Published in final edited form as:

J Surv Stat Methodol. 2018 March ; 6(1): 98–121. doi:10.1093/jssam/smx012.

Use of a Targeted Sequential Mixed Mode Protocol in a Nationally Representative Panel Study

Vicki A. Freedman, Katherine A. McGonagle, and Mick P. Couper

Institute for Social Research, University of Michigan

Abstract

Relatively low response rates in mixed mode studies remain a concern. Whether targeting protocols to match respondents' likely mode is an effective strategy remains unclear. For those without a clear likely mode, how the details about sequencing influence response rates, mode, field work effort, and potential response bias remain important questions. This article describes a targeted sequential design implemented in a 2016 mixed mode supplement with individuals ages 30 and older in the Panel Study of Income Dynamics, the longest running national panel study in the US (N=10,784). Respondents predicted to be likely to respond by web were invited to a web study and sent a paper copy after 6 weeks (web-first); those likely to respond by paper were also invited to participate by web but told that a paper copy would be sent shortly (signal-and-send). An embedded experiment measured the impact of the two protocols among a group of respondents with no clear likely mode (N=889). Over 40% of individuals with no likely mode are under the age of 40, and the group falls between the likely web and paper groups in terms of education and internet use and includes more women and single respondents. Compared to the likely web and paper groups, those with no likely mode had lower response rates and required more fieldwork effort. Among those randomly assigned, the signal-and-send protocol increased response over the web-first protocol from weeks 4 through 7. By week 16, both protocols yielded similar response rates (AAPOR 1 RR=71% vs. 68%, $p=0.49$), field effort (7.9 vs. 8.4 mean weeks, $p=0.251$), and distributions of respondent characteristics. Among those responding, cases randomized to web-first were more likely than those randomized to signal-and-send to respond by web (62.7% vs. 42.4% $p<.001$). We discuss implications for targeted protocols in mixed mode panel surveys.

INTRODUCTION

Interest is growing in the use of the internet to conduct or supplement household surveys, particularly as an option in mixed mode designs. Mixed mode studies offer more than one mode to respondents, typically paper and web. For those designing mixed mode studies, web is often considered the preferred mode by which to receive responses instead of by mail because it is less costly, responses may be obtained more quickly, and data quality may be higher since range checks and skips can be programmed (Couper 2000). Thus, mixed mode studies often aim to achieve two related goals: enhancing overall response rates (and

presumably minimizing response bias) while at the same time maximizing the proportion responding by web.

Some studies suggest that delaying the offer of a paper option in order to help encourage as many respondents as possible to answer by web (i.e., a sequential design) may be preferred for meeting these goals (Dillman et al. 2009; Messer and Dillman 2011; Holmberg et al. 2010; Smyth et al. 2010). A sequential web-first design has been shown to increase response rates relative to a web-only invitation and perform as well as a mail-only invitation in some studies (Biemer et al. 2016; Messer and Dillman 2011; Millar and Dillman 2011) but not in others (Frieze et al. 2010; Israel 2009; Lebrasseur et al. 2010; Newsome et al., 2012; Smyth et al. 2010). In contrast, concurrent offers of more than one mode appear to be consistently associated with lower response rates relative to a mail-only design (Medway and Fulton 2012). With respect to the proportion of responses by web, concurrent offers of more than one mode are associated with lower response by web relative to sequential offers of web and then paper (Holmberg et al. 2010).

Studies also suggest that, relative to offering paper and web options concurrently, signaling to respondents in the initial web invitation that a paper questionnaire will be sent does not have a substantial negative influence on response rates and increases the percentage responding by web (Holmberg et al. 2010; Smyth et al. 2010; Tancreto et al. 2012). When coupled with a reminder post-card, this strategy has been shown to increase response rates (relative to concurrent offers and to a mail-only option) in areas in the US with large proportions of households likely to use the internet (Matthews et al. 2012). Despite these advances in developing effective mixed mode strategies, how best to bolster response rates in such studies remains an important focus of ongoing research (Medway and Fulton 2012; Messer and Dillman 2011; Millar and Dillman 2011; Wood and Kuntz 2014).

Theories of survey participation suggest that attending to respondents' mode preferences may be an important step in further improving response rates, especially if targeted protocols can be developed that facilitate ease of responding without increasing the complexity of the response task. In particular, researchers have suggested that in panel studies it may be possible to predict (based upon known characteristics from prior waves) respondents' likelihood of using the web to participate in surveys and then to target field protocols accordingly (Olson et al. 2012; Smyth et al. 2014). Although the implications of tailoring protocols to respondent characteristics has been explored (see, for example, Luiten and Schouten 2013, McGonagle and Freedman 2016), studies have either used demographic characteristics or prior information about online behavior but not both to make such assignments. It also remains unclear what type of strategy should be implemented for those without a clear likely mode, and among this group how the timing of a paper option influences response rates and response mode as well as fieldwork effort and potential response bias.

This paper describes the results of a targeted sequential web-then-paper design implemented in a supplement to the 2015 Panel Study of Income Dynamics (PSID), the longest running national panel study in the United States. A group with high predicted probability of response by web was invited to participate by web with no initial mention of paper, and was

subsequently sent paper questionnaires beginning in week 6 (web-first). A second group with a high predicted probability of response by paper was also invited to complete the survey by web but with a signal that a paper copy would soon follow (signal-and-send); paper questionnaires were sent beginning in week 2. Both groups received multiple follow-up reminders and additional paper questionnaires. An embedded experiment measured the impact of the alternative protocols among a group of respondents with no clear likely mode. We first describe the results of the nonexperimental targeted design of the PSID mixed mode supplement and examine how characteristics of respondents without a clear preference for web or paper compare to those of respondents likely to respond by web and by paper. We then focus on the effect of the experimental data collection protocols on four key outcomes:

- overall response rates by week;
- the likelihood of responding by web;
- fieldwork effort, including weeks in the field and number of reminders; and
- characteristics of respondents.

