THERE'S NO PLACE LIKE HOME: USING TIME DIARY DATA TO INCREASE EFFICIENCY IN A TELEPHONE SURVEY

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1. Introduction

For telephone studies, a major part of data collection costs are due to failed attempts to contact target respondents. Furthermore, survey organizations all over the United States are witnessing declining response rates, and are having to make more phone calls to achieve the target number of interviews for many RDD studies (see for example, Triplett 2000).

To counter the trend of lower response rates, survey researchers have spent time studying how to increase cooperation rates using advance letters and incentives (see for example, Singer et al. 1999; Kropf et al. 1999). However, in the last ten years, the ideal times to contact potential respondents has not been widely studied.

The present study addresses the issue of the ideal time to contact a respondent by utilizing a new set of data to predict respondent availability. In this paper, we use national time diary data to model respondent availability. In a time diary study, respondents are asked to report in chronological order all of their activities for a given period of time, usually, a 24-hour period. We use the data to estimate the percentage of adults who are at home (not asleep) during the times of day most survey calling is done (defined as 9:00 am to 9:00 pm). The time diary models are then used to inform interviewer scheduling for a survey conducted in the state of Maryland. More interviewer effort was shifted to the "ideal" times to contact respondents. An experimental design is used to test the efficiency of the new interviewer assignments in order to understand if the time diary models provide useful information. Aside from the efficacy of the new interviewer shifts, the data also permit us to understand whether or not one can reach more respondents, controlling for level of effort, during the times that are predicted by the diary data model.

2. Previous Literature

Survey researchers have long recognized that finding an efficient call scheduling is key to completing a telephone survey on time and within budget. Distribution of call attempts is typically based mostly on experience, but also on retrospective studies of call results (Massey et al. 1996; Kalsbeek and Ahmed 1998; Weeks et al. 1987; Weeks et al. 1980).

For example, Massey et al. (1996) studied more than 684 different calling patterns to see the proportion of households that are reached with one, three and five call attempts. Their work is consistent with other retrospective studies: they conclude that the optimal pattern for call scheduling to reach households is a mix of weeknight and weekend calls. The calling pattern that performed the most poorly was one that had two or more weekday calls. They suggest survey research operations should make at least one daytime call during the first five calls. Among the calling patterns they studied, the best calling patterns are ones that contained no more than one daytime weekday dialing.

However, one problem with retrospective data is that it only tells researcher where the respondent was at the time of an interview. Time diary data provide a 24-hour profile of each respondent. Clearly, there is need for a more complete analysis of optimal times to make calls. Time diary data provide this opportunity.

In addition to providing data about when respondents are at home, time diary data can also provide information about their activities. Although it was not part of the present study, such data could possibly be used to assess the likelihood of completing an interview at different times of day. This likelihood is a function of both availability and willingness to cooperate. The latter may well be affected by the typical respondent activities (e.g. meal times, personal grooming times etc.) at the time of contact.

3. The Time Diary Data

The University of Maryland's Survey Research Center (SRC) conducted the study, "Estimating Exposure to Pollutants Through Human Activity Pattern Data: A National Micro-Behavior Approach" under a cooperative agreement with the U.S. Environmental Protection Agency (EPA). The study was comprised of two years of data collection with the sample distributed evenly by calendar quarter. The telephone interviewing began on September 17, 1992 and ended on October 1, 1994. The final combined two-year sample consists of 7,514 interviews with adults.

The target population for the time diary study was all persons residing in telephone households in the 48 contiguous United States. Telephone households were selected using a standard two-stage Mitofsky-Waksberg random digit dial sample design. In telephone

households consisting of only adult respondents 18 or older, one adult was selected at random. In households consisting of both adults and children (respondents 17 years of age or younger), some proportion of the time an adult was selected at random, and at other times a child was randomly selected. In this analysis of respondent availability, the children are dropped from the sample, and only adults (18 and older) are considered.

