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Responsive Survey Design, Demographic Data Collection, and Models of Demographic Behavior

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ABSTRACT

Declining response rates have led survey methodologists to explore innovative ways to use process data ("paradata") to address nonresponse by altering the survey design. We introduce and explain the concept of responsive design – the suite of tools created to use paradata to improve the representative qualities of surveys. By improving representation of reluctant respondents, responsive design can also change our understanding of substantive issues studied by demographers. Using the National Survey of Family Growth Cycle 6 we illustrate how responsive survey design can improve both demographic estimates and models of demographic behaviors based on survey data. By juxtaposing measures from regular and responsive data collection phases, we document characteristics of the general population that are systematically under-represented in surveys not taking special effort to interview reluctant respondents. Using multivariate models already established in the literature and based on NSFG data, we demonstrate how respondents recruited through responsive survey design produce different model estimates than those recruited during regular data collection. Results demonstrate the wide potential of responsive survey design to improve the quality of science in demographic research based on survey data. Methodologically, the results also provide one of the first evaluations of substantive consequences of implementing responsive design.

INTRODUCTION

The sample survey has been a fundamental building block of demographic research throughout the history of the discipline. Many of the field's key advances in both empirical evidence and theoretical reasoning are founded on information from surveys. But even as sophistication of both survey measurement and survey analysis dramatically advances, the general population's growing reluctance to participate in surveys poses an enormous threat to the field. This problem is greatest in relatively rich countries of Europe and North America, but it is growing across the world. The problem has been documented in detail (Groves and Couper 1998), but demographers' standards for acceptable survey response rates continue to drop, and social scientists devote increasing effort to the study of the consequences of nonresponse for the substantive issues they investigate. In the midst of growing awareness of a looming scientific crisis, data collection methodologists have pioneered innovative approaches for using newly available data collection technologies to address the nonresponse problem. Together these approaches are termed "responsive survey design" and they can be used to simultaneously improve survey representation of reluctant respondents and control costs of data collection. Here we describe the application of responsive survey design to a key demographic survey in the United States – the National Survey of Family Growth. Using the NSFG example, we demonstrate how responsive survey design can be used to improve both demographic estimates and models of demographic behaviors based on survey data.

Computerization of the survey data collection process was the essential technological shift that allows responsive design to be used. Though "paper and pencil" data collection continues to be used in some rural parts of the world, "computer-assisted personal interviewing" or CAPI is now used by the majority of the world's demographic survey data collections. Use of computer software for questionnaires promoted data collection instruments that could be more easily tailored to respondents' unique circumstances or previous responses and also allowed for dynamic error detection during field work and more rapid release of data in electronic form. All of these are desirable in the creation of new demographic data. But

computerization also provided the means for the creation of survey "paradata", or data about the data collection process itself (Couper 1998). Now, paradata from CAPI data collection, combined with internet technologies that allow paradata to flow from decentralized data collection staff to centralized management, provide the means to centrally manage responsive survey designs in large scale demographic surveys.

The National Survey of Family Growth (NSFG) Cycle 6 (2002-03) featured CAPI interviewing, collection and analysis of paradata, and responsive design on a large scale. The study involved more than 12,500 personal interviews collected nationwide by a staff of more than 300 interviewers. Specifically, the study was designed in multiple phases – a main phase, designed following protocols established before data collection began, and a responsive phase, designed explicitly to use analyses of paradata to direct changes of protocol targeted to improve representation of reluctant respondents (Groves et al. 2005). By juxtaposing measures from these two data collection phases, we are able to document characteristics of the general population that are systematically under-represented in surveys that do not take special effort to interview reluctant respondents. Then, using models established in previous research based on NSFG data, we are able to demonstrate how respondents recruited during the responsive phase produce different results, indicating that the addition of reluctant respondents through responsive survey design may change what we learn from demographic models based on survey data. Together this body of evidence shows how responsive survey design provides a new methodological tool to improve the quality of science in demographic research based on survey data. The evidence also provides one of the first wide ranging evaluations of the substantive consequences of implementing responsive design methods. We close by describing the recent evolution of responsive survey design and discussing the wide potential of these techniques to improve demographic data collection.

KEY BUILDING BLOCKS OF RESPONSIVE DESIGN

The dynamic nature of modern societies presents survey researchers with increased uncertainty about the performance of their survey design, increased effort required to obtain interviews, and thus increased costs of data collection (de Leeuw and de Heer 2002; Groves and Couper 1998). The development of computer-assisted methods of data collection has provided survey researchers with tools to capture a variety of process data or "paradata" about the data collection process (Couper 1998; Hapuarachchi et al. 1997; Scheuren 2001). Paradata can be used to change the design during the course of data collection, in efforts to achieve response rate targets or lower survey errors and costs. The responsive use of paradata to modify the design during the field period has been labeled "responsive design" (Groves and Heeringa 2006).

