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**ABSTRACT**

This research note presents analyses of data from a pilot study in Nepal designed to provide an initial examination of the errors and costs associated with an innovative methodology for survey data collection. We embedded a randomized experiment within a long-standing panel survey, collecting data on a small number of items with varying sensitivity from a sample of 450 young Nepalese adults. Survey items ranged from simple demographics to indicators of substance abuse and mental health problems. Sampled adults were randomly assigned to three different arms: a standard one-time telephone interview, a “single sitting” back-and-forth interview with a live interviewer using text messaging, and an interview using text messages within a *modular design* framework. Respondents in the modular arm were asked to respond (via text messaging with a live interviewer) to only one question on a given day, rather than complete the entire survey. We find that the two text messaging modes increased the probability of disclosing sensitive information relative to the telephone mode, and that respondents in the modular design arm, while responding less frequently, found the survey to be significantly easier. Further, those who responded in the modular arm were not unique in terms of available covariates, suggesting that the reduced response rate resulted in limited nonresponse bias. Given these promising initial findings, we conclude by suggesting directions for future research and testing.

## INTRODUCTION

All common modes of survey data collection have been affected by recent societal changes and increasing reluctance of the public to cooperate with survey requests (Abraham et al. 2006). Survey researchers are faced with a challenge of finding innovative methods for collecting high-quality survey data and improving the survey experience. Recent research in survey methodology suggests that the collection of survey data via text messages on mobile phones or Web browser applications is feasible and produces high-quality data (Schober et al. 2013; Cocco and Tuzzi 2013; Brenner and DeLamter 2013; Schembre and Yuen 2011; Kuntsche and Robert 2009). This is important, given the rapidly increasing proportions of people in the U.S. who use mobile phones but not landline phones (Blumberg et al. 2013). In Nepal, which is the focus of the present study, subscriptions for mobile phones increased 5% in 2006 and 75% in 2011 (MOHP et al. 2012; MOHP et al. 2007). Also important is the fact that most people with mobile phones send and receive text messages (73% of mobile phone owners in the U.S., according to the Pew Research Center; Smith 2011). The development of new methodologies for mobile data collection needs to be accompanied by rigorous studies of the errors and costs that can arise from using these methods.

This study presents one of the first comprehensive examinations of the errors and costs associated with what is known as a *modular design* approach to data collection among market researchers (Kelly et al. 2013; Smith et al. 2012; Johnson et al. 2012). Modular design works under the assumption that the behaviors and attitudes a person will share on a survey do not change substantially over a short period of time. These designs involve breaking a survey into pieces, rather than requiring participants to answer the entire survey in one sitting (which can lead to break-offs or lower-quality responses). This approach differs somewhat from split questionnaire or “matrix sampling” designs, where different respondents are only given random subsets of the items in the full survey (Raghunathan and Grizzle 1995); in modular designs, all respondents eventually have the opportunity to answer all questions, just not in a single sitting. This type of data collection methodology involving “brief” measurement shares similar features with ecological momentary assessment (EMA) methods (e.g., Shiffman et al. 2008; Moskowitz and Young 2006; Stone and Shiffman 1994) and day reconstruction methods (DRM; Kahneman et al. 2004) in epidemiology and psychology. These methods collect brief measures of behaviors and attitudes in real time and in natural environments, limiting recall bias and enabling detailed

monitoring of behaviors over time. In theory, modular designs could effectively combat problems with break-offs in longer web and mobile phone surveys, but this theory needs to be tested before the method can become widely used.

A vast inter-disciplinary literature demonstrates the negative effects of longer surveys (regardless of the mode of data collection) on both response rates and data quality (e.g., Heberlein and Baumgartner 1978; Goyder 1982; Yammarino et al. 1991; Burchell and Marsh 1992; Dillman et al. 1993; Bogen 1996; Edwards et al. 2004; Galesic and Bosnjak 2009). Furthermore, a recent study (Kelly et al. 2013) suggests that only 25% of smartphone users are willing to spend more than five minutes completing surveys. Survey researchers thus need to adapt to the increasing preferences of people to use mobile devices and the limited desire of people to spend long periods of time on surveys.