BACKGROUND

Research on predicted mode

Individuals may have preferences and habits that make one mode more attractive and convenient than another. For instance, those who are not regular internet users may prefer to respond to a paper questionnaire. Moreover, irrespective of how the initial invitation is sent, internet users may have different habits that make some follow-up protocols more convenient than others. For instance, individuals who use email regularly may be more likely to see (and respond to) reminders sent by email. An ongoing concern in survey research is that respondents who have different habits or preferences may respond to surveys at different rates and hence introduce bias into estimates. In response to this issue, some researchers have attempted to target mixed-mode fieldwork strategies that involve a web-based option to match subject characteristics (see, for example, Luiten and Schouten 2013; McGonagle and Freedman 2016).

Notwithstanding this interest, research on predictors of web vs. mail mode preference and the consequences of matching mode preference is relatively limited. In an observational investigation of stated mode preference, Smyth and colleagues (2014) found that younger adults and those with a college education preferred internet to paper. In addition, measures of familiarity with and access to internet were the strongest predictors of stated mode preference. In contrast, measures of safety concerns, physical abilities, and normative concerns were relatively weak predictors. With respect to consequences, Olson and colleagues (2012) undertook an experimental study of the effect of matching stated mode preference on response rates and mode of response. They analyzed the behavior of respondents who were randomly assigned to one of four conditions: web-only, mail-only, web followed by mail, and mail followed by web. The authors found that those who had previously stated a preference for web (during a prior telephone study) were more likely to participate in a subsequent web-only condition. They also found stated preference predicted

mode selection (web vs. mail) when given the option of two modes, but it was not associated with fieldwork effort.

Both studies recommended that an informed assignment of sample members to likely response mode be undertaken if such information is available on the sample frame. Olson and colleagues note “[t]his approach would be perhaps most useful in a longitudinal survey where information is available on each sampled person prior to the survey request, but mode preference was not asked.” However, the authors did not provide guidance on how to assign sample members who have no clear likely preference.

In this analysis, we test two alternative protocols for the group that has no clear likely mode: (1) an initial invitation to a web survey, with the addition of a paper questionnaire beginning in week 6 (web-first) and (2) an invitation to web that signals a paper questionnaire will be sent, with the first copy mailed in week 2. We refer to this second strategy as “signal-and-send.”

Targeting protocols to predicted mode

The web-first design involves initially offering a web questionnaire and then offering a paper questionnaire after a delay in fieldwork (Holmberg et al. 2010; Dillman et al. 2009; Messar and Dillman 2011; Tancreto et al. 2012). Some research has focused on the value of adding a paper questionnaire late in the fieldwork period (Messer and Dillman 2011; Smyth et al. 2010; Millar and Dillman 2011). For example, Millar and Dillman (2011), found in an experiment with undergraduate students that adding a paper questionnaire in a final contact in a web survey improved response rates (but switching to web after offering a paper questionnaire did not). Studies focusing on the introduction of the paper questionnaire in the first few weeks of fieldwork, with or without a signal that the paper questionnaire was coming, also suggest potential benefits of the web-first design (Holmberg et al. 2010; Tancreto et al. 2012; Matthews et al. 2012). Holmberg and colleagues (2010), for example, tested several protocols that varied in the introduction of the timing of the paper questionnaire (from concurrent to delayed by three weeks) and found similar response rates across designs ranging from 71% to 76%; however, the percentage of responses by web was highest for the group with the three-week delay. American Community Survey experiments also suggest advantages of a protocol that first signals in the invitation to web that a paper questionnaire will be sent if an online survey is not completed and then sends the questionnaire in two weeks (Tancreto et al. 2012; Matthews et al. 2012).

Despite these advances in understanding of the web-first protocol, questions about the timing of the paper questionnaire remain, particularly in the context of targeting protocols to groups (e.g. those likely to answer by web, likely to answer by paper, and with no clear likely preference). In one of the only panel studies we are aware of that targeted protocols using information about online behavior, household members in a 2014 mixed mode supplement to the PSID were initially invited to either a web survey or given an initial choice of answering by web or waiting for a paper questionnaire (McGonagle and Freedman, 2016). Initial assignment was based on whether they reported “having connected to the internet through a computer or laptop at home at some time in the past year” in the main telephone survey preceding the supplement. The study also found that a delayed (week

10) mailing with credentials to login, a first paper copy for web and third paper copy for choice, and an experimentally assigned small pre-paid incentive significantly increased response rates – especially by paper for those initially assigned to the web group. The authors concluded that they may have underestimated the preference for paper among study participants. Their findings also raise the question of whether the fieldwork period might have been shorter for some subjects if a paper copy had been offered earlier.

Together these findings suggest that using additional information about respondents to assign protocols may be valuable and that introducing a paper questionnaire earlier in the fieldwork period may encourage earlier participation by some respondents. In this paper we adopt both strategies, using demographic and internet-related variables to predict likely mode and then assigning one of two protocols in which both groups are sent multiple paper copies – the web-first group beginning in week 6 and the signal-and-send paper group beginning in week 2.

Theoretical considerations in mixed mode study participation

Several related theories have guided researchers attempting to enhance response rates in mixed mode surveys. Groves and colleagues' (2000) leverage-saliency theory, for example, suggests that mode preference is a design feature that can be leveraged by survey designers and consequently offering more than one mode should enhance participation. However, studies have found lower response rates when concurrent choices are offered (Medway and Fulton 2012). Several possible explanations for this finding have been offered. De Leeuw and Berzelak (2016), for example, suggest that offering a choice increases the burden for the respondent (because they must decide both whether *and* how to participate) and may weaken the saliency of the survey request (because additional material on choices about how to respond is included in the invitation). Others have suggested that psychological theories about decisional conflict may be relevant (Schwartz 2004). In this paradigm, when two options are offered, individuals must make a decision about how to respond; if there is no compelling reason to select either one, or if the respondent is not willing to put in the effort required to decide, response may be discouraged. Together these theoretical and practical considerations have led to the adoption of designs with sequential mode requests.