Of course clear evidence that data collection outcomes can be altered through intervention is an important prerequisite for the implementation of responsive design. There is a consensus from decades of survey methodological research that survey participation is enhanced by repeated calls on sample households (Goyder 1985), lengthened data collection periods and interviewer workloads permitting those calls (Botman and Thornberry 1992), prenotification of the survey request through advance letters (Traugott, Groves and Lepkowski 1987), use of incentives (Singer 2002), reduced interview burden (Goyder 1985), interviewer behavior customized to the concerns of the householder (Groves and Couper 1998), and alternative modes of data collection. These, among others, are the tools that a survey researcher can employ to intervene into survey data collection to achieve more desirable distributions of respondent attributes. Therefore these tools form a key building block of responsive design – the parameter researchers can change in response to analyses of paradata.

Because each of these tools is also directly associated with a cost, paradata driven responsive design can be used to maximize the effectiveness of these tools while controlling costs. Fundamentally all survey design options involve cost-error tradeoffs (Groves 1989). Without cost limitation we might use the maximum level of each of the tools described above in every data collection. In fact, were resources limitless and cost no longer a constraint, social scientists might take a census

(interview everyone rather than a sample survey of people) regardless of the topic they wish to study. There are many different forms of potential survey error, including sampling error, non-response error, or measurement error (Groves 1987). Once cost constraints are introduced, researchers are faced with tradeoffs between costs of data collection and control of these sources of error (Groves 1989). Responsive design uses paradata to systematically intervene to maximize these tradeoffs in ways that can be both documented and replicated (Groves and Heeringa 2006). The systematic application of responsive design is an important advance over the ad hoc application of these tools during data collection.

THEORY AND PROCESS OF RESPONSIVE DESIGN

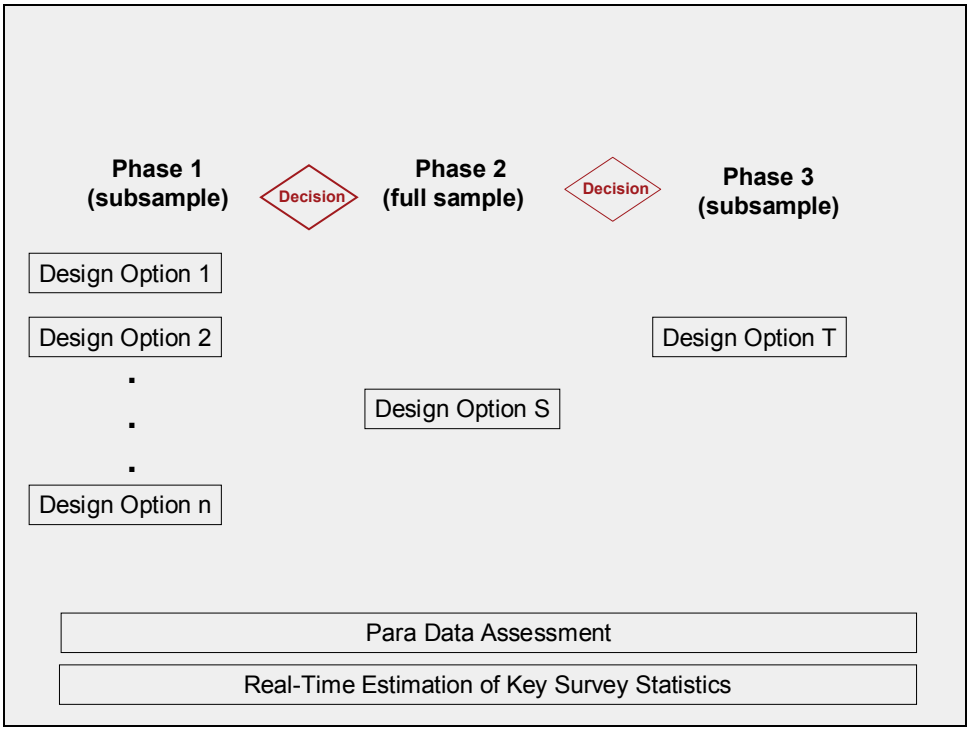
Responsive designs are organized around "design phases" (Groves and Heeringa 2006). The first phases often involve collecting paradata that inform the cost and error properties of alternative design features (e.g., number of calls made to sample cases, nature of incentives). By allowing these features to change during the data collection, the researcher can improve the quality of estimates given fixed data collection budgets. By way of definition, responsive survey designs:

a. pre-identify a set of design features potentially affecting costs and errors of survey statistics;
b. identify a set of indicators of the cost and error properties of those features;
c. monitor those indicators in initial phases of data collection;
d. alter the active features of the survey in subsequent phases based on cost/error tradeoff decision rules; and
e. combine data from the separate design phases into a single estimator.

Figure 1 illustrates the key components of a three phase responsive design, in which the first phase is mounted with N design options applied simultaneously (possibly on different replicate subsamples). Examples of these design options might include whether an incentive is offered, the number of follow-up calls to nonrespondent households, the use of a short or long version of a questionnaire, or alternatives for the number of sample persons to select per household. During Phase 1

(as displayed at the bottom of Figure 1) paradata are collected to inform the researcher of the interviewer hours spent calling on sample households, driving to sample areas, conversing with household members, and interviewing sample persons. The paradata may include observations about the characteristics of housing units (e.g., whether they have some access impediments) or comments by contacted sample persons predictive of later actions. Supplementing the paradata are key statistics from the survey analyzed as functions of interviewer effort, computed on intermediate data sets as interviews are completed.

