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1. Introduction

The numbers of households and persons in the U.S. who have cell phones have greatly increased in the last 5 years, and many calls that formerly were made on traditional landlines phones are now made on wireless phones. Estimates of the number and characteristics of households by telephone service type are limited, but recent studies have begun to explore this issue. Tuckel and O'Neil (2004) report on cell phone ownership between 2000 and 2003. In 2003, the National Center for Health Statistics began collecting data on the types of phones in the household in the National Health Interview Survey, and the results from this survey are given by Blumberg, Luke, and Cynamon (2004). Tucker, Brick, Meekins, & Morganstein (2004) report from a February 2004 supplement to the Current Population Survey (CPS) that nearly 6 percent of households have cell phones but no landlines, and this is a large increase from earlier estimates according to data from the Consumer Expenditure Survey up to 2003.

As the percentage of households and persons in the U.S. with landline telephone service decreases, the coverage in traditional random digit dial (RDD) telephone surveys decreases and estimates from these surveys have more potential coverage bias. A related problem is that it may become more difficult to reach even those households with landlines that have cell phones and rely on their cell phones for most of their calls.

The Joint Program in Survey Methodology (JPSM) at the University of Maryland undertook to study some of these issues in a survey for its 2004 JPSM Survey Practicum. The 2004 Practicum was proposed by the Bureau of Labor Statistics, Westat, and the Census Bureau and supported by these groups along with Survey Sampling Inc. The goal of the 2004 Practicum was to design and conduct a study to evaluate the feasibility of conducting surveys on cell phones. As described below, the study sampled telephone numbers from a frame of cell phone numbers and a traditional RDD sample in a national survey, similar to earlier efforts of Steeh (2004). Experiments were constructed, for the cell phone frame, to evaluate the effect of sending an advance text message and of offering different levels of incentives.

In the following sections, we introduce the design of the study and the development of the questionnaire. We then report the data collection procedures and issues evolving from data collection. Response rates are presented next, followed by analyses and results of survey procedures. Finally, lessons learned from the study are discussed, along with implications for future cell phone research.

2. Survey Planning and Development

While the issues associated with traditional RDD samples from landlines are well-known, there are additional issues that have to be considered when surveying cell phones. The most important of these are discussed briefly below.

Cell Phone Issues

Survey researchers who sample cell phones face a set of legal, cost, safety and privacy issues that are different from those associated with sampling landlines. Many of these are related to regulations from the U.S. Federal Communication Commission (FCC) in its implementation of the U.S. Telephone Consumer Protection Act (TCPA). The TCPA places "a ban on autodialers and artificial or prerecorded voice messages programmed to call ... cellular phones, or a call for which a charge is made to the calling party." While the specifics of the TCPA have caused a great deal of discussion (e.g., Lavrakas, 2004), procedures that require the interviewer to initiate the call to the telephone number are generally acceptable.

A second component of the TCPA deals with the charges associated with the telephone call. Unlike some European countries, in the U.S. most calls to a cell phone incur a cost to the wireless service subscriber, thereby increasing respondent burden. One way to deal with this issue is to reimburse or compensate respondents for the call, a procedure adopted for the 2004 Practicum Survey.

The key safety concern posed by cell phone surveys is that the respondent may be involved with other activities, such as driving a car, that require full attention. The procedures we developed to deal with this involved training interviewers about the problem and offering a callback in these cases. Additionally, items to assess the nature of this problem were included in the interview itself. In terms of privacy, since the cell phone is viewed as a personal device by many users, calls to the phone by strangers may be more of a concern than on landlines. Another related concern raised is that wireless conversations are not as secure as those over a landline because it can take place in a public place and thus may not be as confidential. Many of these issues are discussed by Steeh (2004), who provided guidance on our questionnaire and survey procedures.

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Sample Design

The 2004 Practicum study included two samples: the Cell Sample and the Landline Sample. Both samples were drawn by Survey Sampling Inc. (SSI) from the May 2004 Telcordia data base. The Cell Sample was selected from all exchanges and 1000-blocks in the 50 states and D.C. where the NXXTYPE (the type of service) was cellular (types 04, 55, 60) or PCS (65, 68), the number was dialable, and the change code was not new, or deleted. The file contained 282,722,000 10-digit telephone numbers eligible for sampling.