Theories of social exchange have also been invoked in the design of studies (Dillman et al. 2009). This framework suggests that respondents will be more likely to participate if the task is not costly in terms of effort or time, provided they trust the source of the request and that benefits of participating will accrue. Benefits in this context may be a token incentive payment, feeling positive about contributing to science, or in the case of a long-term multi-generational panel study like the PSID, continuing a family tradition. Social exchange theory also suggests it is important to make participation as convenient as possible, irrespective of the benefit. This notion is consistent with experimental evidence that sending respondents an embedded link to a web study after an initial mail invitation improves response rates (Millar and Dillman 2011). That is, providing respondents with their preferred mode and method for accessing the survey may decrease costs to the respondent by making it convenient to participate.

Key Hypotheses

Drawing upon these theories, we test several hypotheses about response rates and mode of response to highlight the effectiveness of alternative protocols when there is no clear preferred mode of response. Specifically, among the group with no likely mode, we hypothesize:

H1: The signal that a paper copy will be coming in an invitation that also includes web credentials will result in a lower response rate during the first two weeks of collection than the web-first protocol that does not mention paper. This may occur either because the signaling of a second mode reduces the saliency of the survey request or because it provides the respondent with a choice to postpone participation.

H2: The sending of a paper copy during week 2 to the signal-and-send group will initially result in a higher overall response rate than the web-first protocol that sends reminders but does not mail a paper copy until week 6. We believe this difference will occur because the saliency of the physical copy will immediately ease the task of responding for the signal-and-send group.

H3: The sending of a paper copy during week 6 to the web-first group will equalize overall response rates between the web-first and signal-and-send groups. This pattern may occur because the saliency of the physical copy will ease the task of responding for nonrespondents in the web-first group.

H4: The signal-and-send protocol and web-first protocol will yield similar response rates by the end of the field period. Because the major differences between the protocols are the signaling and timing of paper copies, we expect that by the end of the field period the two groups will achieve the same overall response rates.

H5: The web-first protocol will result in higher rates of response by web than the signal-and-send protocol among those responding. We believe this will occur because during the first 6 weeks they will not have an opportunity to respond by paper and because they are sent fewer copies of the paper questionnaire.

H6A: The signal-and-send protocol will result in less overall field effort as measured by weeks in the field than the web-first protocol. Because the paper copy is provided at week 2 rather than week 6, we hypothesize that on average the signal-and-send group will respond earlier and therefore require fewer weeks in the field.

H6B: The signal-and-send protocol will result in less overall field effort as measured by count of reminders than the web-first protocol. Because the paper copy is provided at week 2 rather than week 6, we hypothesize that on average the signal-and-send group will respond earlier and therefore require fewer reminders. Note, however, that because the web-first protocol allows one more reminder than the signal-and-send protocol (as described in more detail in the Methods section), we test whether the difference between the two protocols is greater than 1.

H7: The web-first and signal-and-send protocols will yield groups of respondents with similar characteristics. Although respondents likely to answer by web and by paper are likely to look very different in terms of demographic characteristics, since

the group assigned to the experiment is drawn from individuals with no clear likely mode of responding, we expect characteristics of respondents will not vary for the two protocols.

METHODS

Data

A targeted contact protocol with an embedded experiment was included in a 2016 mixed mode supplement to the US Panel Study of Income Dynamics (PSID). PSID began in 1968 with a representative sample of approximately 5,000 U.S. families, with an oversample of families of low socioeconomic status. Families have been interviewed annually from 1968-1997, and biennially since 1997. The main interview is about 75 minutes on average and collects a variety of data on economic, health, and social behavior using telephone as the primary mode (see McGonagle et al. 2012 for more information). In 2016 PSID invited 10,784 individuals designated as household heads or their spouses/partners in the 2015 main PSID telephone survey to complete a 20-minute mixed mode supplemental survey focused on wellbeing and daily life. Eligible individuals were required to be age 30 or older.

The active study period occurred between March 2016 and June 2016; responses continued to be collected passively through the end of 2016. The protocol was approved by the University of Michigan's Health Sciences and Behavioral Sciences Institutional Review Board.

Assignment to Web-first or Signal-and-Send Paper Protocol

To assign respondents to their protocol group, a linear probability model predicting mode of response to PSID's first (2014) mixed mode study was used (McGonagle and Freedman, 2016). The model was estimated using respondents who were at least age 30 linked to information about their online use collected in the main PSID interview in 2015. We included in the prediction model use of the internet through a computer or laptop at home in the last year, frequency of computer use, frequency of smart phone use, whether has own, shared or no email and frequency of email use, and several demographic characteristics (age, couple status, sex, and whether as of 2013 had at least a college education). We also included whether the individual was the respondent (vs. spouse/partner of the respondent) on behalf of their household to the main PSID telephone interview in 2015. Model coefficients, shown in Table 1, suggest having an internet connection at home is the most important predictor of response by web, followed by age, and having either one's own or a shared email account.

We assigned individuals to web-first if they had a predicted probability of responding by web of 0.70 or greater, based on the model coefficients in Table 1 and values from their main PSID telephone interview. We refer to this group as the "likely web" group. We assigned individuals to the signal-and-send paper protocol if they had a predicted probability of responding by web of less than 0.30 (which is equivalent to a predicted probability of responding by paper of 0.70 or greater). We refer to this group as the "likely paper" group. Although the cutoffs that we selected were arbitrary, our intent was to identify groups that

had a clear probability of answering by web or by paper and to identify a third experimental group that would be large enough to randomize to two experimental conditions.