All interviewing was conducted from the SRC Telephone Facility on the College Park campus. The 7,415 interviews averaged approximately 13 completed interviews for each day of the year. Average interview time was 25 minutes. The following information was collected from each respondent:

(1)   a 24-hour personal diary, with detailed activity and location coding

(2)   a set of questions on the demographic background of the respondent

The data include location codes, to show the total number of minutes a respondent spent on the diary day at each location. It is relatively straight-forward to recode the data into two categories, "at home" and "not at home". These data are aggregated and divided into units of one-hour time blocks in one of the seven days of the week.[1] Each person is given an "at home" or "not at home" code for each unit of time. These data are used to inform decisions about distributions of call attempts in a statewide study.

4. Monthly Telephone Study: Behavioral Risk Factors Surveillance System (BRFSS)

The efficacy of the time diary data to model availability for predicting the best time to contact respondents is tested on a year-long survey in Maryland, the BRFSS. The BRFSS is a state-based health surveillance system sponsored by the Centers for Disease Control and Prevention and the Maryland Department of Public Health and Mental Hygiene. In 1999, SRC collected data from approximately 400 respondents statewide each month. Data collection took place from March through December 1999. Call data considered in the present study are taken from the period of time from July-December 1999.

5. Methodology, Data and Hypotheses

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[1] Because only 13 interviews are conducted in one day, the data are aggregated across weeks and months in order to come up with an estimate of how many people are home during a given hour during a given day.

The first step in the analysis was to analyze the time diary to ascertain when potential respondents were at home. Based on those models, we made modifications to the interviewer schedule and compared efficiency before and after the changes. These interviewer schedule changes were implemented in August 1999, creating a natural experiment. Interviewing efficiency was compared before the changes (the control group) to after the changes (the treatment group). The interviewing staff remained relatively constant over this period. All July interviews comprised the control group, and all interviewing August and after comprised the treatment group.

In order to understand whether using the time diary models improved our ability to contact respondents, we employed two measures of efficiency. The first was "first contacts" standardized for level of effort. Here, level of effort is defined by number of phone numbers dialed during the hour. We use first contacts as a measure of efficiency because these contacts are the only ones that are unaffected by any prior interviewer contact or information about the household (i.e., the interviewer noted that the respondent wanted to be called back the next day early in the evening, etc.). Level of effort is defined by the number of phone numbers dialed by all the interviewers together.

In order to understand whether the changes in calling patterns actually bear fruit in terms of increased numbers of interviews, a measure of efficiency based on the number of interviews is also employed. The second measure of efficiency is interviews made upon first contact standardized by level of effort. This measure of efficiency, unlike the number of first contacts may be affected by interviewer performance. However, the likelihood of gaining an interview should be strongly affected by whether the interviewer contacts the respondent during a convenient time.

Thus, a dataset is constructed for which the units of analysis are the hours from 9:00am to 9:00pm of each day. The variables include the month, day and time of the interview, the percentage of people predicted to be at home during the hour, the number of dials made during the hour, the number of first contacts made during the hour, and the number of interviews completed upon first contact during the hour. These data allow us to create other variables which are expected to affect efficiency such as whether the hour was a weekend or weekday hour, and whether the hour was a dinner hour (5:00pm-7:00pm).

These data not only allow us to compare the treatment and control groups, but also allow us to test conventional wisdom that weekend calling is more efficient than weekday calling and that calling during the dinner hour is a sure-fire way to reduce efficiency. Four

hypotheses are tested with this experimental data:

H1: Hours that the time diary data predict more people will be home will produce more efficiency than hours in which the time diary data predicts fewer people will be home.
This is a simple test of the overall ability of the time diary data to predict efficiency. An ordinary least squares (OLS) regression can be used to predict the effect of the percentage of people predicted to be at home on efficiency, controlling for factors such as whether the sample is new, whether the call was made on the weekend, or whether the call was made during dinner.