The file was sorted by FIPS state and county, carrier name, and 1000-block. A random start was selected and a systematic sample of 8,500 telephone numbers was drawn. A random sample of 500 these numbers were allocated to the pretest, and the remaining 8,000 were used in the main data collection. Addresses could not be obtained for the Cell Sample, thus precluding the use of advance letters.

The Landline Sample followed the standard SSI procedure for drawing an equal probability sample for a list-assisted RDD surveys, in which all 100-banks of wireline telephone numbers with at least one listed number could be sampled. The number of telephone numbers in the 100-banks in the frame was 264,362,500. The banks were sorted by state and county and a systematic sample of 4,688 telephone numbers was drawn. The sampled numbers were then pre-screened by SSI and a total of 1,590 of the sample were pre-identified non-working and non-residential numbers. Of the 4,688 numbers, 200 were assigned to the pre-test, leaving a total of 4,488 telephone numbers for the main sample. Addresses were obtained for 2,084 landline numbers, and prenotification letters were mailed to all those addresses.

As the sample was designed as a household one, no subsampling of household members was required. Any person answering the phone, who was a household member and at least 18 years old, could respond for either the Cell Sample or the Landline Sample. The interviews for both samples were administered using Westat's computer-assisted telephone interviewing (CATI) system. Respondents in the Cell Sample were offered options to complete the survey on a landline phone, or to set up an appointment for a callback at a more convenient time such as when the call was free.

Questionnaire Development

Survey development work, including focus groups and a one-day pilot test, was done by JPSM in April, 2004. The instrument contained two parts. The first part was a short screener with two questions to determine the eligibility of the respondent and to screen out business phone numbers. The second part, called the extended interview, was the main body of the interview. The interview lasted on average about 10-minutes and asked questions about phone ownership and

usage, attitude towards cell phones, social behaviors and demographics.

Cell Sample Experiments

Two experiments were conducted for the Cell Sample component of the study. One experimented with the use of text messages. The second experimented with the amount of incentives offered to respondents. No incentives were provided to the Landline Sample.

Since no addresses could be obtained for the Cell Sample, we examined the use of text messages as an alternative form of prenotification. Buskirt, Callegaro, and Steeh (2004) report on the methods of contacting wireless subscribers in the U.S. with text messages, and on the results of a study on text messaging used to seek participation in a survey. In the Practicum, about 85 percent of the total Cell Sample had text messaging capability as determined by the carrier. The total Cell Sample was randomly assigned to one of two groups with equal probability, and a text message was sent to one group provided they were text-message capable.

Since it is generally impossible for a survey organization to determine the payment plan associated with a cell telephone number or carrier, a payment that would at least reimburse the respondents for the cost of the call was deemed necessary. The minimum payment was set at \$5 by making the conservative assumption that the highest cost of the call would be about \$.45/minute and that the call would take about 10 minutes. The second level was set to be \$10 to provide some variation. The Cell Sample was randomly split into two groups and \$5 was offered for one group and \$10 for the other group. The respondents were asked their name and address so that the payments could be sent to them.

The two experiments were assigned independently. Thus, about 25 percent of the Cell Sample numbers were assigned to each of the four conditions (text message/no text message crossed with \$5/\$10 incentive).

3. Data Collection

The main data collection was preceded by a short pretest. As a result of the pretest, a few changes were made to the questionnaire. The pretest cases were set aside and not fully worked and were not included in the analysis file. The main study was conducted from July 14 to September 5, 2004⁵. The numbers include all the telephone numbers in the sample, including those identified by SSI as nonresidential or nonworking prior to data collection. All the numbers that were not identified as nonresidential or nonworking by SSI were dialed by Westat interviewers.

⁵ The RDD sample was released on July 14 and the cell phone sample was released on July 18.

