FURTHER ANALYSIS OF TELEPHONE CALL HISTORY DATA FROM THE BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM

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Sample surveys, especially telephone-administered surveys, are frequently used to obtain statistical information on various populations. Respondents are selected using probability sampling with the goal of obtaining a complete set of responses from each selected member of the population. However, nonresponse occurs when data on some of the selected subjects are not collected. If these nonresponders are different from responders, survey estimates will be biased unless compensatory action is taken. Therefore, it is of great importance to take steps that will decrease nonresponse and the nonsampling error it creates. This can be accomplished by taking a direct and more cost efficient role by calling during optimal contact times and by limiting the factors that are associated with refusals.

Today, most telephone interviews are conducted through computer assisted telephone interviewing (CATI). In addition to providing an efficient method of data collection, CATI keeps track of calling information by recording for each phone number a call history that includes the day, time, and call outcome or disposition for each attempt. We examined these call histories in order to investigate two important topics of nonresponse research: factors that optimize first-attempt contact rates and factors that convert an initial refusal to a completed interview. This analysis is the second phase in an ongoing research project funded by the Centers for Disease Control and Prevention through the North Carolina State Center for Health Statistics that is exploring nonresponse in a large, national, CATI-operated telephone survey.

Background

Much research has been published concerning different aspects of nonresponse. The literature of contact rates is abundant because the importance of an interviewer establishing contact with the selected household. In particular, Weeks et al (1980) in their 1980 article investigated first attempt contact rates in a household survey. They found that weekday nights and weekend evenings are the most successful times to contact respondents. Likewise, Groves and Couper (1998) in their book *Nonresponse in Household Interview Surveys*, found that weekday evenings were the best times to contact subjects while weekend days are also productive. However, it is still unknown where these results correspond to telephone surveys.

Once contact is made to a household, the next factor affecting nonresponse is the respondent's decision to participate in the survey. Groves, Cialdnini, and Couper (1992) list five variables that influence survey participation: characteristics of the sample person, attributes of the interviewer, societal-level factors, attributes of survey design, and the respondent-interviewer interaction. Yet, out of all these factors, the respondent-interviewer interaction and the attributes of the interviewer are the only variables of which calling rooms can work on in hopes of improving response rates. Socio-demographic characteristics of the interviewer, such as race, gender, and age, have all been studied. However, interviewers' experience seems to be the only variable that researchers agree has significant impact of successful interviewing. Groves, Cialdnini, and Couper conclude that more experience allows interviewers to "tailor" their interaction with the respondent since experienced interviewers have a bigger "repertoire" of past situations to refer to in their present calling attempts (1992, p.488). It would be useful to know if these same findings hold for large telephone surveys.

Although there is ample literature on overall refusals, literature on refusal conversion is less abundant. A refusal conversion is defined as obtaining an interview from a respondent whom initially refused. Lessler and Kalsbeek recommend for conversion attempts that an interviewer must first learn and understand the reason why the initial refusal occurred. Next, an experienced interviewer should make the conversion call a few days after the initial refusal in order to either reach the respondent at a better time or to reach a different member of the household (1992, p.170).

This paper consists of both exploratory and confirmatory analysis. Many of the analyses presented in this paper provide a more detailed look at the topics that were initially investigated by Ahmed (1998). We chose to investigate two important topics that lead to nonresponse, non-contact and refusals. We sought to determine when people are at home using first-attempt calls. After an initial refusal occurred, we investigated the environmental and timing factors that contribute to successful conversion.