H2: Hours during the treatment months (August-December) will be more efficient than hours during the control month (July).
This hypothesis posits that changes implemented in interviewer scheduling and emphasis due to time diary data made during the treatment months will result in increased efficiency as compared to the control month. An OLS regression similar to the one above, except that it includes a dummy variable for treatment or control month.
H3: Weekend calling will be more efficient that weekday calling.
H4: Dinner hour(s) calling (from 5:00pm-7:00pm) will be less efficient than non-dinner hour calling.

Standard Calling Plan

In order to understand the experiment fully, one must compare the standard calling plan to the time diary calling plan. Our standard schedule for interviewing in the BRFSS is detailed in Table 1. This table indicates that the Survey Research Center interviewing times are based on conventional wisdom of survey researchers and experience. Greater emphasis on interviewer effort and scheduling was given to the evening shifts. Occasionally, an interviewer would be scheduled to call on the BRFSS during the time period from 9:00am-11:00am, but this occurred very rarely, and usually in the case of a series of callback times suggested by the household informants. Almost no calls were made in the time period from 4:00pm-5:00pm during the week.

Table 1: Standard Interviewing Schedule *Prior* to Modifications Based on Time Diary

Day	Shifts
Saturday	3:00pm-7:00pm
Sunday	5:00pm-9:00pm
Weekdays (Monday-Friday)	9:00am-11:00am (depending on appointments) 11:00am-4:00pm; 5:00pm-9:00pm

Time Diary Calling Plan

Because conventional wisdom has served survey practitioners well, one may not see drastic changes in the interviewer schedule itself due to the time diary calling plan, even though there were some significant changes, such as calling during more Saturday and Sunday hours. Fewer calls were made during other hours. However, what we did attempt to implement were changes in interviewer emphasis—that is, adding more interviewers to hours where we expected greater numbers of potential respondents to be at home and not asleep.

Table 2 shows the results of the analysis of the time diary data for activity at home. Percentages of people home in certain hours are shown in bold. These are the times that it is expected that SRC could and should devote more resources to calling, as there is a sufficient number of people at home during the given hours.

Table 2: The Results of the Analysis of the At-Home Data

Time/Day	Sunday	Monday	Tuesday
9:00am	**57%**	39%	33%
10:00am	**51%**	36%	31%
11:00am	**47%**	34%	30%
12:00pm	**45%**	32%	30%
1:00pm	**46%**	31%	30%
2:00pm	**45%**	33%	29%
3:00pm	**47%**	36%	30%
4:00pm	**50%**	43%	38%
5:00pm	**57%**	**51%**	**51%**
6:00pm	**61%**	**63%**	**61%**
7:00pm	**65%**	**68%**	**63%**
8:00pm	**59%**	**68%**	**66%**
9:00pm	**59%**	**67%**	**65%**

Table 2, continued

Wednesday	Thursday	Friday	Saturday
33%	32%	30%	**53%**
30%	32%	28%	**49%**
30%	31%	28%	**45%**
30%	32%	27%	**44%**
30%	30%	26%	**41%**
30%	29%	26%	**41%**
32%	32%	27%	**42%**
39%	43%	33%	**47%**
50%	**47%**	**41%**	**53%**
60%	**57%**	**50%**	55%
65%	**60%**	**54%**	57%
65%	**63%**	**63%**	56%
63%	**62%**	**62%**	58%

As illustrated in Table 2, the Field Schedule was changed to take advantage of increased numbers of people at home during the weekend. Shifts were added all day on the weekends—instead of focusing just on afternoon and evenings. The exception is Saturday evening. While the table indicates that it would have been wise to schedule people on Saturday evenings, the practicality of that action is limited by interviewer availability. It is very difficult to schedule interviewers to work on Saturday night. Another difference in this schedule from the standard one is that the weekday 11:00-4:00pm shift was de-emphasized, and in many cases, completely eliminated. If calls were made during this period, generally they were appointment calls (both suggestions and hard appointments).