For operational reasons, individuals who were married or cohabiting and had a different predicted mode than their spouse/partner were re-assigned to match their spouse/partner's initial assignment, with preference given to the signal-paper over web-first protocol. Because they were treated differently than the rest of the sample, these individuals were excluded from analyses. The remaining individuals who did not have a strong propensity for either mode were randomly assigned to web-first or signal-and-send. We refer to this group as the “no predicted mode” group.

Analytic Sample

Of the 10,784 invited respondents, 37 were found to be deceased and 36 did not receive the same follow-up protocol because they lived outside the country. Of the remaining 10,711 eligible sample members, we excluded 646 individuals who were reassigned so that they matched their spouse's protocol assignment, leaving 10,065 for this analysis. The final sample was divided as follows: 7,572 cases (75.2%) assigned to web-first; 1,604 (15.9%) assigned to signal-and-send paper; and the remaining 889 (8.8%) randomly assigned to web-first (N= 444) and signal-and-send (N=445).

Data Collection Protocols

We designed both the initial invitation and a 16-week follow-up protocol based on our review of the literature on best practices for mixed mode studies.

Initial Invitation—For both the web-first and signal-and-send groups, the study invitation included the web address of the survey, a \$5 token of appreciation, login credentials that were unique and randomly generated, and an information sheet describing the study. The invitation letter sent to the signal-and-send group also stated, that if they preferred, they may complete a paper questionnaire that would be mailed in a few weeks. No mention of a paper questionnaire was made in the initial invitation letter sent to the web-first group. In both protocols, participants were told that they would receive a \$20 check upon completion of the survey.

Follow-up Protocol—Non-respondents were reminded to complete the survey on average once per week throughout the 16-week active field period. We alternated hard copy re-mailing of login credentials with either an email notification with an embedded link to the questionnaire (for 65% of the sample with an available email address) or a phone call reminder (for the remaining 35% with no available email address). Mail and email reminders consistently mentioned the purpose of the study, the length (20 minutes), the incentive payment (\$20), and provided login information. For the signal-and-send group all reminders also mentioned that the paper copy could be returned in the envelope provided; for the web-first group these statements were included after the first paper copy was sent. For both groups, a complimentary pen was included with the first paper copy of the questionnaire.

Starting in week 6, reminder calls to all non-respondents began. Telephone reminders were designed to highlight information in the most recent mailing. Each calling period lasted several weeks and interviewers successfully reached or left messages with about 60%-70% of the active sample, depending on the week. The relatively few respondents who requested a telephone-administered version of the survey were also accommodated beginning in week 6. Toward the end of the fieldwork period, respondents reporting that they used smartphones and who provided a number were texted a reminder and a link to the survey. The final mailing in week 14 mentioned the study was closing soon and included login instructions, a final paper copy of the questionnaire, and an additional token of appreciation of \$5.

The major differences between the protocols for the two groups are highlighted in Table 2. The web-first group did not receive a signal that a paper questionnaire was coming and was mailed paper copies in weeks 6, 9 and 14. The signal-and-send group was told in the invitation that a paper questionnaire would be sent and was then mailed paper copies in weeks 2, 5, 9 and 14. In addition, in week 7 the web-first group received up to two contacts (email and a phone reminder) whereas the signal-and-send group received only one. Consequently, over the full 16-week field period, the maximum number of possible contacts was 17 for the web-first group and 16 for the signal-and-send group.

Outcomes and Key Contrasts

The results in this paper are based on responses obtained during the 16-week active collection period. Respondents who submitted a web questionnaire, mailed back a paper questionnaire, or completed an interview over the phone were considered complete. For the few respondents who submitted more than one mode we considered the first completed questionnaire as the mode of response.

With the full analytic sample we calculated weekly response rates (AAPOR RR1 defined as completed interviews divided by the number of eligible and unknown if eligible individuals). In addition, we calculated final response rates overall and by response mode, field duration (number of weeks in field), and number of reminders. Among analytic sample members responding, we also calculated the percentage responding by web. We examined these outcomes by protocol group crossed with a summary indicator of the predicted probability of responding by web, so that six groups were examined in all: very high probability and web-first ($>.85$; 56.3%); high probability and web-first ($>.70$ - $\leq .85$; 18.9%); medium probability with neither mode likely who were randomized to web-first or signal-and-send ($>.30$ - $\leq .70$; 8.8%); low probability assigned to signal-and-send ($>.15$ - $\leq .30$; 8.4%); and very low probability assigned to signal-and-send ($\leq .15$; 7.5%). In addition, for respondents from the two randomized groups we present distributions of demographic characteristics and use of communications technologies.

Statistical Methods

We conducted a series of t-tests based on regression models that were adjusted for the correlation of individuals within couples. We first compared characteristics of the group that had neither a high probability of web nor a high probability of paper (the “no likely mode” group) with the groups that had a high probability of responding by web and by paper. Next,

within the no likely mode group, we tested for differences in characteristics of those randomized to the web-first and signal-and-send groups (to ensure the randomization yielded similar groups). We also tested for differences between randomized groups in response rates, response mode, weeks in field, and distribution of respondent characteristics.

RESULTS

Characteristics of Group with No Likely Mode and Evaluation of Randomization

Individuals with no likely mode differ from those likely to respond by web and by paper on all characteristics included in the prediction model (left side of Table 3). A few differences are noteworthy. The age distribution of the group with no likely mode is similar to the likely web group: over 40% of individuals in both groups are under the age of 40. The group with no likely mode falls between the likely web and paper groups in terms of educational attainment: 20% have no education beyond high school versus 12% in the high probability web and 30% in the high probability paper group. The group with no likely mode is also comprised of higher proportions of women (61% vs. 54% and 55%) and single respondents (63% vs. 25% and 51%). With respect to use of communication technologies, the group with no likely mode falls between the likely web and paper groups in terms of internet access at home, computer use, smartphone use, and email use. The average predicted probabilities and proportion using web in the PSID's first mixed mode study also vary as expected across the three groups.

