allows researchers to collect passive data from the device, in addition to the survey responses. The passive data collected via the application differs somewhat by operating system: Android permits more passive data collection than Apple's iOS.

The passive data delivered to us for the survey respondents included the following: device location, applications installed, operating system, cellular service provider. Delivery of device location and data on installed applications were unique to us, under a non-disclosure agreement, for research purposes.

[2]See `http://www.pollfish.com/terms/respondent` for more information.

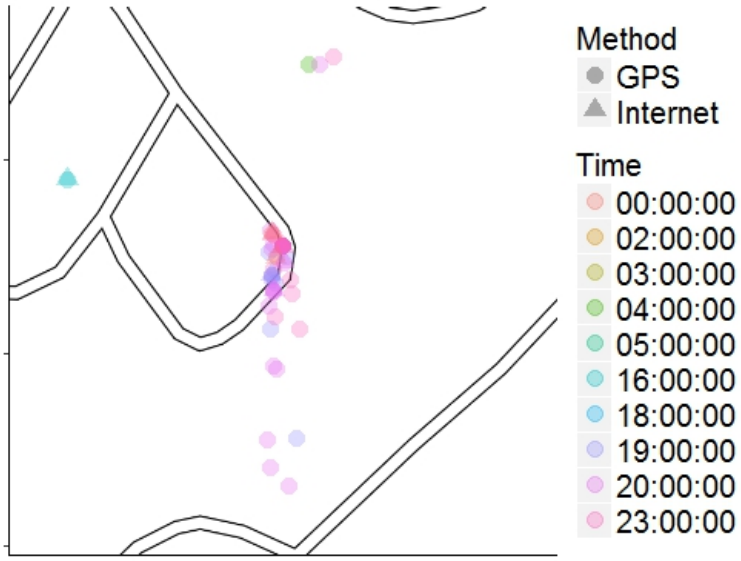

Figure 1: Location of exemplary User by Method of Internet-Access and Time

Device Location

The latitude and longitude of the mobile device's location can be derived in two ways. If the device's GPS is on and is communicating with satellites, the device can provide a latitude and longitude that is quite accurate (e.g McNamara, 1981). If the GPS device is not able to provide a location, the IP address of the phone can be matched to a location. IP locations are less accurate (Poese et al., 2011).

Pollfish delivered 930,090 coordinates to us, collected from May 5th, 2015 to April 26th, 2016. These dates clearly exceed the time frame of our survey data collection. Overall 61% of all the coordinates came from GPS signals and 39% from IP addresses. We received no coordinates for 38 cases.

For the 2,221 cases for which we do have coordinates, the number of readings varies from just one to 15,550 coordinates for one respondent (median 79). The percent of respondents' coordinates coming from the more accurFate GPS reading varied from 0% to 97.5%. For 31% of respondents, no coordinates came from the GPS device, most likely because the GPS sensor on the device was never or rarely turned on. We show the whereabouts of a randomly chosen individual in Figure 1. It is evident that we can track respondents' various locations down to precise addresses.

Applications installed

We have data on installed applications for all 2,257 respondents. Respondents have installed 19,402 unique applications. The number of applications per person varies from two to 330 (median 25). The most commonly installed applications are Facebook, Pandora, Instagram, Snapchat; each has been installed by more than 600 respondents.

When we look at application *category*, there are only 1,960 unique categories in the data set. The most common is Tools, followed by Social, Entertainment, Shopping, and Communication.

Operating System

Table 1 shows that nearly all of the respondents in our data set use the Android operating system (98.4%). This result is not surprising, because the Pollfish application is embedded in many more Android applications.

OS	Freq	Percent
Android	2,222	98.5
iOS	35	1.5

Table 1: Mobile Platform of Respondents

Cellular service provider

The passive data also contains the name of the provider used by each user. Our 2,257 respondents use 66 distinct providers, though some appear to be duplicates: "SUN" and "Sun," for example. In 14.7% of cases, the given provider is "Unknown."

Web surveys cannot collect most of these variables. They can capture user agent strings from the browsers used to complete the survey. These strings contain the IP address of the device used, the operating system, and the browser name and version (Callegaro, 2010). The IP address can be linked back to a geography, but not with very good precision (Poese et al., 2011). In addition, the IP address captures the location at only one point in time, not repeatedly as the mobile does. No information about installed applications or cellular provider is available to web surveys, and both these variables correlate with income and socio-economic status.