Figure 1. An Illustration of a Three Phase Responsive Design



At the end of Phase 1, the researcher makes a decision about the Phase 2 design options that appear to be prudent (the middle portion of Figure 1). This decision will be guided by the paradata information on costs and sensitivity of values and standard errors of key statistics. Phase 3 is often a phase introduced to control the costs of the final stages of data collection while attaining desirable nonresponse error features for

key statistics. This might involve a second phase sampling of remaining nonrespondents, the use of different modes of data collection, or the use of larger incentives. After the third phase is complete, the survey data collected in all three phases are combined to produce the final survey estimates.

THE PRACTICE OF RESPONSIVE DESIGN

Modern computer-assisted interviewing software offers a needed infrastructure for responsive design. The software system used in the NSFG permits daily uploading from the field interviewer of all call records and travel documentation for her day's activities. These administrative data contain some paradata deliberately introduced into the NSFG field design – observations about whether the household may contain children, observations on the likelihood of non-English speakers, observations about concerns raised by a household toward the survey request. In addition, the software uploads all completed interview records. These data are used in background analytic processes to estimate the propensity that the next call on a case will yield an interview, whether the interviewer's effort on her workload might be redirected to improve the balance of the respondent data set on key auxiliary variables, and whether the level of calling on some cases has reached an unproductive level. Based on these statistical analyses of paradata, the survey researcher can choose to flag some active cases for greater attention by interviewers. The downloaded information to the interviewer's laptop on the nightly transmission provides flags on certain cases that direct the interviewer to call on these cases first at the next work shift.

Applying Responsive Design Approaches in the NSFG

The field work for Cycle 6 of the NSFG was organized in two distinct phases of operation. The main data collection phase occurred during an 11-month period from March 2002 through January 2003. During this initial phase paradata were collected to monitor information about the data collection. Paradata included items of data such as interviewer performance, observations on neighborhoods and housing units, day and time of call attempts, and observations on contact with household members (e.g.

whether they asked a question about the survey or responded with a negative statement about the survey). These paradata were used to build predictive response propensity models – logistic models predicting the odds that the next call on a sample case would produce an interview, given a set of prior experiences with the sample case (for a full description of the paradata collected and their use in propensity models see Groves and Heeringa 2006). Expected propensities were summed over all cases and used to group cases into quartiles, which formed strata for the responsive design phase sample. Thus on the basis of these propensity models, a Phase 2 sample with high probability to be interviewed was selected.

The second responsive design phase occurred during the last month of fieldwork—February 2003. For this phase the recruitment protocol was altered in attempt to attract sample people on whom the earlier phase protocols were not effective. The responsive phase recruitment protocol entailed use of the most productive interviewers on staff, increased use of proxy informants for the screening interview to lower the burden of obtaining screener information, a small prepaid token incentive (one-eighth of the main interview incentive as compared to no prepaid incentive in the main phase) for completing the screening interview, and promise of additional incentive (double the main incentive) for completing the main interview. The responsive phase was successful in increasing the overall response rate, by recruiting a large number of respondents who failed to participate in initial phases.

Evaluating Responsive Design in the NSFG

The second phase of data collection in responsive design adds cases to the data base, necessarily improving the overall response rate in the study. The American Association for Public Opinion Research has published a standardized set of guidelines for determining the overall response rate of a study that includes a phase of responsive design, weighting those cases to provide a precisely appropriate response rate calculation (to learn more about those calculations for the NSFG, see Groves et al. 2005).

But a key question remains: exactly how different are the cases added to the study through responsive design? Responsive design brings more respondents into the study, but those additional respondents only change what we know if they are different from respondents in the main study in some important ways. Moreover, if they are different in ways that are closely related to key substantive topics being studied adding the cases is more important than if they are different, but those differences are essentially orthogonal to the topic being studied. So evaluation of the substantive consequences of responsive design depends greatly on assessing the substantive differences between respondents in the main study and respondents in the responsive design phase.

One way to assess these differences is to simply compare the characteristics of main study respondents to characteristics of responsive design phase respondents. One might wish to compare their basic demographic characteristics, such as age, race, employment status or education. In general, theories of nonresponse emphasize that busy people are less likely to participate in surveys and are harder to locate (Groves and Couper 1998). This principle yields predictions regarding the expected difference in characteristics for the two phases of data collection – in general the responsive design phase respondents should be characterized by life circumstances that make them busier than main study respondents. So, for example, with regard to employment, we would expect responsive design phase respondents to be somewhat more likely to be employed full time than main study respondents. Other characteristics that create time pressure in individuals' live should similarly be more prevalent among responsive design phase respondents.