Call Scheduling

The same general scheduling protocols were used for both the Cell and the Landline Sample. Up to 14 attempts were made to each case to establish contact. For the initial contact, the scheduling algorithm scheduled calls over different times of the day and different days of the week, including day, evening and weekend calls. Cases received at least one call in each of the required time periods before they were finalized. If a contact was made and a refusal occurred, an additional set of up to 8 calls (a total of up to 22 calls) was permitted to re-contact the case for the refusal conversion attempt. While the calling protocols for the two samples were intended to be identical, the Landline Sample cases were released earlier than the Cell Sample cases. As a result, the distributions of first call attempts for the two samples are different as presented later.

About 35 percent of the Cell Sample completed interviews were done during weekday days, when free minutes are least likely. The other completes were obtained in the weekday evenings (35%) and weekends (30%). An analysis of the success of contacting and completing the interviews at different times is given later.

Refusal Conversion

If a respondent refused to participate in the screener when they were contacted, a refusal conversion was made provided the refusal was not hostile. The conversions were generally scheduled about two weeks after the initial refusal. If the respondent refused again, the case was finalized without a second attempt. Refusal conversions were done for both the screener and the extended interviews. All Landline Sample refusals were attempted for conversion because the number of completed interviews from this sample was lower than anticipated. For the Cell Sample, the number of targeted completed interviews could be obtained by doing refusal conversion for a random subsample of 75 percent of the initial refusals in the screener. To account for the subsampling, the weights of the initial refusal cases that were not subsampled for conversion were set to zero and the weights of the subsampled cases were increased proportionately. These subsampled weights are used to compute weighted response rates for the Cell Sample.

Result Code Issues

An unanticipated issue arose in the assignment of result codes for the Cell Sample when respondents answered “No” to the question “Are you at least 18 years old?” in the screener. In the Cell Sample, these cases were coded “ineligible” reflecting the common perception that the cell phone has a single user. In the Landline Sample, when a person under 18 answered the phone, we asked to speak to an adult and set an appointment if none was available at the time.

Near the end of the survey, a relatively large number of ineligible Cell Sample cases were observed (the final count had 350 cell cases coded ineligible). The larger than expected number of cell phone with persons under 18 years old concerned us, and we conducted a validation on a random sample of 50 ineligible cases to verify that the respondents were truly under 18 years old. The validation was done on paper rather than CATI and included two questions– the number of persons under 18 who used this cell phone in the past two months and the number of persons 18 and older who used it in the last two months. Only 21 of the 50 cases were completed (with responses for both questions). Of the 21 completed cases, only 4 cell phones were solely answered by persons under 18, seven were phones shared by adults and teenagers, and 10 were reported to be only adult phones. Even though the validation was small, the results suggest that treating any cell phone answered by a person under 18 as ineligible is likely to cause coverage problems. A procedure more like that used for landline phones of checking to see if an adult uses the cell phone is needed.

4. Response Rates

In this section we provide the outcomes for both the screener and extended interviews by the sample type (shown in Tables 1a and 1b). Nearly half (48%) of the Cell Sample numbers were either nonresidential or nonworking. The percentage of numbers that were either nonresidential or nonworking is even higher from the landline sample (56.7%), but over half of these numbers (33.3% of all Landline Sample numbers) were pre-identified by SSI and never dialed by the interviewers. For the Landline Sample, 9.2 percent of the cases could not be classified by residential status after multiple call attempts, while for the Cell Sample 10.8 percent had unresolved residency status. Thus, 41.2 percent of the Cell Sample dialed by the interviewers was found to be residential, while 51.1 percent of the Landline Sample was classified this way.

Table 1a. Detailed results of 2004 JPSM Practicum screener interview, by sample type

Final status	Total		Cell		Land	
	N	%	N	%	N	%
Screener						
Total completed screener	1,592	12.7	943	11.8	649	14.5
Total noncontact	1,275	10.2	862	10.8	413	9.2
Total refusal	2,394	19.2	1,720	21.5	674	15.0
Total out of scope	6,387	51.1	3,842	48.0	2,545	56.7
Total screener	12,488	100.0	8,000	100.0	4,488	100.0

Table 1b. Detailed results of 2004 JPSM Practicum extended interview, by sample type

Final status	Total		Cell		Land	
	N	%	N	%	N	%
Extended						
Total completed interviews	1,358	85.3	787	83.5	571	88.0
Total other nonresponse	93	5.8	69	7.3	24	3.7
Total refusal	138	8.7	84	8.9	54	8.3
Total out of Scope	3	0.2	3	0.3	0	0.0
Total extended	1,592	100.0	943	100.0	649	100.0