This need motivated the study described here – a survey implemented with a randomized experiment in Nepal that permits a comparison of the modular design approach to survey data collection via the use of text messaging with alternative data collection modes. With our analyses, we seek initial answers to three questions about this approach:

1. How do modular survey responses on both sensitive and non-sensitive questions compare to those collected using other text messaging approaches and more standard data collection modes?
2. How do various paradata (e.g., item non-response indicators, time required to answer a question, etc.) compare between persons assigned to a modular approach and those assigned to alternative data collection approaches?
3. Do people responding to a modular survey using text messaging find the survey easier compared to alternative data collection modes?

## **METHODS**

### ***The Chitwan Valley Family Study (CVFS)***

The modular design approach described above was implemented and tested using a subsample of the Chitwan Valley Family Study (CVFS) in south central Nepal. The CVFS is an ongoing, 15-year panel study of a stratified systematic sample of 151 communities, 2,280 households, and over 11,000 individuals in Nepal, and features a case-control comparison design at the community level (Axinn and Yabiku 2001; Barber et al. 1997).

This unusual panel study provides an outstanding environment for testing the proposed modular design approach, where relatively high cooperation rates among panel cases (a 92% response rate among originally sampled individuals to date, using AAPOR RR5) enable a focus on the measurement properties of the approach (Axinn, Ghimire and Williams 2012). Data are collected from a scientific, representative probability sample, and respondent contact information, including mobile telephone numbers and substantial survey information collected from previous waves, is readily available from the panel.

### ***Randomized Assignment***

We first prepared a complete list of 685 sampled CVFS household members between the ages of 18 and 24 who had a mobile phone. We then randomly assigned the 685 individuals into three groups, and randomly selected 150 individuals from each group for a total sample of 450 individuals. The first group (*voice interview*) was recruited and asked all of the survey questions during a single telephone call. The second group (*text message interview*) was asked all of the survey questions in a single (one-time) series of text message exchanges with a human interviewer. The third group (*modular design interview*) was asked one survey question per day via text message exchanges with a human interviewer. Respondents in the second and third groups were reimbursed for all expenses related to the text messages. While the target sample size of the proposed study is relatively small (450 people), we expected a 95 - 97% response rate in each group, which would yield more than 80% power to detect small-to-moderate effect sizes at the 0.05 significance level when using chi-square tests. A 50% response rate on a given survey item within a given group would still enable us to detect moderate effects with 80% power at the 0.05 level.

Three trained Nepali interviewers then contacted all 450 sampled individuals by telephone. These three interviewers explained the study, requested participation in the study, completed the informed consent process, and clearly explained the data collection protocol randomly assigned to each respondent. Interviewers encouraged respondents in the two text messaging arms to delete text messages after they responded to the survey questions. Individuals selected to complete the survey by telephone were asked to complete the survey during the recruitment call. Any individual who declined to participate in the study was re-contacted once by a supervisor-level staff person in Nepal who also encouraged participation in the study.

Finally, we administered an approximately five-minute interview in three different ways. For the *voice interview* group, a trained interviewer asked approximately 15 closed-ended and multiple-choice type questions. For the *text message interview* group, we arranged a one-hour time frame during which the respondent could exchange text messages with the human interviewer. In this group, the survey questions were first transmitted by the interviewers, and the interviewer then waited for a response to each question before transmitting the next question. After one hour, the interview was considered “complete,” and any break-offs or item-missing data was noted and recorded. For the *modular design interview* group, we sent one text message with one question per day for 15 consecutive days after the initial telephone contact. No reminders or follow-up contacts were made for missing responses on each day, and respondents were allowed to respond to a daily question on a later date. In each of the three groups, a final question assessed respondent burden from the survey process using a Likert-type question, with possible response options “very easy,” “somewhat easy,” “somewhat hard,” and “very hard.”