Data

The results discussed in this paper are based on the call history data from the Behavioral Risk Factor Surveillance System (BRFSS), a large telephone survey conducted in all 50 states. The Centers for Disease

Control (CDC) established the BRFSS in 1984 to collect "uniform, state-specific data on preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases." (CDC, 1997). Data are currently collected every month in all 50 states, the District of Columbia, and three territories. The CATI software records the call history of each phone number, consisting of the time, day, interviewer identification, and disposition for each call attempt. These call histories enable us to study nonresponse patterns in the BRFSS. Our sample includes ten states that operate using the Ci3 CATI software. Although these states come from a convenience sample and were not randomly selected, they are geographically diverse. With ten states each obtaining several hundred interviews per month, the call history data set contains over 80,000 phone numbers that have been placed in calling to obtain the BRFSS per month goal. However, we reduced the data to 34,939 phone numbers by eliminating numbers that we felt were non-residential. Thus, these likely residential numbers included phone numbers with dispositions of completed interviewer, refusal, language problems, and no eligible respondent.

In addition to call history data, information of the calling room and interviewers was collected. Supervisors in each sample state completed a questionnaire on characteristics of their calling room. These characteristics primarily focused on their refusal conversion procedures comprising of four parts: if interviewer had access to refusal information, if interviewers were designated as converters, if interviewers were trained to deal with refusals, and if interviewers were given conversion scripts. Also, a questionnaire was completed for each 1997 BRFSS interviewer whenever possible. These interviewer surveys provided information on the age, race, gender, and experience level of the interviewers. The call history data, state, and interviewer questionnaires are all linked using the interviewer's identification number and state identification.

Analysis Plan

Goal 1: Best Contact Times

This goal investigates optimal times to make first-attempt calls in order to successfully reach respondents at home. The data consists of all first call attempts with likely residential phone numbers. Each attempt is classified as one of four outcomes: "pick-up", "answering machine", "ring-no-answer", or "other". A "pick-up" occurs if anyone in the household answers the phone and includes appointments, initial refusals, no eligible respondent, or completed interviews. A "ring-no-answer" occurs if the phone rings and is not picked up, and an "answering machine" outcome is assigned if the answering machine picks up the call. The "other" outcome includes fast busy and null attempt. We were interested in determining when "pick-up" is highest relative to the other three outcomes. The day is segmented into 15-minute time intervals in order to detect more subtle changes of "pick-up" rates over time. We produced graphs that visually demonstrated the relationship between time and calling outcome. These descriptive graphs are smoothed using a uniform kernel density due to the small sample sizes (reported in parenthesis on the x-axis) in many of the intervals. We also computed χ^2 statistic for testing the general association between the relevant calling outcome and time variable. This analysis and all further final analysis were produced in SUDAAN in order to account for the sampling design and to produce unbiased variance estimates (Shah, Barnwell, and Bieler, 1997). In the first two goals, the design is unweighted and stratified by state and month and as a result we used the "stratified with replacement" design option in SUDAAN. Although the inference of our design in not tied to a particular state or population of BRFSS, stratification was implemented because our inference is to the calling process and different states have different ways of calling.

Goal2: Refusal Conversion Rates-Phone Number Data

This goal investigates predictors of phone number refusal conversion. The data consists of all phone numbers with an initial refusal that are likely residential phone numbers. This subset reduced our data to 4,144 phone numbers. For this goal, the emphasis of the analysis is in producing a parsimonious logistic model that predicts refusal conversion. The predictors include state, number of days between the initial refusal and the final call attempt, and the number of attempts between the initial refusal and the final call attempt. We also included indicators of whether the respective calling room used certain refusal conversion procedures (listed in data section), number of refusal conversion procedures, amount of BRFSS experience and gender of the interviewer who encountered the initial refusal.

Due to the high collinearity between many of the variables, diagnostics of the full model were evaluated in SAS. After completing model diagnostics, the final model was produced in SAS (Stokes, Davis, and Koch, 1995) using backwards selection. After model selection, we introduced interactions into our final model in order to determine if any main effects become nonsignificant in the presence of the interactions. Next, final estimates, for both the final model and the final model after interactions, were produced in SUDAAN.