The right side of Table 3 demonstrates that the randomization of the group with no likely mode to web-first and signal-and-send paper protocols resulted in balanced groups. The predicted probability of answering by web for each group was on average .49 for both groups and the percentage responding by web in the prior PSID mixed mode study was 25.5% and 25.6%, respectively.

Effect of Web-first vs. Signal-and-Send on Overall Response Rates by Week

Table 4 summarizes findings for Hypotheses 1-7. Contrary to our first hypothesis, among those with no likely mode, the signal-and-send and web-first protocols (dashed lines in Figure 1) yielded similar response rates for the first 3 weeks of the study. That is, in this group there does not appear to be a negative effect of signaling that a paper copy is coming.

Consistent with hypothesis 2, at the end of week 4, approximately two weeks after the first paper copy was sent to the signal-and-send group, response rates are 8 percentage points higher for the signal-and-send group than for the web-first group, and remain 8 to 11 percentage points higher until the end of week 7. Consistent with hypothesis 3, beginning with the end of week 8, approximately 2 weeks after the first paper copy was sent to the web-first group, response rates are no longer significantly different between the two groups and this remains so through the end of the fieldwork.

Effect of Web-first vs. Signal-and-Send on Overall Response Rates

Overall response rates are u-shaped across groups in Table 5. The highest rates are for those with a very low probability of web or very high probability of web (81.4% and 78.1%,

respectively). The lowest rates are toward the middle of the predicted probability distribution. Consistent with hypothesis 4, among those with no likely mode, the web-first and signal-and-send protocols yielded similar response rates by week 16 (68.2% vs. 70.6%; $p=0.485$).

Differences between the very high probability web and high probability web groups (not shown) generally declined throughout the field period from about 5 percentage-points in the first few weeks to less than 2 percentage points for weeks 10-16. Response rates first favored the low probability web group over the very low probability web group but from week five through the end of fieldwork the very low probability web group had response rates that were approximately 10 to 13 percentage points higher than the low probability web group (not shown).

Effect of Web-first vs. Signal-and-Send on Response Mode

As expected, the percentage of responses obtained by web among those responding falls sharply from over 90% in the very high probability web group to less than one in ten among the very low probability web group (Table 5). Among those with no likely mode, consistent with hypothesis 5, the web-first protocol yields a substantially higher percentage of web responses than the signal-and-send protocol among those responding (62.7% vs. 42.4%; $p=.001$). This pattern holds for weeks 3-16 (Figure 2).

Effect of Web-first vs. Signal-and-Send on Field Effort

The field effort across groups in Table 5 resembles an inverted u-shape. The shortest field work and fewest reminders are observed for those with a very high and high probability of web (5.9 and 6.5 weeks; 6.8 and 5.8 reminders, respectively) and with a very low probability of web (6.9 weeks; 5.1 reminders). Longer times and more reminders are observed for groups in the middle. Contrary to hypothesis 6A, however, mean weeks in the field are not significantly different between the randomly assigned protocols for the group with no likely mode (8.4 weeks for web-first vs. 7.9 weeks for signal-and-send, respectively; $p=0.251$). Nor are there differences in reminders between the two groups ($p=.866$ for difference from 1.0).

Effect of Web-first vs. Signal-and-Send on Sample Characteristics

Consistent with hypothesis 7, sample characteristics are indistinguishable between the web-first and signal-and-send protocols with respect to demographic characteristics examined here: age, education, sex, couple status, and whether the individual participated as respondent in the 2015 main PSID interview (Table 6). In addition there were no statistically significant differences between the groups in use of communication technologies, in the predicted probability of responding by web, or in the use of web in a prior mixed mode study.

DISCUSSION

This study describes a targeted sequential web-then-paper design implemented in a national mixed mode study. Using predicted probabilities to assign individuals to one of two

protocols—varying when and how the paper mode was introduced—we demonstrate that targeted protocols can achieve both a reasonably high response rate—68%-81% depending on the protocol and probability of responding by web—and a high proportion of web responses. Moreover, the prediction model used to assign likely mode performed well, correctly predicting web for 90% of the high probability web cases responding and correctly predicting paper for 83% of the high probability paper cases responding.

We also identified a group that had no likely mode of responding based on a prediction model using information on both demographic characteristics and technological habits. This group is similar to the high probability web group in that 40% are younger than age 40, but the two groups also differ in a number of fundamental ways: those with no likely mode are more likely to be single, women, have less than a college education, and are less likely to use all types of communication technologies. This group's overall response rate is considerably lower and the effort required to achieve that response rate is greater than both the high probability web and high probability paper groups.

For the group for which there was no clear preferred mode of response, we also tested hypotheses about the effect of the competing protocols on response rates and mode of response. Although we found no negative effect on response rates of signaling a paper copy would be sent, we found response rates higher in this group from weeks 4 through week 7—until the group randomized to web-first had a chance to return a paper questionnaire. After week 8, response rates between the two protocols had equalized and remained indistinguishable for the rest of the field period. Characteristics of the two groups of responders were also indistinguishable. Consistent with prior studies (Homborg et al. 2010), those randomized to the web-first protocol had a greater proportion of web responses—a difference from the randomized signal-and-send group of approximately 13 percentage points.