The main substantive objectives of the NSFG are the study of partnering (sexual, cohabiting, and marital relationships) and parenting (childbearing, family planning, contraceptive use, and childrearing). The literatures on both entry into sexual partnerships (Thornton, Axinn and Xie 2007) and entry into parenthood (Rindfuss, Morgan and Swicegood 1988) emphasize how both of these types of important life transitions have the potential to significantly increase role conflict with other social activities. Albeit, the theories of role conflict are usually invoked to inform our

understanding of the complex interplay between family transitions like marriage and childbearing on the one hand and non-family activities like work and school on the other hand. But these ideas apply equally well to taking an hour or two out of a busy schedule to complete a survey interview. Thus we have strong theoretical reasons to expect both intimate sexual partnerships and parenthood will produce reluctance to participate in surveys, and the more partnership transitions or more parenting transitions a person experiences, the greater we my expect the reluctance to be. Again, those situations are expected to be somewhat more prevalent in the responsive design phase. Thus the specific topics at the focus of the NSFG measurement effort may be topics highly likely to be associated with the likelihood of participation in surveys.

So, overall we expect respondents in the responsive design phase to be disproportionately those most reluctant to participate in surveys. Theory predicts life circumstances that create time pressure and role conflict, such as full time employment, relationship transitions, and parenthood, should be the most likely to be highly represented in the responsive design phase of a survey. Of course other factors may also produce reluctance to participate in surveys. High representation in the responsive design phase of a survey provides a window into what some of those other factors may be. Empirical evidence for such differences can be assessed by simply comparing respondents from the responsive phase to respondents from the main phase of the NSFG.

Another way to assess these differences is to compare models of demographic behavior estimated separately among cases selected across differing design phases. This approach is more complex than a simple comparison. It implies a full multivariate model of an important demographic outcome, built as closely as possible to the specifications produced by previous research, with known expectations for values of key parameters. By estimating such a model once with data from the main study and second time with data from the responsive phase, one can capture a heuristic sense of the differences in substantive conclusions likely to result from adding reluctant respondents to the study by using responsive design. Differences in parameters across these models fit to these two different data sources provide an informative view of

likely consequences of implementing responsive design for substantive interpretations of demographic models. This is a key test of the consequences of responsive design because it goes beyond the simple identification of differences to assess the extent to which such difference across groups of respondents are likely to alter our substantive conclusions based on analyses of survey data.

In the paragraphs below we evaluate responsive design using both approaches. First we compare the characteristics of respondents from the main study with characteristics of respondents from the responsive phase. Second, we estimate multivariate models of key NSFG outcomes twice – once using data from the main study and then using data from the responsive phase. Our objective in this second approach is not innovative modeling, so we draw simple models as directly as possible from established modeling strategies or previously published research based on the NSFG.

DATA AND METHODS

Data for this study were taken from the National Survey of Family Growth (NSFG), Cycle 6. Fieldwork for the NSFG, conducted between March 2002 and February 2003, was done by professional female interviewers who questioned 12,571 men and women ages 15 to 44 in their homes. The NSFG obtained detailed information on factors affecting childbearing, marriage and parenthood.

For these analyses, we focus on two groups among the respondents: those interviewed during the main data collection phase and those interviewed during the responsive design phase. Furthermore, we subdivide these groups by gender, so that our sample contains men interviewed during the main phase (n = 4,601), women interviewed during the main phase (n = 7,146), men interviewed during the responsive phase (n = 327), and women interviewed during the responsive phase (n = 497). Of course the responsive phase of the study is, by design, a small proportion of the total interviews collected. One consequence is limited statistical power for testing differences between the main and responsive phases. This limitation prevents us from detecting small differences and focuses instead on large differences across phases.

COMPARING RESPONDENT CHARACTERISTICS FROM NSFG RESPONSIVE DESIGN PHASE

To compare characteristics of respondents from the responsive design phase in the NSFG we examine three different empirical dimensions of the NSFG Cycle 6 data. The first dimension compares basic demographic characteristics of those respondents interviewed in the main study to those interviewed in the responsive design phase. The second dimension compares behaviors across substantive domains of greatest importance to the NSFG, partnering behaviors and parenting behaviors. Because the NSFG also invests significant effort into the measurement of attitudes and related subjective phenomena, the third dimension compares responses to questions about attitudes across the main and responsive phases of the NSFG. Because attitudes and related subjective phenomena are known to have different measurement properties than behaviors (Tourangeau, Rips and Rasinski 2000), this dimension may reveal additional insight into the nature of reluctant respondents added through responsive design.

Comparing Demographic Characteristics

In Table 1 we present the percentage of respondents in various age, race, genealogical, labor force and educational categories by interview phase and gender. We test whether the percentages in each category in the main phase are different from the same percentages in the responsive phase. The overall pattern of age differences is that the responsive phase sample is older than the main phase sample. For both men and women, the responsive phase sample is significantly less likely to be under age 20 and more likely to be age 30 or older. There is also a strong difference in labor force participation, manifested more among women. Women in the responsive phase are much more likely to be employed full time compared to women in the main phase. The proportion of Hispanics in each interview phase is significantly different for both genders (20% of women in the responsive phase compared to 13% of women in the main phase, and 24% of men in the responsive phase compared to 15% of men in the main phase). Among both genders the responsive design phase contains fewer Blacks and Whites, although the differences in percentage White are not statistically

significant. Being foreign born is also significantly more likely among those in the responsive design phase for both men and women. Finally, we also see some potentially important difference in educational attainment, with those in the responsive design phase being characterized by somewhat higher educational attainments than those in the main phase.