Pollfish does not normally make these passive data variables available to clients. They use these data internally and have released it to us for research purposes only. Other mobile survey companies may have different policies for delivery of passive data.

5 Advantages of Mobile Surveys

This unique passive data is useful in both the data collection and analysis of surveys.

5.1 Imputation

As discussed above, Pollfish asks age and gender of all respondents during the first survey but does not necessarily have other demographic variables on file. And, survey researchers are often interested in race, ethnicity, education and other individual characteristics depending on their target population.[3] Of course, a survey could ask these questions, but best practices suggest that surveys completed via mobile devices should be kept as short as possible. Thus, we have explored the possibility of imputing demographics from the passive data captured by the application.

We first look at the potential to predict respondent race and ethnicity using location data. For the 69% of cases for which we have GPS-derived latitude and longitude, we can determine the Census block groups where respondents are *at the time of being surveyed*, and can in many cases identify the block group of the respondents' residential address (Figure 1).

The American Community Survey data reports race and ethnicity at the block group level; see Table 2. Combining respondent location and block group data, we can impute respondent characteristics. There are several possible imputation methods.

Table 2: American Community Survey 5-year Estimates

Block Group FIPS Code	White	Black	Hispanic	Other
051310013044	1114	23	56	52
	89.5%	1.8%	4.5%	4.2%
051310013045	1922	35	18	57
	94.6%	1.7%	0.9%	2.8%
051310013053	808	17	0	218
	77.5%	1.6%	0.0%	20.9%

1. We could impute the modal race to all respondents in the block group. However, in 80.9% of groups in the US, the modal race category is white and this method would likely assign too many respondents to the white category. The results of using this approach to impute race are given in Table 1.

[3]Pollfish is in the process of adding more demographics, but this point holds for an array of possible variables.

Overall, 77% of respondents are assigned the same race they reported in the survey data. This error is asymmetric: white respondents are much more likely to be identified correctly than any other race.

2. We could select a value at random from the block group distribution. That is, a respondent living in block group 051310013053 would be assigned to the white category with 77.5% probability and to the other category with 20.9% probability.

3. To capture the uncertainty in the imputation process, we could use multiple imputation. The final data set would have k copies of each case, each with race imputed using Method 2 above.

Imputing characteristics based solely on location data works best for variables with a high degree of spatial homogeneity, like race and, to a lesser extent, income. It works less well with gender and age, since block groups are heterogeneous on these characteristics. Table 4 shows that the Method 1 described above does not work well for imputing education: only 40% of respondents are assigned to the same category they reported in the survey data.

All imputation models would likely benefit from the inclusion of other variables from the paradata, such as operating system, provider and installed applications. For example, having a news application installed is correlated with higher education, as shown in Table 5.

If we can improve these models, we can make questionnaires shorter, which should increase response rates and perhaps improve data quality as well. The location variables collected in the mobile mode are powerful tools in the models and the same location detail is not available from online surveys.

5.2 Targeting

Another advantage that the mobile data provides is the ability to target respondents by location. For example, we might want to survey only respondents in swing states, or a community organization might want to learn more about the attitudes and concerns of those in the city it serves. Small area geographic location targeting is possible with mobile application surveys in a way it is not with other modes. Pollfish does not yet offer the ability to target persons at the micro level, such as those who just exited a grocery store or walked by a coffee store, but such options may be possible soon. Targeting could also be used retrospectively to identify persons who were in Manhattan during Hurricane Sandy, for example. At best, web survey with a panel may be able to target people based on home or work location, but not current location.

Ecological momentary assessments are surveys meant to capture people in-the-moment and collect information about behavior, emotions, mood, etc (Burns et al., 2011). Mobile survey applications are especially well suited to such surveys, because they can pop up at

	Actual Race				
Imputed Race	White	Black	Hispanic	Other	Total
White	616	52	50	22	740
	0.962	0.531	0.725	0.786	
Black	18	41	4	3	66
	0.028	0.418	0.058	0.107	
Hispanic	4	2	13	0	19
	0.006	0.020	0.188	0.000	
Other	2	3	2	3	10
	0.003	0.031	0.029	0.107	
Total	640	98	69	28	835
	0.766	0.117	0.083	0.034	

Table 3: Confusion Matrix Race: Count, Column %.