6. Results

First, the overall efficacy of the time diary data is analyzed. Table 3 indicates the results of the first analysis. Here, we try to understand whether first contacts are influenced by the percentage of people at home and other variables.

Table 3 provides support for the hypothesis that hours that the time diary data predict more people will be home will produce more efficiency than hours in which the time diary data predicts fewer people will be home. The table indicates that the level of effort (dials) does not determine the number of first contacts standardized by number of dials. Not surprisingly, whether the numbers were dialed during the first month of the quarter (when the sample was fresh) is highly and significantly related to this efficiency measure. Contrary to conventional wisdom, weekend calling is less efficient than calls made during the week.

Table 3: First Contacts Standardized by Dials (as a percentage)

Variable	Beta	S.E.	Std. Coeff.	p
Constant	-4.295	2.008		p=0.03
% at Home	0.125	0.038	0.178	p=0.00
Dials Made	0.004	0.003	0.064	p=0.26
Weekend Call	-1.995	0.906	-0.096	p=0.03
Dinner Hour Call	0.659	1.214	0.029	p=0.59
New Sample	4.321	0.812	0.217	p=0.00

R^2=0.321; Adj. R^2=0.095; n=545; F=12.43 (p=0.000).

Table 4 presents the results of our second measure of efficiency, interviews upon first contact per level of effort. Besides the difference in the dependent variable, the model presented in this table is slightly different. Rather than including the number of dials in the model, the number of first contacts standardized for dials is included. It is expected that the level of effort (reported in sheer number of calls made) will have more effect on the number of first contacts than the number of interviews upon first contact. A more important effect on interviews is the number of first contacts actually made. Indeed, this is borne out by Table 4. In fact, not surprisingly, the number of first contacts made has the largest effect on the number of interviews, with a standardized coefficient of 0.343. However, the percentage of people at home does not trail that coefficient by far. Both are highly significant.

Table 4: Interviews Upon First Contact standardized by dials (as a percentage)

Variable	Beta	S.E.	Std. Coeff	p
Constant	-8.356	2.923		0.00
Percent at Home	0.412	0.070	0.267	0.00
First Contacts Made	74.948	8.527	0.343	0.00
Weekend Call	-4.506	1.793	-0.099	0.01
Dinner Hour Call	2.862	2.087	0.059	0.17
New Sample	2.903	1.653	0.067	0.08

R^2=0.261; Adj. R^2=0.255; n=545; F=38.223 (p=0.000).

Here again, weekend calls are less efficient than weekday calls, and dinner hour calls have no effect on efficiency.

Table 5 examines the effects of the treatment variable indicating whether the calls were made with the standard or new calling plan. One can see that the treatment variable is marginally significant (the results reported here are for a two-tailed test, and the coefficient is in the predicted direction). However, the treatment variable may be subject to some degree of measurement error, as there were some shifts where adding greater emphasis was easier than others, which may explain the weak relationship.

Table 5: The Effects of the Treatment Months on First contacts standardized by dials (as a percentage)

Variable	Beta	S. E.	Std. Coeff	p
Constant	-4.295	2.008		0.033
Treatment	2.024	1.325	0.080	0.127
Percent at Home	0.126	0.037	0.179	0.001
Dials Made	0.0034	0.003	0.061	0.290
Weekend Call	-2.003	0.905	-0.096	0.027
Dinner Hour Call	0.698	1.213	0.031	0.565
New Sample	5.335	1.048	0.268	0.000

$R^2=0.327$; Adj. $R^2=0.107$; n=545; F=10.771 (p=0.000).

Finally, Table 6 indicates the effects of the treatment month on number of interviews. Table 6 clearly indicates that the treatment months had no effect on the level of efficiency, where efficiency is defined by interviews on first contact.