The weighted screener response rate using AAPOR RR3 is 26.5 percent for the Cell Sample and 38.5 percent for the Landline Sample. In computing these rates we classified the ineligible Cell Sample cases (because they were with a person under 18) as nonresponse⁶. The rates were computed using the CASRO method that assigns the unresolved residency status numbers to be residential at the same rate as found for the resolved numbers. The percentage of screener nonresponse due to refusals was 21.5 percent for the Cell Sample and 15 percent for the Landline Sample, indicating a greater tendency of refusing in the Cell Sample.

In each completed screener the household respondent was asked to respond for the survey so there are 1,592 total cases available for the extended or main interview (943 from the Cell Sample and 649 from the Landline Sample). For the main interviews, the AAPOR RR2 was 83.5 percent for the Cell Sample and 88.0 percent for the Landline Sample. The combined response rate (screener RR3 multiplied by extended interview RR2) is 22.1 percent for the Cell Sample and 34.0 percent for the Landline Sample. Excluding the “underage” cases (see fn. 2) raises the response rate in the Cell Sample to 24.5 percent.

Response Rates By Experimental Conditions

The \$10 group achieved a higher screener response rate than the \$5 group (29.9% vs. 22.7% using the weighted AAPOR RR3, $p < .0001$). The same pattern is observed for the extended interviews with an AAPOR RR2 for the \$10 group of 85.7 percent and for the \$5 group of 80.6 percent ($p < .001$). Thus, the combined response rates over the screener and extended are substantially higher for the \$10 group (25.8%) than for the \$5 group (18.6%).

The screener response rates for those in the group sent the text message (26.2%) and those in the group not sent the

text message (26.5%) are not statistically different. At the extended level, the response rate for those sent the message was 83.7 percent, while for those not sent the message the response rate was 82.2 percent. Over the two stages taken together, the response rates for the two groups were virtually equal (21.8% for those sent a message and 21.9% for those not sent a text message).

Since the payment and the text messaging treatments were crossed treatments, we examined the response rates at the screener and extended level to assess whether there were any interactions. Table 2 shows the weighted response rates for the four conditions at both the screener and the extended levels. At the screener level, there is no interaction effect ($p = .99$) between the payment level and the text message (essentially the text message had nearly no effect for either payment level). However, at the extended level, there is an indication of an interaction ($p = .054$), with those in the \$5 group who received the text message have a 7.5 percentage point higher response rate, while in the \$10 group the difference is 2.4 percentage points but the no message group has the higher rate.

Table 2. Screener and extended response rates for the four experimental conditions in the cell sample

Response rate	\$5 payment		\$10 payment	
	No message	Message	No message	Message
Screener	18.6%	18.1%	24.0%	23.7%
Extended	76.2	83.5	86.8	84.2

5. Analysis of Survey Procedures

Many operational procedures have been refined over time for conducting RDD surveys from a sample of landline telephones, but some of these may not be either appropriate or efficient for surveying cell phones. In this section the procedures used in the 2004 Practicum sample are assessed for the Landline Sample and the Cell Sample to provide a perspective on the relative efficiency of the procedures. Specifically, this section examines the efficiency of contacting and getting cooperation by time periods, and the level of effort, in terms of call attempts and refusal conversion attempts, by sample type.

First Call Attempt Results

The outcomes of first call attempts are good indicators of times when people answer their telephone. More detailed analysis of the effectiveness of call scheduling protocols that include subsequent call attempts is limited because the sizes of the samples for the Cell Sample and the Landline Sample are relatively small. Thus, in this section we only look at first call attempts.

⁶ Many of the cases in the Cell Sample in this category (respondent younger than 18 years old) were teenagers sharing phones with adults and we suspect some were ‘hidden’ refusals. If the cases with a respondent under 18 were excluded all together, the AAPOR 1 rate for the Cell Sample would be 29.4 percent.