Goal 3: Refusal Conversion Rates-Attempt Data

This goal also examines the attempt-level predictors of refusal conversion. In this section of our analysis, the data are comprised of all attempts after the

initial refusal among likely residential phone numbers. This allows us to look at conversion rates for each call attempt after an initial refusal and not just for each phone number. Each attempt after the initial refusal will be referred to as the "referent" or "subsequent" call attempt. This transformation of the main data set into attempt level data produced 11,583 observations. For certain variables we graphed the relationship between the predictor and successful conversion and computed χ^2 statistics for these associations.

Again, we were interested in finding a parsimonious logistic model that predicts refusal conversion. The initial predictors consisted of nineteen variables and included predictors of time of day and number of call attempts. Other predictors included attributes of both the initial refusal and referent interviewer, and refusal conversion techniques of the calling room

Due to the high collinearity between many of the variables, diagnostics of the full model were evaluated in SAS. The model selection was implemented exactly the same as the above phone number conversion model. Final estimates, for both the final model and the final model after interactions, were produced in SUDDAN. The sampling design remained unweighted and stratified by state and month. However, we used the "with replacement" design option in this goal since the sample is a cluster of phone numbers and attempts within a phone number are correlated.

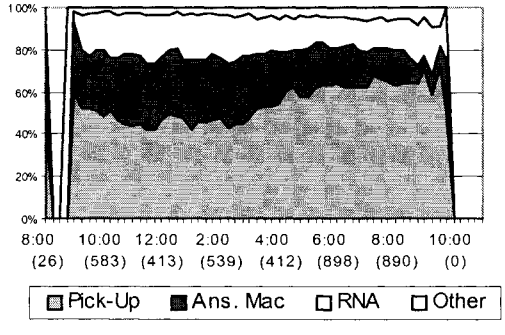
Results

Goal 1: Best Contact Times

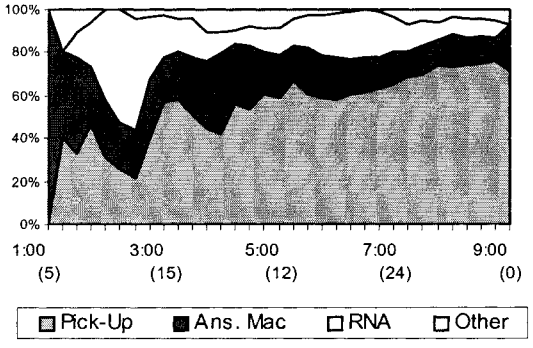
Our first step was to segment the day into 15-minute time intervals for first-attempt calls. We combined Monday through Thursday since these days displayed similar calling patterns. As shown in Graph 1, an increase in the relative percent of pick-ups for Monday through Thursday occurred from 11:30am to steady increase in the percent of "other" outcome (χ^2=135.58, df=1, p<0.0001). Furthermore, we saw a 1:00pm and after 2pm (χ^2=123.42, df=1, p<0.0001; χ^2=477.22, df=1, p<0.0001, respectively). The percent of answering machines declined from daytime to nighttime (χ^2=606.98, df=1, p<00001). The percent of ring-no-answers dropped after 2:30pm from morning to evening, and this association between "other" and morning versus evening was significant (χ^2=66.84, df=1, p<0.0001).

Saturday and Sunday traditionally have unique first-attempt calling patterns that differ from the workweek. We analyzed Saturday and Sunday separately (see Graph 2 for Sunday's distribution). On Saturday, we noticed a slight but nonsignificant increase in the percent pick-up rate from 12:30pm-3:00pm and after 6:00pm (χ^2=1.38, df=1, p=0.2423; χ^2=0.20, df=1, p=0.6582, respectively). The relative percent of answering machines grew slightly after 4:00pm on Saturday (χ^2=7.87 df=1, p=0.0022). Sunday evening produced the best pick-up rates out of all times of the week. An increase in the percent of pick-ups occurred after 3:30pm on Sunday (χ^2=13.1011, df=1, p=0.0003). Moreover, there was a small but nonsignificant decreasing trend in the percent of answering machines after 3:30pm (χ^2=1.51, df=1, p=0.1783).