### *Questionnaire*

The 15-item questionnaire (see online Appendix) collected a series of simple yes/no and numeric responses to demographic questions (e.g., age, marital status), drug use behavior questions (e.g., “Have you ever smoked marijuana?”), mental health questions, and social media behaviors (e.g., “Do you have a Facebook account?”). These questions were adapted from other surveys, and chosen specifically because they represent behaviors or lifetime histories where respondent answers are unlikely to change over a short period of time (15 days). IRB approval was obtained for the use of the questionnaire and the entire pilot study.

### *Data Analysis*

Consistent with our three research questions, we used chi-square tests and one-way analysis of variance to compare the three arms by: 1) distributions for key survey variables; 2) item nonresponse rates for each of the 15 survey items, along with other paradata describing response behavior; and 3) respondent burden. For each survey item, we also compared respondents in the modular design arm with the full sample assigned to the modular arm in terms of distributions on selected auxiliary variables, to get a sense of possible nonresponse bias in the estimates.

## RESULTS

Overall, unit nonresponse was not a critical issue in any of the three study arms. The rates at which people agreed to participate in the study were 98.7% (148/150), 94.7% (142/150) and 94.7% (142/150) in the voice interview, text message, and modular design arms, respectively. We therefore focus on features of the measurement process with our analysis, and item-missing data rates.

Table 1 presents comparisons of descriptive statistics (means and percentages) for the various survey items between the three arms, in addition to the number of sampled persons responding to each item in each arm. Table 1 also shows, for the modular design arm, the percentage of valid responses that arrived the same day that the question was originally texted.

The results in Table 1 suggest that the arms did not tend to differ in terms of reports on the more factual survey items (e.g., age, marital status). We view this as good news for the use of the text approaches in collecting more objective information. Interestingly, we found evidence of differences between the arms in reporting on the more sensitive survey items, which in some cases emerged to be significant (e.g., ever smoking marijuana, prolonged period of losing interest in things you enjoy). We found general evidence of more honest reporting of less socially desirable behaviors in the text conditions, particularly for the mental health items and ages of onset. These results are largely consistent with recent work in this new area (Schober et al. 2013), suggesting that the texting approaches offer benefits similar to that of self-administration. We also note that respondents in the modular design condition found the survey to be significantly easier than respondents in the other two conditions, and that the single-sitting text message condition was also found to be marginally easier than the telephone condition. We also view this as good news for the potential of the modular design approach to reduce respondent burden.

Although the vast majority of respondents in the modular design arm responded to the survey questions on the same day that they were initially texted, this group had higher item non-response rates than the other two groups (see item-specific respondent counts, Table 1). This introduces an increased risk of nonresponse bias. We therefore analyzed covariates that were fully available for all panel members, and examined differences in distributions on these variables between those responding to each item and the full sample assigned to the modular arm (Table 2). Large differences in these distributions between respondents and the full sample indicate nonresponse bias for any survey items correlated with these measures.