Much of the analysis in this section focuses on the ability to reach residential telephone numbers. To make the analysis pertinent to this goal, phone numbers that were determined to be nonworking, nonresidential, or out of scope and had never had a human contact in the call history are excluded. In addition to those numbers determined to be residential, the tabulations in this section also includes all screener cases whose eligibility was unknown. Using this definition of residential (including unknown residential numbers), first call attempts were made to 4,448 Cell Sample numbers and 2,059 Landline Sample numbers. These calls yielded 1,447 and 745 successful contacts, respectively. A successful contact is defined as one in which a person answered the phone, irrespective of whether they actually completed the screener interview.

A standard approach to contact analysis for RDD surveys is to classify all first call attempts into one of four time periods: weekday daytime, weekday evening, weekend daytime, and weekend evening. Table 3 presents the first call attempt contact rates by the four grouped time periods for the Cell Sample and the Landline Sample. A chi-square test shows that the contact rates across the four time periods for the Cell Sample are not significantly different (between 32% and 33%) across the four time periods. The Landline Sample does exhibit the more typical pattern identified in previous RDD landline samples, with lower contact rates during the weekday early hours than weekday evening or weekend periods ($\chi^2=31.5$ with 2 df, $p<.001$). Previous research in landline surveys often shows the contact rate is higher during weekday evenings than weekend daytime, but this was not observed in our sample.

Table 3. First call contact rate, by sample type and time period

	Weekday 9am-7pm	Weekday 7pm-9pm	Weekend 9am-7pm	Weekend 7pm-9pm
Cell	33.4% (686)	32.5% (1,411)	32.3% (1,908)	32.5% (443)
Landline	25.2 (457)	36.7 (180)	39.7 (1,422)	(0)

Note: Numbers in () are the number of cases in the time period. Only numbers eventually identified as residential or unknown eligibility are included. For the first call attempts, no landline calls were made during weekend evening.

The fact that the first call contact rate for the Cell Sample does not vary much across the times has important operational implications. A possible explanation is that people carry their cell phones and answer them anywhere and at varied times, whereas landline phones can only be answered when someone is at home (except for call forwarding).

Further analysis (presented in Table 6) on the first call cooperation rates shows that the best times for completing the screener in the Landline Sample (weekday evenings 7pm-9pm) is the worst time for the Cell Sample, where success is a high percentage completed and a low percentage refused. For the

Cell Sample, the completion rate during weekends was higher than during weekday daytime and evenings. Overall, the probability of getting a refusal at the Screener on the same first call that was a successful contact is higher from the cell phone sample than from the landline sample, which implies respondents have a higher resistance to interviews over cell phones as anticipated. Note that the sample size in the weekday 7 pm – 9 pm period is small for the Landline Sample. As a result, the statistical power for some of the analyses is limited. In future methodological research, randomly assigning cases to different time slots should be considered, at least for the first call attempts.

Level of Effort

This section examines the effect of the different levels of effort used to encourage sampled households to respond to the survey. The different levels of effort considered here are the number of call attempts to first contact, the total number of call attempts, and the effect of refusal conversion.

We begin by presenting the mean number of call attempts and mean number of call attempts to first contact for all sampled telephone numbers in the Cell Sample and Landline Sample, by residential status of the number. Table 4 shows that on average, the Landline Sample required more calls overall and more calls to establish a first contact. The larger number of calls for the Landline Sample holds across residential status, suggesting that the difference is not highly related to the percentage of residential cases in the two samples. Since many cell phones may be left on and near a potential household respondent, the lower number of calls to contact and complete is not unexpected. Of course, as noted earlier the Cell Sample had a lower response rate than the Landline Sample, and more elaborate cost evaluations are needed for drawing conclusions on the relative costs of the two samples.

Table 4. Number of call attempts and number of call attempts to first contact, by sample type and residential status

	Cell	Landline	Difference
Average # of call attempts			
Total	4.73	6.51	1.88*
All residential	5.49	6.27	0.92*
Nonresidential	1.81	2.66	0.85*
Unknown	14.43	17.29	2.86*
Average # of calls to first contact			
Total	3.52	4.27	0.75*
All residential	3.00	2.78	0.21**
Nonresidential	1.60	2.27	0.67*
Unknown	N/A	N/A	N/A

Note: Landline sample numbers that were pre-identified as business or nonworking numbers are excluded. The average number of calls to first contact for non-working numbers in the nonresidential category refers to the first indication of the non-working status.