Graph 1: Distribution of First-Attempt Calls for Monday-Thursday



Graph 2: Distribution of First-Attempt Calls for Sunday



Refusal Conversion Rates -Phone Number Level:

After investigating aspects of first-attempt contact rates, we were interested in learning what contributes to the overall conversion of a phone number where an initial refusal occurs. The outcome of interest was whether a completed interview occurred after the initial refusal. The explanatory variables are described in the method section. The overall model was reduced after examining regression diagnostics. The first table illustrates the significant predictors after using backwards selection, and does not take into account interactions. This table provides the results of the logistic modeling and includes the significant predictor, parameter estimate,

odds ratio, and its associated confidence interval. The categories where the beta coefficient equals zero and the odds ratio equal one denote the reference cell used in logistic regression. An asterisk (*) signifies the odds ratio is statistically significant at α=0.05.

Table 1: Phone Number Level Predictors of Successful Conversion

Significant Predictor	Parameter Estimate	Odds Ratio (95% CI)	
Number of call attempts between the initial refusal and the final call attempt	-0.10	0.91 (0.87,0.94)	*
Number of days between the initial refusal and the final call attempt	0.07	1.08 (1.03, 1.13)	*
Gender of Interviewer encountering the initial refusal (Male=1)	0.62	1.85 (1.40, 2.46)	*
Calling room provides scripts for the conversion attempt	-0.59	0.55 (0.43, 0.72)	*
Calling room train converters to deal with refusals	0.72	2.05 (1.64, 2.58)	*

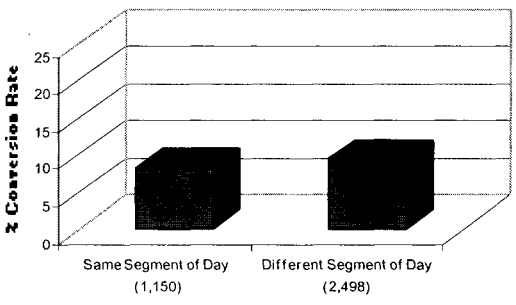
The final model contained six variables. As the number of call attempts between the initial refusal and the final call attempt increases, there is less chance of completing an interview. The results show that for each call attempt after an initial refusal the odds of completion are decreased by 9 percent. However, the greater the number of days between the initial refusal and the final call attempt increased the chance of completing an interview. For each day after the initial refusal, the odds of completing an interview increased by 8 percent. The remaining variables deal with interviewer and calling room characteristics. Interestingly, we found that if a male interviewer encountered the initial refusal, there was almost a two-fold increase in successfully converting the respondent. In addition, our model shows calling rooms that provide scripts for conversion attempts have approximately an 80 percent decrease in successfully converting an initial refusal as compared to calling room that do not provide scripts. Finally, we discovered calling rooms that train converters to deal with refusals had a two-fold increased odds of conversion.

After selecting the final model, we introduced interactions into the model in order to see if the main predictors remained significant. Only two of the six main predictors remained significant after accounting for interactions. The number of days between the initial refusal and the final call attempt [beta coefficient=0.05, OR=1.05 (1.02,1.07)] and calling rooms that train converters to deal with refusals [beta coefficient=0.30, OR=1.34 (1.12,1.61)] both maintained their significance although the strength of their association decreased.

Refusal Conversion Rates—Attempt Level Data

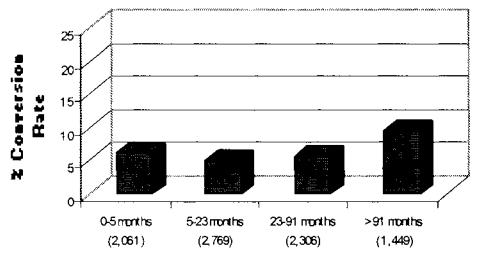
After examining conversion rates for each sample phone number with an initial refusal, we decided to break down our analysis to see effects at the attempt level. This will enable us to not only to discover predictor of refusal conversion for a phone number, but also to find predictors for a certain call attempt after an initial refusal. Every attempt after an initial refusal is considered a separate observation in this analysis.