Findings are most germane to panel studies that can use information from one wave to help target mixed mode collection protocols at subsequent waves or for supplements. Although the PSID sample is national in scope, we excluded those less than age 30 in order to avoid overlap with another PSID supplement. Findings therefore do not generalize to young adults that are often central in studies of the use of the web for data collection. An additional limitation is that the size of the sample randomized to the web-first and signal-and-send paper protocols – although ample to find main effects of substantive interest – was not large enough to support an investigation of whether effects differed for key demographic subgroups. Understanding how subgroups may differ in their responsiveness to these approaches is an important next step for future work designing targeted protocols.

Despite these limitations, our findings offer important guidance to those designing mixed mode studies, particularly in the context of a panel study. We found that a few basic demographic variables coupled with minimal information on use of communication technologies offered a highly predictive model of mode choice. Consistent with Smyth et al. (2014) and Olson et al. (2012), we conclude that using such information to target protocols to those with a high probability of answering by web or by paper is recommended. For the group with no likely mode, however, we conclude that the choice of protocol depends in part

on the planned length of fieldwork. For very brief collection periods of less than 8 weeks, a signal-and-send paper protocol may yield a response rate for this group that is 8-11 percentage points higher than a web-first protocol. Studies that have a longer collection timeline, however, may wish to use a web-first protocol for those with no likely mode in order to maximize response by web.

Our results also provide some insight into resources needed for the two protocols. The web-first protocol brought in a greater percentage of responses by web and such responses can be expected to have fewer collection costs than paper questionnaires (e.g., no printing, no data entry, less postage). However, for the group with no likely mode, the web-first protocol also involved (by design) on average only one additional reminder over the signal-and-send protocol. Consequently, on balance, using web-first instead of signal-and-send paper for the group with no likely mode—less than 10% of cases in this sample—is likely to result in savings, but the amounts are likely to be small relative to the overall costs of collection.

Our findings also highlight more generally the need to improve the protocol for the group with no likely mode. This group is likely to be heterogeneous but a majority of individuals in this group are young, single, female, with less than a college education, and use a smartphone regularly. In analyses not shown we also found that web respondents from this group had the highest rate of mobile device use—exceeding 50%—compared to about 31% and 35% of web respondents from the high probability paper and web groups. Future research that investigates whether encouraging this group to their smartphones, rather than the web generally, may be beneficial. This type of research would be especially valuable in light of the importance to the future of household panel surveys of engaging the participation of younger adults.

This paper adds to the growing body of literature on mixed mode survey designs that highlight the critical importance of attention to detail when designing data collection protocols. Our findings underscore that modeling likely mode and implementing targeted protocols accordingly is a fruitful approach, particularly in panel studies where a rich set of covariates to predict mode may be available. More generally, our findings reinforce theories that offering more than one mode can enhance response rates if done in a manner that avoids decisional conflict and that is convenient and inclusive for respondents based on their likely response mode.

Acknowledgments

This work was supported by the National Institute on Aging of the National Institutes of Health [grant number R01-AG040213]. The views expressed are those of the authors alone and do not represent those of the funding agency or the authors' employer.

References

- Biemer, PP., Murphy, J., Zimmer, S., Berry, C., Deng, G., Lewis, K. A Test of Web/PAPI Protocols and Incentives for the Residential Energy Consumption Survey. Paper presented at the annual meeting of the American Association for Public Opinion Research; Austin, TX. May; 2016.
- Couper MP. Web Surveys: A Review of Issues and Approaches. *Public Opinion Quarterly*. 2000; 64:464–494. [PubMed: 11171027]

- De Leeuw, E., Berzelak, N. Survey Mode or Survey Modes? In Christof Wolf, Dominique Joye. In: Smith, Tom W., Fu, Yang-chih, editors. The Sage Handbook of Survey Methodology. London: Sage Publications; 2016. p. 142-156.chapter 11
- Dillman, DA., Smyth, JD., Christian, LM. Internet, mail, and mixed-mode surveys: the tailored design method. 3rd. John Wiley & Sons, Inc; Hoboken, NJ: 2009.
- Dillman, DA., Messer, BL. Mixed-Mode Surveys. In: Marsden, PV., Wright, JD., editors. Handbook of Survey Research. Bingley, UK: Emerald; 2010. p. 551-574.
- Friese CR, Lee CS, O'Brien S, Crawford SD. Multi-Mode and Method Experiment in a Study of Nurses. Survey Practice. 2010; 3(5) <http://www.surveypactice.org/index.php/SurveyPractice/article/viewFile/141/pdf>.
- Groves RM, Singer E, Corning A. Leverage-Saliency Theory of Survey Participation: Description and an Illustration. Public Opinion Quarterly. 2000; 64:299–308. [PubMed: 11114270]
- Holmberg A, Lorenc B, Werner P. Contact strategies to improve participation via the Web in a mixed-mode mail and Web survey. Journal of Official Statistics. 2010; 26:465–480.
- Israel GD. Obtaining Responses by Mail or Web: Response Rates and Data Consequences. Survey Practice. 2009; 2(5) <http://www.surveypactice.org/index.php/SurveyPractice/article/viewFile/177/pdf>.
- Lebrasseur D, Morin JP, Rodrigue JF, Taylor J. Evaluation of the Innovations Implemented in the 2009 Canadian Census Test. Proceedings of the American Statistical Association Survey Research Methods Section. 2010:4089–4097.
- Luiten A, Schouten B. Tailored fieldwork design to increase representative household survey response: an experiment in the Survey of Consumer Satisfaction. Journal of the Royal Statistical Society: Series A (Statistics in Society). 2013; 176:169–189. DOI: 10.1111/j.1467-985X.2012.01080.x
- Matthews, B., Davis, MC., Tancreto, JG., Zelenak, MF., Ruiter, M. American Community Survey Research and Evaluation Report Memorandum Series #ACS12-RER-21R1. Washington, DC: US Census Bureau; 2012. 2011 American Community Survey Internet Tests: Results from Second Test in November 2011. http://www.census.gov/content/dam/Census/library/working-papers/2012/acs/2012_Matthews_01.pdf
- McGonagle KA, Freedman VA. The Effects of a Delayed Incentive on Response Rates, Response Mode, Data Quality, and Sample Bias in a Nationally Representative Mixed Mode Study. Field Methods. 2016; doi: 10.1177/1525822X16671701
- McGonagle KA, Schoeni RF, Sastry N, Freedman VA. The Panel Study of Income Dynamics: Overview, Recent Innovations, and Potential for Life Course Research. Longitudinal and Life Course Studies. 2012; 3:268–284.
- Medway RL, Fulton J. When More Gets You Less: A Meta-Analysis of the Effect of Concurrent Web Options on Mail Survey Response Rates. Public Opinion Quarterly. 2012; 76:733–746.
- Messer BL, Dillman DA. Surveying the General Public over the Internet using Address-based Sampling and Mail Contact Procedures. Public Opinion Quarterly. 2011; 75:429–457.
- Millar MM, Dillman DA. Improving Response To Web and Mixed-Mode Surveys. Public Opinion Quarterly. 2011; 75:249–269.
- Newsome, L., Levin, K., Brick, PD., Schafer, B., Vigil, M. Best Approaches to Mode Order and Non-Response Prompting in a Multi-Mode Survey. Paper presented at the annual conference of the American Association for Public Opinion Research; Orlando, FL. May; 2012.
- Olson K, Smyth JD, Wood HM. Does Giving People their Preferred Survey Mode Actually Increase Survey Participation Rates? An Experimental Examination. Public Opinion Quarterly. 2012; 76:611–635.
- Schwartz, B. The Paradox of Choice: Why More Is Less. New York: Harper Perennial; 2004.
- Smyth JD, Olson K, Millar MM. Identifying Predictors of SurveyMmode Preference. Social Science Research. 2014; 48:135–144. [PubMed: 25131280]
- Smyth JD, Dillman DA, Christian LM, O'Neill A. Using the Internet to Survey Small Towns and Communities: Limitations and Possibilities in the Early 21st Century. American Behavioral Scientist. 2010; 53:1423–1448.
- Tancreto, J., Zelenak, MF., Davis, MC., Ruiter, M., Matthews, B. American Community Survey Research and Evaluation Program, Final Report. Washington, DC: U.S. Census Bureau; 2012 Feb