**Table 1:** Comparisons of descriptive estimates and respondent counts (n) among the three study arms

Estimate	Voice Interview Arm	Single-Sitting Text Message Arm	Modular Design Arm [% same day resp.]	F-statistic / Chi-square (X2) statistic, p-value
Mean Age	21.2 (n = 148)	20.7 (n = 142)	21.0 (n = 105) [90.5%]	F(2,392) = 1.6, p = 0.21*
% Married	41.2 (n = 148)	36.4 (n = 140)	38.8 (n = 98) [89.8%]	X2(2) = 0.7, p = 0.71
Mean Age First Married (If married)	19.2 (n = 61)	18.4 (n = 51)	19.4 (n = 22) [86.4%]	F(2,131) = 1.6, p = 0.21*
% Traveled Outside of Nepal	13.5 (n = 148)	22.9 (n = 140)	13.9 (n = 79) [89.9%]	X2(2) = 5.2, p = 0.08
Mean Age First Drink (If drinker)	17.1 (n = 42)	15.3 (n = 43)	10.8 (n = 10) [60.0%]	F(2,92) = 7.2, p < 0.01
% Having Drink In Past Week	11.9 (n = 42)	21.6 (n = 37)	16.0 (n = 25) [88.0%]	X2(2) = 1.4, p = 0.51
% Fair / Poor Self-Reported Health	46.0 (n = 148)	40.3 (n = 139)	32.2 (n = 87) [88.5%]	X2(8) = 25.3, p < 0.01
Mean Age First Smoking (If smoker)	16.0 (n = 18)	13.7 (n = 28)	11.6 (n = 7) [71.4%]	F(2,50) = 2.4, p = 0.10*
% Ever Smoked Marijuana	5.4 (n = 148)	12.4 (n = 137)	5.4 (n = 92) [84.8%]	X2(2) = 5.8, p = 0.05
% Ever Smoked Other Narcotic	2.7 (n = 148)	4.3 (n = 139)	3.5 (n = 86) [80.2%]	X2(2) = 0.6, p = 0.76
% Ever Long Depression Period	21.0 (n = 148)	24.3 (n = 140)	26.8 (n = 82) [80.5%]	X2(2) = 1.1, p = 0.58
% Ever Discouraged with Life	18.2 (n = 148)	24.1 (n = 141)	27.0 (n = 89) [88.8%]	X2(2) = 2.8, p = 0.25
% Lose Interest In Things Enjoyed	10.1 (n = 148)	20.4 (n = 142)	20.8 (n = 77) [85.7%]	X2(2) = 7.0, p = 0.03
% Use The Internet	62.8 (n = 148)	66.9 (n = 142)	60.2 (n = 83) [83.1%]	X2(2) = 1.1, p = 0.58
% With Facebook Account	66.2 (n = 148)	69.0 (n = 142)	62.8 (n = 78) [84.6%]	X2(2) = 0.9, p = 0.64
Perceived Burden			[84.9%]	X2(2) = 30.3, p < 0.01
% Very Easy	51.4 (n = 148)	69.7 (n = 142)	80.3 (n = 66)	
% Somewhat Easy	42.6	19.0	13.6	
% Somewhat Hard	4.7	8.5	4.6	
% Very Hard	1.3	2.8	1.5	

\* Bartlett's test of equal variance among the three groups was satisfied at the 0.01 level.

**Table 2:** Differences between respondents providing valid measures and the full sample of persons assigned to the modular design condition in terms of means or percentages on selected auxiliary variables, by survey item

Survey Item	Difference between Modular Design Respondents and the full Modular Design Sample In Terms Of:									
	Mean Age (Years)	Percentage Female	Percentage with School within 10 minute walk	Percentage with Market within 10 minute walk	Percentage with Health Post within 10 minute walk	Percentage Currently Enrolled in School	Mean Number of Months Enrolled in School since 2008	Mean Number of Months Recorded in CVFS Sample	Mean Number of Support Groups	Mean Current Household Size
Q1 (Age)	-0.10	-0.35	1.79	-1.94	-1.26	2.91	1.88	0.78	0.04	-0.29
Q2 (Marital Status)	-0.04	4.82	0.16	-1.40	-1.19	3.05	0.91	-0.51	0.20	-0.06
Q4 (Outside Travel)	0.04	2.31	0.60	0.02	0.50	0.47	0.04	-0.51	0.40	-0.31
Q7 (Self-Rep Health)	-0.19	0.17	-2.94	-6.28	-4.84	3.14	1.20	-0.52	0.25	-0.19
Q9 (Marijuana)	-0.05	2.42	0.74	-3.82	-0.50	0.23	0.50	-0.49	0.11	-0.25
Q10 (Other narcotic)	-0.16	-0.31	-0.93	-3.08	3.77	-1.82	0.26	-0.07	0.06	-0.39
Q11 (Long Depress)	-0.10	2.53	2.70	-0.50	1.27	-2.13	-0.15	-0.23	0.17	-0.50
Q12 (Discouraged)	-0.08	4.47	-0.07	-1.21	-1.25	1.49	0.05	-0.37	0.18	-0.20
Q13 (Lose Interest)	<0.01	5.09	5.17	-1.77	0.38	-4.19	-1.29	-0.03	0.28	0.06
Q14 (Use Internet)	-0.08	0.59	2.96	-1.47	1.92	0.66	1.77	0.33	0.21	-0.19
Q15 (Facebook)	-0.18	-0.76	-0.99	-4.07	-1.48	-1.19	-0.60	-0.53	-0.22	-0.54
Q16 (Ease of Survey)	-0.01	8.22	-5.65	-3.72	0.38	0.79	0.59	0.70	-0.24	-0.53