* $p<.0001$.

** $p<.05$.

Another variable that measures level of effort is refusal conversion. As noted earlier, a random sample of 1,481 of the 1,940 screener refusals were selected for conversion in the Cell Sample. Of those refusals, only 7 percent were successfully converted into completed screener interviews (100 of 1,481). For the Landline Sample, all 874 refusals were eligible for refusal conversion and 16 percent were successfully converted (136 of the 874). Thus, the refusal conversion was much more effective for the Landline Sample. The same pattern existed for the extended or main interview, with 11.3 percent of the Cell Sample refusals successfully converted as compared to 19.3 percent of the Landline Sample extended refusals.

Finally, the survey provides a unique opportunity to examine the effect of levels of effort by the type of telephone service in the household, where type of service is categorized as cell-only, land-only, and the both cell and land. Since type is only known for households with completed interviews, the results of this analysis are tentative. Nevertheless, we felt it was worth exploring this issue since it is related to other issues that arise in weighting and are discussed in Brick et al (2005). Table 5 gives the average number of calls to first contact and the average number of call attempts overall and for each sample by the type of service in the household.

Table 5. Average number of calls to first contact and number of calls by type of service and sample type

	Cell-only	Land-only	Cell & landline
Combined sample			
Average calls to first contact	2.18	2.31	2.59
Average call attempts	3.19	3.86	4.08
Cell sample			
Average calls to first contact	2.18	N/A	2.69
Average call attempts	3.19	N/A	3.99
Land sample			
Average calls to first contact	N/A	2.31	2.45
Average call attempts	N/A	3.86	4.21

Note: Only data for respondents are tabulated.

Table 6. First contact call extended completion rate by sample type and time period

Time period	Total	Cell sample	Landline sample
Total			
Number	502	316	186
completed (%)	74.5%	71.5%	80.1%
Weekday 9am-7pm			
Number	70	47	23
completed (%)	68.6%	70.2%	65.2%
Weekday 7pm-9pm			
Number	103	84	19
completed (%)	76.7%	75.0%	84.2%
Weekend 9am-7pm			
Number	293	149	144
completed (%)	75.1%	68.5%	81.9%
Weekend 7pm-9pm			
Number	36	36	-
completed (%)	75.0%	75.0%	-

6. Conclusion

The 2004 JPSM Practicum addressed operational and statistical issues applicable to conducting surveys on cell phones, including sampling, pre-notification, incentive amount, call scheduling, special disposition codes for certain call results, and weighting⁷. This paper examines the operational or data collection issues, and demonstrates that interviewing people on cell phones is feasible, although more research and data collection is needed to help resolve some of new problems.

The study found a lower response rate and a higher refusal rate from the cell sample than from the landline sample. But the differences are not drastic. An important question not addressed here is whether there are specific nonresponse biases arising as a result of the lower response rates.

Time of call attempt was not related to contact rate in the cell phone sample, contrary to standard landline sample findings. The likelihood of getting a successful contact was almost the same across all four time periods examined in the study. The lack of differences in contact rate across different times may result from the mobile nature of cell phones. Once a successful contact was established, the interview rate was higher for weekends and the refusal rate was higher for weekdays, when compared to other times.

⁷ The weighting of the dual sample frame is discussed in Brick et al. (2005).

One of the experiments conducted showed that higher offers of reimbursement resulted in a higher response rate. On the other hand, the text messaging experiment did not show that sending text messages enhanced the contact rate or the response rate for the cell phone sample. In this study, it was not possible to identify if the text message was actually received by the respondent. Tracking of the actual reception of the text messages would be helpful. Further research to explore the effectiveness of the text messages and the incentives is certainly warranted.

Households with only a cell phone required a lower level of efforts for completing the survey, compared to households with landline only and those with both services. This finding is tentative since it is based only on respondents. There was also an indication that the phone use patterns of people are different by type of phone devices. The survey results showed that, in general, more efforts were required to get a completed interview from people with both telephone services than from people with only a cell phone.

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