Universe: all respondents for which we have GPS location data and who self-reported that the answered the survey at home

	Actual Education			
Imputed Education	HS/Less	Some CL	CL/Post CL	Total
HS/Less	267	193	130	590
	0.664	0.675	0.650	
Some CL	67	48	26	141
	0.167	0.168	0.130	
CL/Post CL	68	45	44	157
	0.169	0.157	0.220	
Total	402	286	200	888
	0.453	0.322	0.225	

Table 4: Confusion Matrix Education: Count, Column %

	Actual Education			
News Apps	HS/Less	Some CL	CL/Post	Total
< 1	556	373	270	1199
	0.870	0.789	0.776	
$1 - 3$	78	93	71	242
	0.122	0.197	0.204	
> 3	5	7	7	19
	0.008	0.015	0.020	
Total	639	473	348	1460
	0.438	0.324	0.238	

Table 5: News App Usage by Education

any time and alert the user that a survey request has come in, more directly than an email with a link to an web survey. In addition, the assessments can be triggered by location. For example, if a user enters a bar, the application could pop up questions about drinking behavior. Such microtargetting is not offered at this time by Pollfish (or other applications, as far as we know), but it may be possible soon.

5.3 Cross-Platform Development

Mobile applications also offer uniformity across devices that is not always possible with browser-based surveys. The browsers built into mobile devices differ in how they display web page elements. For example, dropboxes work differently in browsers on Apple devices than on Android. The particular browser used can also matter. Some survey platforms allow designers to preview how a browser survey will look on a mobile device, but they do not show operating system and browser based differences; others providers offer no preview of how the survey looks on mobile device browsers at all. These differences in how the web survey is displayed may affect how respondents respond to questions and bias survey data collected via web surveys with mobile survey applications.

An application, on the other hand, can provide a more consistent look and feel across operating systems and devices, which may result in less unwanted variation in responses. In addition, mobile surveys can take advantage of native platform-based attributes.

5.4 Incentives

Incentives are used in all modes to increase response rates. However, incentives can be hard to deliver to web survey respondents. Unless names and addresses are known before hand, this information must be collected in the survey so incentives can be sent.

Providing incentives via the mobile survey application is easier. Mobile devices are already connected to a user account and money can be easily added to the balance.

6 Disadvantages of Mobile Surveys

In addition to the above advantages that mobile surveys offer over web surveys, there are also disadvantages.

6.1 Representation

Both web and mobile surveys suffer from undercoverage. As noted above, 68% of Americans have smartphones, but just 73% have desktop/laptops. From 2011 to 2015, smartphone penetration increased from 35 to 68%, while desktops of laptop ownership increased from just 71% to 73% from 2004 to 2015 (PEW, 2015*b*). Thus the coverage rates of the two modes are nearly equal.

However, mobile surveys require another step: users need not only to have a phone but also to install the survey application (or a third party application in which the survey app is embedded). Of the 68% of US adults have a smartphone, many will not install a survey application. In a recent experiment, 61% of long time panel participants downloaded a survey application (PEW, 2015*a*): the compliance rate in a general population study would likely be lower. Even those who do install the application will not respond to all survey requests. Thus there are several sources of undercoverage and non-response (together called representation) in mobile surveys. At this time, it is not possible to reach a representative sample of the US population via a mobile survey.

Web surveys (whether by computer, laptop or mobile device) also suffer from undercoverage and nonresponse. However, it is certainly the case that a web survey is available to a higher proportion of the US population than a mobile survey, because no additional application installation step is needed.

Mobile surveys may be best suited to special populations with whom the survey sponsor has a trusted relationship, such as the long term panel participants used in the Pew Research Center study cited above. This situation may change in the coming years.