Overall, the differences between respondents and the full sample in the modular arm were slight across the survey items. There is some evidence of a higher percentage of respondents to the mental health items being female, suggesting possible nonresponse bias if gender is predictive of mental health reports. We found that gender was in fact not significantly associated with reports on Q11, Q12, or Q13, suggesting that the increased reporting on these items was not simply due to a higher proportion of females responding than expected. We also see evidence of respondents to the ease of survey question being more likely to be female; importantly, gender was not found to be associated with responses to this question either, both across conditions and for the modular design condition only, suggesting that the earlier finding of increased ease of use was not simply due to more females responding to this question. Finally, we see some evidence of respondents to the self-reported health question tending to live farther away from markets and health posts, but these differences were also slight.

## **DISCUSSION**

### ***Summary of Results***

This study presents evidence of the potential of modular survey designs to collect similar or higher-quality data on a variety of survey items relative to other survey modes, in a manner that is easier for survey respondents. Whether the increased reporting of sensitive events and behaviors in the texting modes (including the modular design arm) is due to decreased time pressure or increased privacy in these modes relative to telephone (voice) interviewing remains a topic for future research. Although we did find evidence of higher rates of item-nonresponse in the modular design group, respondents did not systematically vary from the full sample assigned to that design in terms of distributions on a variety of auxiliary variables, suggesting minimal nonresponse bias in estimates derived using variables that are correlated with these auxiliary measures.

### ***Directions for Future Work***

Although the results of this work are promising, many unanswered questions remain. What is the best way to convince representative samples of persons in general populations (possibly contacted using address-based sampling; e.g., Link et al. 2008; Iannacchione et al. 2003) to provide mobile phone or email contact information, and participate in surveys using

modular designs? Can we develop applications for cooperating persons with smart phones, alerting them when “daily” questions are available for answering? What strategies can be used to increase item response rates if only one question will be asked per day? Will there be selection bias for those who agree to participate using a given mode? Are there interviewer effects associated with modes of data collection that involve text messaging with human interviewers?

Future work also needs to consider the feasibility of modular design approaches for web surveys and longer surveys with more content, using more diverse groups of individuals across a wider range of settings. The effort required to start a survey online may be higher, and engaging in this effort just to answer a single question on a given day may not be appealing to respondents. Given surveys with more content, different “doses” of questions in modular designs need more exploration.

The stability of response distributions and correlations between modular design survey measures over time also requires further examination. Future studies using modular designs should assign *random* orders of survey questions to respondents to study this stability in more detail. The present study, which allowed respondents as much time as needed to respond to a daily question, did not employ this randomization and always asked questions in the same order to the modular design arm. If the response distribution for a given survey item changes substantially over time during the course of a given survey, the modular design approach may not be as effective, instead representing a series of surveys on time-sensitive measures rather than the desired “one-time” survey. Ideally, during the time period of a given survey, the response distribution for a given survey item should not change substantially during that period, and one could accumulate the responses collected on different days to form a final estimate. We do note that in repeated measures designs, where many measures of the *same* variable are desired over a short time period, this “rapid measurement” approach may work well (Axinn, Jennings and Couper 2014).

Although the results of the present study suggest that these designs could simplify the survey response process for people using mobile technologies in their daily lives, this is one of the first steps in an exciting area that is ripe for future research.

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