Graph 3: Conversion Rates for Differing the Time of Day After an Initial Refusal (Attempt Level)



Since the literature was limited in attempt-level conversions, we first wanted to look at graphs of certain predictors by their associated conversion rates. Although we produced many graphs, we are only able to present two. Normally after an initial refusal, the next attempt is scheduled at a different time of the day in hopes of calling at a more convenient time or reaching a more cooperative respondent. Therefore, we categorized the time into three levels: before noon, 12pm-6pm, and after 6pm and determined if the initial refusal and the next call were in the same time category.

Graph 4: Conversion Rates for Interviewer's BRFSS Experience (Attempt Level)



Then, we produced conversion rates for this dichotomous variable, and found that changing the time of day did not seem to dramatically affect conversion rates (χ^2=2.11, df=1, p=0.1463).

Next, we investigated the relationship between the interviewer's BRFSS experience and conversion rates (χ^2=66.52, df=3, p<0.001). Overall, the greater the interviewer's experience, the greater the conversion rates. However, interviewers with 0-5 months of experience tend to produce higher refusal conversion rates than those with immediate experience levels.

After illustrating the relationship between certain variables and their conversion rates, we next decided to formally run all the predictors in a logistic model to find a parsimonious model of variables that predicts attempt-level conversion. The overall model was reduced after examining regression diagnostics. The second table illustrates the significant predictors after using backwards selection, but does not take into account interactions. The following table provides the results of the logistic modeling. An asterisk (*) signifies the odds ratio is statistically significant at α=0.05.

Table 2: Attempt-level Predictors of Successful Conversion

Significant Predictor	Parameter Estimate	Odds Ratio (95% CI)	
Number of attempts between the initial refusal and the referent call attempt	-3.05	0.05 (0.05,0.05)	*
Calling room trains converters to deal with refusals	0.54	1.72 (1.47,2.00)	*
Call attempt on which the initial refusal occurred	2.95	19.15 (18.40,19.94)	*

The final model contains three variables. We also ran this model with interactions, and all the main effects remained significant in the presence of the pairwise interactions. The higher the number of attempts between the initial refusal and the referent call attempt decreased the likelihood of completing an interview of the call attempt. For each attempt after the initial refusal a twenty-fold decrease occurs. Furthermore, our model shows calling rooms that train interviewers for conversions have a 72 percent higher likelihood of completing an interview for each attempt after an initial refusal. Finally, the call attempt on which the initial refusal occurred strongly predicts an attempt-level complete. For a one-unit increase in each attempt where an initial refusal occurs, the odds for each attempt of completing an interview is nineteen-fold.

Discussion

With nonresponse rates increasing, calling rooms are looking for new ways to combat this type of survey error. Our analysis is the second phase of an ongoing study sponsored by the CDC that looks at nonresponse in the BRFSS, a large CATI-operated telephone survey. We first investigated how time of day is associated with first-attempt contact rates. We found that on Monday through Thursday, contact rates, or pick-ups, improved slightly around lunchtime and then steadily increased after 2:00pm with the early evening having the best contact rates. Furthermore, on weekends we found that pick-up rates were high especially in the evenings. Our results agree with previous literature particularly by Weeks et al (1980) and by Groves and Couper (1998). Although this literature studied face-to-face studies, our research shows that the same trends occur in large telephone surveys. Although most of survey calling takes place on the weekdays, survey supervisors may want to increase their calling on weekend evenings, especially on Sunday in order to maximize the times when respondents are at home.