Table 6: The Effects of the Treatment Months on Interviews on First contact standardized by dials (as a percentage)

Variable	Beta	S.E.	Std. Coeff	p
Constant	-7.346	3.949		0.063
Treatment	-1.004	2.638	-0.018	0.704
Percent at Home	0.412	0.070	0.267	0.000
First Contacts Made	75.167	8.553	0.344	0.000
Weekend Call	-4.501	1.794	-0.099	0.012
Dinner Hour Call	2.859	2.089	0.059	0.172
New Sample	2.391	2.132	0.055	0.262

$R^2=0.511$; Adj. $R^2=0.253$; n=545; F=31.826 (p=0.000).

8. Discussion and Planned Future Research

Clearly, the time diary data distribution is a good model to predict when potential respondents are at home. The number of people at home, as predicted by the time diary data, is strongly related to the number of first contacts made per level of effort, as well as the number of interviews gained on first contact, as predicted in the first hypothesis.

However, the question remains whether the time diary data afford us any increase in efficiency over conventional methods for scheduling, including retrospective data, conventional wisdom and experience. Here, the finding is not so clear as it is for the first hypothesis. While work conducted during the treatment months appeared to be more efficient in terms of number of first contacts made, there was no increase in efficiency where number of interviews is concerned. What accounts for this result?

This result parallels another result that may be related. Interestingly, weekend interviewing was shown to be not as efficient as weekday interviewing. Could it be that the significant increases we made in weekend interviewing caused the weekends to appear less efficient than they really are? Could the treatment changes actually have caused a decrease in efficiency because of the weekends? If so, then one would expect, that once the "weekend" variable is removed from the analysis, the "treatment" variable might become negative and potentially statistically significant. Upon conducting this analysis, we find this is not the case for either measure of efficiency.

Thus, this analysis found little support for the two hypotheses dealing with conventional wisdom. Calling on the weekend appears to be less efficient, and calling during the dinner hour appears to have no effect on efficiency.

This analysis may be somewhat limited in its generalizability. First, we cannot control for seasonal differences. This research needs to be extended over a full year to account for seasonal differences.

Second, the time diary data analyzed here is national data, while the study upon which calling protocol changes were tested were only tested in the state of Maryland. Still, we are encouraged that the time diary data performed so well in predicting when the Maryland study participants might be at home.

Finally, the EPA time diary data set is a rich source of information that could be used to develop models of availability and likelihood of cooperation. In addition to a detailed analysis of at-home activities, models could provide predicted availability differences by season and geographic region as well as a host of demographic characteristics. We can analyze the data such that we know what percentages of certain populations are home (and not asleep) at given times of the day. For example, as indicated by Table 7, we know higher percentages of men and women with a college degree are at home and not asleep at various times in the day. This table gives the average number at home over all seven days; more detailed analysis by day is possible.

Table 7: When are College-Educated Individuals Home?

	Men	Women
9:00 am	32.4%	38%
10:00 am	29.6%	34.5%
11:00 am	26.9%	32.8%
Noon	25.9%	30.9%
1:00 pm	27.4%	30.2%
2:00 pm	26.2%	29.8%
3:00 pm	27%	31.7%
4:00 pm	33.4%	36%
5:00 pm	40.2%	46.5%
6:00 pm	53%	55.5%
7:00 pm	59.8%	61%
8:00 pm	63%	64.1%
9:00 pm	65%	68%

Averaging over all seven days, we know that 60 percent of men with a college degree are home at 7:00 in the evening, 63 percent are home at 8:00 and 65 percent are home at 9:00pm. For women, 61 percent of women with a college degree are home at 7:00pm, 64 percent are home at 8:00 and 68 percent are home at 9:00. These are clearly the best times to contact college educated men and women. The present study is only an initial foray into the possible uses of these data. Certainly there is the possibility of more powerful models of general population or sub-population availability behaviors.

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