21. 2011 American Community Survey Internet Tests: Results from First Test in April 2011. 2012 http://www.census.gov/content/dam/Census/library/working-papers/2012/acs/2012_Tancreto_01.pdf

Wood M, Kunz S. CAWI in a Mixed Mode Longitudinal Design. Understanding Society Working Paper Series No. 2014-07. 2014 Aug. 2014.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Figure 1. Response Rates by Week and Data Collection Protocol Group

Note: Diamonds and squares on dashed lines indicate points that are significantly different between random groups $p=.037$ (week 4); $p=.035$ (week 5); $p=.002$ (week 6); $p=.033$ (week 7)

Figure 2. Web Response Rates by Week and Data Collection Protocol Group

Note: Diamonds and squares on dashed lines indicate points that are significantly different between random groups $p=.016$ (week 3); $p=.008$ (week 4) and $p<.001$ for all subsequent weeks.

Table 1

Linear Probability Model Coefficients Predicting Response by Web (vs. Paper)

Predictor	Coefficient	SE	p-value
<u>Demographic characteristics</u>			
Age group 40-49 (vs. 30-39)	-0.030	0.01	0.02
50-59	-0.061	0.01	<0.01
60-69	-0.107	0.01	<0.01
70+	-0.174	0.02	<0.01
Education college or more	0.048	0.01	<0.01
Male	0.016	0.01	0.07
Married or cohabiting (vs. single)	0.022	0.01	0.05
Respondent to Main PSID	-0.028	0.01	0.01
<u>Use of communication technologies</u>			
Connected to the internet from home last year	0.415	0.02	<0.01
Uses a computer every day or a few times a week	0.086	0.02	<0.01
Uses a smart phone every day or a few times week	0.049	0.01	<0.01
Has own email (vs. none)	0.112	0.01	<0.01
Has shared email (vs. none)	0.128	0.02	<0.01
Uses email every day or a few times a week	0.074	0.01	<0.01
Constant	0.234	0.02	<0.01

N=5300 R-squared=0.50; F(14,5285)=372.78

Table 2

Overview of Major Differences in Mixed Mode Data Collection Protocols

	Week																Max. Contacts
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Group																	
Web-first							p#1			p#2					p#3		17
Signal-and-Send	s		p#1			p#2				p#3					p#4		16

s=signal paper questionnaire to be sent; p=paper questionnaire sent

Table 3

Characteristics of Data Collection Protocol Groups

Characteristics	Unlikely Web (LW)	Likely Paper (LP)	No Likely Mode	p-value for difference from LW; LP	No Likely Mode Randomly Assigned to:			p-value for difference
					Web-first Protocol	Signal-paper Protocol	Signal-paper Protocol	
<u>Age</u>								
<40	39.1	9.2	41.5	<.001; <.001	41.7	41.4		.592
40-49	23.3	11.6	13.5		13.7	13.3		
50-59	20.1	28.4	17.9		19.4	16.4		
60-69	14.0	26.9	14.7		14.6	14.8		
70+	3.4	23.9	12.4		10.6	14.2		
<u>Years of education</u>								
<=12	12.2	30.2	20.0	<.001; <.001	18.5	21.6		.515
13-15	49.9	57.9	62.9		64.9	60.9		
16+	31.2	5.2	7.8		7.0	8.5		
Not in 2013	6.7	6.8	9.3		9.7	9.0		
<u>Sex of respondent</u>								
Male	46.0	44.8	38.6	<.001; <.001	37.8	39.3		.582
Female	54.0	55.2	61.4		62.2	60.7		
<u>Couple status</u>								
Single	25.1	51.0	62.8	<.001; <.001	63.3	62.3		.795
Married or Cohabiting	75.0	49.0	37.2		36.7	37.8		
<u>PSID respondent</u>								
No	36.9	27.6	18.7	<.001; <.001	18.2	19.1		.692
Yes	63.1	72.4	81.3		81.8	80.9		
<u>Use of communication technologies</u>								
Connected to internet from home last year	100.0	0.0	42.0	<.001; <.001	39.9	44.0		.270
Uses a computer every day or few times a week	91.1	0.0	18.8	<.001; <.001	19.4	18.2		.683
Uses a smartphone every day or few times a week	82.1	9.1	55.3	<.001; <.001	57.0	53.7		.372
Has own email	63.3	4.4	48.1	<.001; <.001	48.9	47.4		.873