After the initial refusal occurs, in most studies an interviewer will try to convert the initial refusal to a completed interview. Since, in some surveys, refusals account for a large and statistically substantial part of nonresponse, it is important for many operations to have a high conversion rate. As a result, calling rooms invest a lot of time in converting these reluctant respondents. If supervisors knew the best ways to convert initial refusals, they could save much time and expense. The first phase of our research in refusal conversion looks at each phone number's conversion rate. The second phase investigates call attempts after an initial refusal. Attempt level analysis allows researchers to focus in on the variation in the call sequence. It will also give interviewers a better understanding of what could happen on each call attempt.

In both the phone number and attempt level models, we detected that that the greater the number of call attempts after an initial refusal, the less likely it is that the phone number would be converted. Studies generally have a maximum number of call attempts for each number and a time limit. One reason for our result may be that the limit of call attempts or time was reached. Also, after a certain number of call attempts, respondents may have become annoyed or tired of researchers trying to reach them. These results tell interviewers that after a number of call attempts have been made following an initial refusal, the likelihood of completing during the attempt is low. This result may prompt supervisors to decrease the number of call attempts after an initial refusal.

Two significant phone number level predictors deal with calling room procedures. Providing scripts to interviewers for conversion attempts decreases the likelihood of a successful conversion in the phone number

level results. This result is discussed frequently in the literature. The accepted reasoning is that imposing scripts does not allow interviewers to use their past experiences and best judgment in conversion attempts. This is why many survey practitioners do not give scripts to their interviewers. For both phone number and attempt level data, calling rooms that train interviewers to deal especially with refusals increase their conversion rates. Since refusal training has been implemented in many calling rooms, this confirms those efforts and indicates that others might consider refusal training.

Our phone number level logistic model also indicated other significant factors that contribute to a successful conversion. We also discovered that the greater the number of days between the initial refusal and the final attempt, the greater the chance for a refusal conversion. This result agrees with the recommendation of Lessler and Kalsbeek to wait a number of days after the initial refusal before proceeding with conversion attempts (1992, p.170). On reason may be that waiting a number of days will lessen the chance of the respondent becoming annoyed with frequent call attempts.

Surprisingly, our phone number level logistic model shows that male interviewers have higher conversion rates. Literature generally points towards females having higher rates, and we feel our result may be due to the fact that only 12 percent of the interviewers are male and with this small number, gender estimates may be biased.

Experience is generally considered a strong predictor of a successful call attempt and univariately this variable does seem to be predictive. For the attempt level data, Graph 4 shows that interviewers with more than 91 months of experience have the highest conversion rates per call attempt. The predominant theory in the literature behind this result is that the more experience an interviewer has, the more situations they are able to use in the present respondent-interviewer interaction. Likewise, experienced interviewers are more confident and better able to deal with reluctant respondents. Our result is specific for BRFSS experience and not overall experience. Yet, the distinction may not be important since most BRFSS interviewers did not have a significant amount of other survey experience. This result shows the importance of having experienced interviewers in calling rooms. This is an incentive for supervisors to try to keep their experienced interviewers. Curiously, those interviewers with less than five months of experience had the second best rates, which could be because these interviewers have recently completed training. However we are unable to differentiate between if experience is effective predictor on its own or if an interaction occurs, i.e. good interviewers are more apt to like their job and therefore stay longer.

Understanding the reasons behind nonresponse is the first step in reducing this type of survey error. Although much of the rationale behind nonresponse involves characteristics and attitudes of the respondent, there are other variables that involve attributes of the calling room. The time of day and day of week seems to influence the contact rates to a household. This is important since contact is the first stage of completing an interview. Moreover, once an initial refusal occurred, the sequence and distance of call attempts may influence the odds of conversion. With this knowledge of good times to call in telephone surveys, supervisors may consider changing their calling schedules. Factors that contribute to a successful interview include interviewer's experience level and calling room refusal conversion procedures. These findings may entice survey organizations to focus more on refusal training and then to strive to keep their experienced interviewers. Overall, we hope that our research and future research will provide insight on important ways to improve response rates either by affirming what is currently being done or by suggesting strategies to reduce survey attrition due to nonresponse.

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