Table 1. Descriptive Statistics: Demographic Measures (weighted percentages)

	Men		Women	
	Main Study (N=4601)	**Responsive Phase (N=327)**	**Main Study (N=7146)**	**Responsive Phase (N=497)**
Age				
Under age 20	17.46	11.06***	16.55	11.88**
Age 20-29	31.02	32.97	31.19	29.69
Age 30 or older	51.52	55.97**	52.26	58.43**
Labor Force Status				
Working full time	60.95	64.20	42.04	53.80***
Working part time	14.18	15.84	19.04	17.28
* p<.05; ** p<.01; *** p<.001 (one-tailed tests)				
Race				
White	66.53	61.67	66.80	63.72
Hispanic	14.83	23.93***	13.47	19.56***
Non-Hispanic Black	12.27	10.61*	14.53	11.95**
Other	6.40	3.80	5.24	4.77
Foreign Born	14.27	23.35***	13.84	17.94**
Education				
No high school degree	23.58	20.76*	21.96	19.12
High school diploma/GED	25.23	29.38	22.14	23.78
Some college	25.70	19.60	26.84	26.19
College degree or higher	25.48	30.27	29.06	30.91
* p<.05; ** p<.01; *** p<.001 (two-tailed tests)				

Our initial comparison is consistent with the conclusion that the addition of a responsive design phase can add significantly different people to those represented in a survey. Not only are these differences statistically significant, but they are so in spite of the relatively small case base for the responsive phase of the survey. Americans in general and academics in particular are fond of arguing over who is the busiest, and adjudication of this issue lies far beyond the scope of the present paper. Nevertheless the specific pattern of results we document appears consistent with the hypothesis that responsive design may draw those with the most survey participation role conflict into the respondent pool. Full time work and older age may be the clearest evidence of this. Being foreign born or having higher education may also create more role conflict for extra activities like a survey interview. We cannot assess the role conflict implied by racial group membership, but this difference may serve as an indication that other factors are also at work.

Comparing Partnering and Parenting Behaviors

We continue comparing samples from the different interview phases in Table 2. As the results show, the samples display some important differences in patterns of both partnering and parenting. First, in terms of many lifetime sexual partners, responsive phase men have had significantly more opposite sex sexual partners than main phase men. Second, strong differences in marital status pertain only to women: Women in the responsive phase are significantly more likely to be currently married (54% compared to 45% in the main phase) and ever married (64% compared to 57% in the main phase). Men are only somewhat more likely to be currently married and ever married. Third, responsive phase women are more likely to have ever cohabited than main phase women, but responsive phase men are less likely to have ever cohabited than main phase men. Neither of these differences is statically significant, however. Finally, in terms of childbearing, there is clear evidence that responsive phase men are more likely to have biologically fathered a child than main phase men. Women in the responsive phase appear somewhat more likely to have had a live birth, and responsive

phase respondents of both sexes appear more likely to have had two or more births, but none of these differences are statistically significant.

Table 2. Descriptive Statistics: Partnering and Parenting Behavioral Measures (weighted percentages)

	Men		Women	
	Main Study (N=4601)	**Responsive Phase (N=327)**	**Main Study (N=7146)**	**Responsive Phase (N=497)**
Partnering				
Many Lifetime Sexual Partners				
4 or more partners	57.93	60.33	44.78	44.50
7 or more partners	37.92	42.12**	22.17	22.79
Currently Married	41.83	44.92	44.85	54.31***
Ever Married	50.33	52.97	57.37	64.32**
Ever Cohabited	30.14	26.26	49.68	52.57
Parenting				
Ever Fathered a Child / Had A Live Birth	45.82	54.54*	58.15	60.14
2 or More Births	29.46	30.57	39.94	42.17
3 or More Births	13.49	13.75	18.56	17.63
4 or More Births	5.10	6.23	6.98	5.90
Multiple Partner Fertility	17.54	12.99	–	–

* p<.05; ** p<.01; *** p<.001 (two-tailed tests)

This pattern of results for partnering and parenting behaviors is also consistent with the hypothesis that busier people are more likely to be added to a survey using responsive design, given what we know about the role conflict associated with these behaviors. Those with many sexual partnerships and those who are or have been

married are more likely to be added in responsive design. Consistent with other evidence that less role conflict is associated with non-marital cohabitation (Thornton, Axinn and Xie 2007), we find here that responsive design does not produce as large a gap in measurement of cohabiting experience as it does in marital experience. Our evidence is also consistent with the expectation that parents are likely to be added in the responsive phase of a survey, though the evidence we present indicates that is more so for fathers than mothers. Of course more detailed measures of statuses producing the greatest potential role conflict, such as the ages of the children, would likely demonstrate these differences more strongly than the gross categories shown here. The same is likely true for partnering, in which recency or relationship transitions may produce stronger observed differences than the gross categories used here.