Characteristics	ILikely Web (LW)	Likely Paper (LP)	No Likely Mode	p-value for difference from LW; LP	No Likely Mode Randomly Assigned to:		
					Web-first Protocol	Signal-paper Protocol	p-value for difference
Has shared email	16.6	3.1	6.5		6.8	6.3	
Uses email every day or few times a week	89.8	2.6	47.4	<.001; <.001	49.1	45.6	.330
Predicted probability of responding by web	0.90	0.16	0.49	<.001; <.001	0.49	0.49	.434
<u>Mode of prior mixed mode study</u>				<.001; <.001			.976
Web	58.2	13.0	25.5		25.5	25.6	
Paper	6.4	51.5	28.7		29.1	28.3	
Non-response	28.7	28.7	36.5		35.8	37.1	
Not in prior study	6.7	6.8	9.3		9.7	9.0	
(N)	7572	1604	889	–	444	445	–

Table 4

Overview of Key Hypotheses and Findings About Group with No Likely Mode

Hypothesis Number	Treatment	Outcome	Hypothesized Direction	Result consistent with hypothesized direction ()
H1	Signal that paper copy is coming to signal-and-send group vs. inviting to web	Overall response rate up to week 3	Signal-and-send < web-first	
H2	Sending of first paper copy during week 2 to signal-and-send group vs. web-first protocol	Overall response rate weeks 4-7	Signal-and-send > web-first	
H3	Sending of first paper copy during week 6 to web-first group vs. signal-and-send protocol	Overall response rate week 8	Web-first = signal-and-send	
H4	Signal-and-send protocol vs. web-first protocol	Overall response rate week 16	Web-first = signal-and-send	
H5	Signal-and-send protocol vs. web-first protocol among those responding	% Responding by web by week 16 among those responding	Web-first > signal-and-send	
H6A	Signal-and-send protocol vs. web-first protocol	Average time in field in weeks by week 16	Web-first > signal-and-send	
H6B	Signal-and-send protocol vs. web-first protocol	Average number of reminders	Web-first > signal-and-send by more than 1	
H7	Signal-and-send protocol vs. web-first protocol among respondents	Demographic characteristics	No differences	

Table 5
Response Rates, Mode, and Field Effort by Likely Mode of Responding by Web and Data Collection Protocol Group

Characteristics	Very High Probability Web:		High Probability Web:		No Likely Mode Randomly Assigned to:		Low Probability Web:		Very Low Probability Web:		p-value for difference between Randomized Groups
	Web-first		Web-first		Web-first	Signal-and Send Paper	Signal-and Send-Paper		Signal-and Send-Paper		
Response rate	78.1		76.5		68.2	70.6	69.8		81.4		0.485
Response rate by mode											<0.001
Web	72.2		63.2		42.8	29.9	17.1		7.0		
Paper	5.7		12.3		24.3	39.3	50.8		72.8		
Phone	0.3		1.0		1.1	1.4	1.9		1.9		
% Web among responding	92.4		82.7		62.7	42.4	24.5		8.6		<0.001
Mean weeks in field	5.9		6.5		8.4	7.9	8.1		6.9		0.251
Total number of reminders	6.0		5.8		7.5	6.6	6.2		5.1		0.866 ^a
(N)	5668		1904		444	445	847		757		–

^aTests whether difference between web-first and signal-and-send paper is different from 1.0. See text for explanation.

Table 6

Characteristics of Respondents by Randomized Data Collection Protocol Group

Characteristics	No Likely Mode Randomly Assigned to:		
	Web-first protocol	Signal-and-send paper protocol	p-value for difference
<u>Age</u>			.410
<40	37.0	34.4	
40-49	11.9	12.7	
50-59	20.5	16.2	
60-69	17.8	18.5	
70+	12.9	18.2	
<u>Years of education</u>			.844
<=12	17.8	19.4	
13-15	66.0	63.7	
16+	9.2	10.8	
Not in 2013	6.9	6.1	
<u>Sex of respondent</u>			.469
Male	34.0	36.3	
Female	66.0	63.7	
<u>Couple status</u>			.750
Single	61.7	60.2	
Married or Cohabiting	38.3	39.8	
<u>Respondent to Main PSID</u>			.796
No	17.5	18.2	
Yes	82.5	81.9	
<u>Use of communication technologies</u>			
Connected to internet from home last year	42.9	48.7	.204
Uses a computer every day or few times a week	22.8	22.3	.895
Uses a smartphone every day or few times a week	53.8	50.3	.432
Has own email	48.2	46.2	.687
Has shared email	7.6	6.1	
Uses email every day or few times a week	46.5	44.9	.701
Predicted probability of responding by web	0.49	0.50	.312
<u>Mode of prior mixed mode study</u>			.836
Web	32.0	31.5	
Paper	37.0	35.0	
Non-response	24.1	27.4	
Not in prior study	6.9	6.1	
(N)	303	314	—