6.2 Privacy

The collection of passive data raises new concerns about privacy. Survey researchers have always collected personal data from respondents, such as: income, beliefs, drug use, etc. And, these data are sometimes linked with addresses and names, though usually only temporarily. However, the passive data available for each respondent via the Pollfish application is much richer than a telephone number or address, as some surveys now have access to. We can determine rather precisely where respondents live and work, their usual travel patterns. As shown above, these data open up powerful opportunities to learn more

about our respondents. The data can also be misused, and the survey field should develop strong respondent privacy protection policies to minimize risk to those who volunteer their data for research purposes.

7 Discussion

Survey researchers regularly trade-off the costs and benefits of different established modes of contact with respondents: face-to-face, mail, telephone, and web. This paper argues that mobile surveys should not be considered a subset of web, but a new type of mode. Similar to web, it is cheaper to recruit samples (with offsetting quality) and faster for those samples to complete, relative to other modes. Varying a little more, the available question types are different web and mobile as the screen becomes smaller or even text only. And, the incentives are different, as it is easy to identify unique users at point-of-sale in mobile. The bigger differences are in question logic and analytics. First, mobile offers the ability to target respondents based on their current location, not a static set of historical locations. Second, mobile provides very different background data than web, most notably detailed location data, but also other strings.

Modes will continue to evolve. At some point in the future there may be no telephone, in that all telephones may be graphical smart phones. But, as we push into the world of online access, web and mobile present two distinct sets of challenges and rewards, and surveys served on these modes will benefit if we treat them as separate modes.

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8 Appendix

Full list of questions and answers to Survey 1

1. What is the highest level of education that you have completed? (single answer, set order): Less than high school / High school / Some college / College / Graduate school

2. What is your race or ethnic group? (multiple answers, set order): White / Hispanic or Latino / Black or African-American / Native American or American Indian / Asian/Pacific Islander / Other

3. Where do you most commonly answer polls on your phone? (single answer, shuffle order): Home / Work / Commuting / Out-and-about

4. Which of these programs/stations do you watch regularly? (multiple answers, shuffle order/last fixed): ABC/NBC/CBS Nightly News / Fox News / CNN / MSNBC / NFL Football / Empire / The Voice / Big Bang Theory / Dancing with the Stars / NCIS / Walking Dead / Sportscenter / How to Get Away with Murder / Other/None

5. Which of these blogs/newspapers do you read regularly (online or offline)? (multiple answers, shuffle order/last fixed): New York Times / Washington Post / Wall Street Journal / USA Today / Los Angeles Times / Daily News of New York / New York Post / Huffington Post / TMZ / Business Insider / Mashable / Gizmodo / LifeHacker / Gawker / Other/None

6. How often do you talk about politics with other people? (single answer/set order): All the time / Daily / A few times a week / Once per week / Once per month / Rarely

7. Who is the Chief Justice of Supreme Court? (single answer, shuffle order/last fixed): John Roberts / Paul Ryan / William Rehnquist / Samuel Alito / Antonin Scalia / Anthony Kennedy / Do not know

8. In which countries does ISIS currently control meaningful territory? (multiple answers, shuffle order/last fixed): Syria / Ukraine / Greece / Iraq / Iran / Turkey / Saudi Arabia / Indonesia / Libya / Pakistan / Do not know

9. What is the maximum number of terms to which the president of the USA can be elected? (single answer/set order): 1 / 2 / 3 / 4 / No limit / Do not know

10. On which of the following does the U.S. federal government currently spend the least? (single answer, shuffle order/last fixed): Foreign aid / Medicare / National defense / Social Security / Interest on debt / Transportation / Do not know

11. What month of the year were you born? (single answer/set order): January / February / March / April / May / June / July / August / September / October / November / December / Rather not say

12. What day of the month were you born? (single answer/set order): 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 / 12 / 13/ 14 / 15 / 16 / 17 / 18 / 19 / 20 / 21 / 22 / 23 / 24 / 25 / 26 / 27 / 28 / 39 / 30 / 31 / Rather not say

13. What is your household income? (single answer/set order): $0 - $30,000 / $30-$70,000 / $70-$100,000 / $100-$150,000 / $150,000+ / Rather not say

14. What is your political party affiliation? (single answer/reverse order): Strong Democrat / Weak Democrat / Lean Democrat/ Independent / Independent/Other / Lean Republican/Independent / Weak Republican / Strong Republican / Not sure