Comparing Partnering and Parenting Attitudes

In Table 3 we present differences in attitudinal measures between the samples. For each of the statements listed, respondents were given answer choices of “Strongly Agree,” “Agree,” “Disagree,” and “Strongly Disagree.” Although the "Neither Agree or Disagree" response was not offered, it was accepted as a response if the respondent insisted. For parsimony, we compare the samples on agreement (a response of either “Strongly Agree” or “Agree”) with each statement.

The results in Table 3 show that the samples display differences in responses to some key attitudinal measures. First consider the partnering domain. Although there is no significant difference between the male samples in response to “It is better for a person to get married than to go through life being single,” there is a substantial and significant difference between the female samples: responsive phase women are more likely to agree than main phase women. This is not surprising given women added in the responsive phase are also more likely to have been married (Thornton, Axinn and Xie 2007). Less directly obvious, in response to the statement “Sexual relations between two adults of the same sex is always wrong,” men added through the responsive phase are more likely to agree while women added through the responsive phase are less likely to agree. This interesting result points toward a pernicious characteristic of

responsive survey design: Not only may factors other than role conflict with completing an interview be at work, but it may be extremely difficult to predict the consequences of adding these reluctant respondents across substantive domains.

Table 3. Descriptive Statistics: Agreement with Partnering and Parenting Attitudinal Measures (weighted percentages)

	Men		Women	
	Main Study (N=4601)	**Responsive Phase (N=327)**	**Main Study (N=7146)**	**Responsive Phase (N=497)**
Partnering				
Better to get married than go through life being single	65.57	68.28	49.87	55.27**
Sexual relations between two adults of the same sex is always wrong	51.36	56.69	42.96	36.32**
Parenting				
Rewards of being a parent are worth it despite the cost	93.10	95.11	94.80	88.51
A working mother can establish just as warm and secure a relationship with her children as a mother who does not work	72.94	69.36	82.78	85.14

* p<.05; ** p<.01; *** p<.001 (two-tailed tests)

Next consider the parenting domain. Sample differences in response to "The rewards of being a parent are worth it, despite the cost and the work it takes" are stronger among women than men. Responsive phase women are less likely to agree than main phase women, although significance in this difference is not found in a two-tailed t-test. In response to the statement "A working mother can establish just as warm and secure a relationship with her children as a mother who does not work", on the other hand, the differences by phase appear slightly stronger for men. So, as one might expect given the more subjective nature of attitudes, we find some significant

differences in attitude measurement in the responsive phase of the survey, but these differences follow a less clear pattern, making interpretation of them more difficult. Nonetheless, it is clear the observed differences span both the partnering and the parenting domains, and are strongest in the partnering domain among women.

COMPARING OF MODELS OF DEMOGRAPHIC OUTCOMES

Our next step will be to estimate models that are common in social demographic literature, first on the main phase sample only, then on the responsive phase sample. The models estimated on the main phase sample provide parameter estimates that would be calculated with no special responsive phase effort to add nonrespondents to the study. Comparison to parameters estimated on the responsive phase sample can provide a heuristic sense of the differences in substantive conclusions likely to result from adding reluctant respondents to the study by using responsive design. This test of the consequences of responsive design documents the extent to which difference across groups of respondents documented above are likely to alter our substantive conclusions based on analyses of survey data.

For these multivariate analyses we use logistic regression to model the odds of the demographic outcome in question, and present model coefficients in tables as odds ratios. All analyses are weighted to control for the complex sampling design of the NSFG. Because our objective here is methodological, not substantive, we do not interpret the model coefficients themselves, but instead focus on statistically significant differences in coefficients estimated on the different samples. In keeping with this methodological focus, we draw the models themselves from the previous literature on each topic and do not construct any theoretical frameworks for these topics here. The specific model parameters, variable construction, and coding in the models was derived from recently published papers on these topics based on NSFG data (Bloom and Bennett 1990; Darroch, Landry and Oslak 1999; Finer and Henshaw 2006; Guzzo and Furstenberg Jr. 2007; Hayford and Morgan 2008; Manlove et al. 2008; Manlove, Terry-Humen and Ikramullah 2006; Zhang 2008). Likewise, because our methodological objective is to learn the extent to which responsive design may alter our substantive conclusions based on survey data across multiple subject matters,

we investigate five different types of models spanning two dimensions of partnering and three dimensions of parenting. The specific subjects were chosen based on an analysis of highly cited recent scholarly works using NSFG data in order to represent the most common uses of these data. Finally, because our methodological objective is in the evaluation of the responsive design data collection strategy, not advances in modeling or analytic strategies, we replicate the modeling strategies used in previous highly cited work with NSFG data. In some cases these modeling strategies do not reflect the most sophisticated possible analysis techniques applied to the specific subject. In such cases we comment on our investigation of more sophisticated modeling strategies to supplement the results.

Responsive Design and Multivariate Models of Partnering

We investigate multivariate models of two dimensions of partnering behavior often analyzed using NSFG data – numbers of sexual partners and marriage. We estimate models of the likelihood of lifetime experience with a large number of sexual partners first and models of the likelihood of marriage second.

Many Sexual Partners. In Table 4 we present multivariate models of the likelihood of experiencing many lifetime sexual partners. Because men tend to report more lifetime sexual partners than women in the United States (Laumann et al. 1994; Smith 1992), we code "many" as seven or more partners for men and four or more partners for women. As described above, our analysis focuses on differences between model coefficients for models estimated on the main phase sample versus models estimated on the responsive phase sample, not on the coefficient values themselves. Table 4 presents a pair of models for men and a pair of models for women to simplify visual inspection of differences in estimated coefficients across the two different samples of men and women. Statistical significance of differences between coefficients is determined in pooled models, not shown in the tables, that add interaction terms between the variable of interest and a dichotomous indicator of the sample phase during which the respondent was added to the study. The statistical significance of these coefficient differences is indicated in a third separate column with a # sign.

Table 4. Many Sexual Partners: Logistic regression predicting lifetime sexual partners (weighted)

	Men (7 or more partners)			Women (4 or more partners)		
	Main Phase (N=4451)	**Responsive Phase (N=321)**	**Significant Difference**	**Main Phase (N=6799)**	**Responsive Phase (N=476)**	**Significant Difference**
Age	1.09***	1.13***		1.07***	1.16***	#
	(16.28)	(6.12)		(15.13)	(7.55)	
Race						
(ref=Non-Hispanic white)						
Hispanic	1.15	0.47*	#	0.51***	0.61	
	(1.29)	(2.15)		(7.51)	(1.55)	
Non-Hispanic Black	2.11***	1.62		1.95***	1.50	
	(6.85)	(1.14)		(8.21)	(1.19)	
Other	0.69*	0.05**	#	0.54***	0.34	
	(2.45)	(2.64)		(4.79)	(1.93)	
Education						
(ref=no high school degree)						
High school diploma/GED	2.01***	0.62	#	1.89***	2.92**	#
	(6.32)	(1.19)		(7.21)	(2.73)	
Some college	2.02***	1.13		1.90***	1.79	
	(6.30)	(0.28)		(7.58)	(1.54)	
College degree or higher	1.71***	0.62		1.58***	1.30	
	(4.60)	(1.11)		(5.10)	(0.66)	
Frequency of attendance at religious services	0.69***	0.83	#	0.64***	0.64***	#
	(13.17)	(1.93)		(20.49)	(4.76)	
Ever married	0.91	0.84		0.96	0.54*	
	(1.07)	(0.57)		(0.63)	(2.14)	
Mother's education	1.04	1.08		1.08*	1.19	
	(0.98)	(0.49)		(2.44)	(1.35)	
Mother worked full time when R was age 5-15	1.31***	1.14		1.25***	2.03**	
	(3.78)	(0.46)		(4.11)	(3.05)	
-2 Log-Likelihood	5099.97	367.08		8159.34	515.48	

Note: Numbers in parentheses are t-ratios
* p<.05; ** p<.01; *** p<.001 (two-tailed tests)
# significant interaction between variable and phase (not shown)

Examining the results displayed in Table 4, among men the coefficients for being Hispanic, being another race besides White, Black and Hispanic, having a high school diploma, and frequency of attendance at religious services are each significantly different between the main phase sample and the responsive phase sample. Religious service attendance reduces the likelihood of experiencing a large number of sexual partners in both models, but the magnitude of this effect is estimated as significantly larger among the main phase respondents than among the responsive phase respondents.[1] Effects of being Hispanic and being another race, on the other hand, appear to be more significant among responsive phase respondents than main phase respondents. Among women, the coefficients for age, having a high school diploma, and frequency of religious service attendance are each significantly different in the responsive design phase than in the main phase. In each case the two different coefficients are in the same direction and the difference in each pair is in the magnitude of the estimate.

Of course it is common in social demography that we place greater theoretical emphasis on the direction of such coefficient estimates than on the magnitude. So one might argue that even though these are statistically significant differences, they are substantively similar and would lead to similar substantive conclusions, at least at a gross theoretical level. As we will see below, this is not always the case, and responsive design sometimes produces coefficient estimates in the opposite direction. In the meantime, however, it remains clear that in the domain of models of sexual partnerships responsive survey design adds cases that lead to significantly different estimates of the magnitude of model coefficients. Again, note that we document these significant differences in spite of the relatively small size of the responsive phase sample, which greatly limits the statistical power of such tests.

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[1] Note that more sophisticated approaches to estimation of the relationship between religious service attendance and sexual partnerships use longitudinal data, not cross-sectional data as in the NSFG. This is because there is known reciprocal causation between religious service attendance and sexual partnerships, in which religious service attendance affects subsequent sexual partnering behaviors, but sexual partnering behaviors also affect subsequent religious service attendance (Thornton, Axinn and Hill 1992). We do not use such an approach here because our aim is to evaluate the way responsive survey design may affect model estimates in typical uses of NSFG data and NSFG data are used by some analysts for this purpose.

Marriage. In Table 5 we present multivariate models of the likelihood of ever being married.[2] Just as presented above, our analysis focuses on differences between model coefficients for models estimated on the main phase sample versus models estimated on the responsive phase sample. The statistical significance of these coefficient differences is indicated with a # sign.

Among men, the results in Table 5 demonstrate that responsive survey design adds respondents producing significantly different coefficient estimates for four different parameters in the models. Coefficients for age, having attended some college, having achieved a college degree or higher, and an intact family background are all significantly different in the responsive phase sample than they were in the main phase sample. Two of the four coefficients remain in the same substantive direction, but change significantly in magnitude. But the signs of the coefficients for both having attended some college and having an intact family background change in the responsive phase sample. Among women even though only two coefficients are significantly different in the two samples – Catholic and an income between the poverty level and twice the poverty level – they also have the same character. Among the main phase respondents being Catholic significantly reduces the likelihood of being ever married, whereas among the responsive phase respondents being Catholic appears to increase the likelihood of being married. Income in the middle category increases the likelihood of marriage among the main phase respondents, but appears to decrease the likelihood among responsive phase respondents. Because of the smaller size of the responsive phase sample, however, these effects do not quite attain statistical significance with two-tailed tests. The busier women drawn into the study via the responsive design protocols in NSFG are characterized by significant and substantively meaningful differences in the relationships between being Catholic and marrying, and being in the middle income category and marrying. Thus the analyses

[2] A more sophisticated approach to analysis of marriage would focus on the hazard of becoming married rather than the likelihood of ever being married (Thornton, Axinn and Xie 2007). We re-estimated the models presented in Table 5 reformulating the dependent variable as the hazard of marriage. Though of course coefficients change, the pattern of differences in these coefficients between main phase and responsive phase samples (not shown in tables) is the same as the pattern displayed in Table 5.

presented in Table 5 demonstrate that differences between main phase respondents and responsive phase respondents can produce both statistically significant difference in our substantive models, but also theoretically meaningful and substantively important differences in these models.

Responsive Design and Multivariate Models of Parenting

We now investigate multivariate models of dimensions of parenting behavior often analyzed using NSFG data. We estimate models of the likelihood of ever becoming a father/mother and having fathered/mothered two or more children. We then investigate models of a newly emerging topic in the literature – multiple partner fertility.

Ever Becoming a Father or Mother. In Table 6 we present models of ever biologically fathering a child or giving birth to a child.[3] This is the only case where, at least among women, there are no significant differences in coefficient estimates between the main phase sample and the responsive phase sample. Thus for the two female samples all of the predictors in the model appear to work similarly for predicting giving birth. Among men, coefficients for being born outside the United States and frequency of attendance at religious services are each significantly different between the main phase sample and the responsive phase sample. The effect of being foreign born is markedly stronger among the responsive phase sample of men than among the main phase sample of men (an odds ratio of 4.93 among the responsive phase sample compared to an insignificant effect among the main phase sample). Further exploration of exactly why the relationship between being foreign born and fathering a child is so different for men recruited during the responsive phase of the survey is beyond the scope of this study. In this analysis it serves as further evidence that adding different types of respondents through a responsive design phase may produce different substantive interpretations of multivariate models.

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[3] We also re-estimated the models presented in Table 6, modeling the dependent variable as the hazard of first birth (analysis not shown). The pattern of differences in these coefficients between main phase and responsive phase samples is the same as the pattern displayed in Table 6.

Table 5. Logistic regression predicting ever married (weighted)

	Men			Women		
	Main Phase (N=4461)	**Responsive Phase (N=321)**	**Significant Difference**	**Main Phase (N=6995)**	**Responsive Phase (N=490)**	**Significant Difference**
Age	1.21***	1.13***	#	1.22***	1.20***	
	(31.24)	(5.91)		(39.07)	(9.36)	
Race						
(ref=Non-Hispanic white)						
Hispanic	1.47**	0.88		1.21	0.82	
	(2.96)	(0.31)		(1.75)	(0.51)	
Non-Hispanic Black	0.54***	0.68		0.28***	0.32**	
	(4.86)	(0.80)		(12.86)	(2.94)	
Other	0.70*	0.43		0.84	1.27	
	(2.21)	(0.98)		(1.20)	(0.43)	
Catholic	0.71***	0.53		0.75***	1.60	#
	(3.65)	(1.87)		(3.83)	(1.63)	
Education						
(ref=no high school degree)						
High school diploma/GED	1.86***	1.54		1.78***	1.39	
	(4.85)	(1.05)		(5.36)	(0.78)	
Some college	1.58***	0.67	#	1.66***	1.46	
	(3.49)	(0.82)		(4.84)	(0.90)	
College degree or higher	2.13***	4.05**	#	1.75***	0.96	
	(5.38)	(2.84)		(5.00)	(0.10)	
Income as % of poverty						
(ref = less than 100)						
100-199	1.45**	0.64		1.38**	0.48	#
	(2.61)	(0.96)		(3.18)	(1.85)	
≥200	1.31*	0.56		1.26*	1.37	
	(2.11)	(1.38)		(2.54)	(0.84)	
Urban Residence	0.58***	0.47*		0.79***	0.59	
	(6.37)	(2.41)		(3.37)	(1.94)	
Number of siblings	1.04*	1.29*		1.02	1.03	
	(2.32)	(2.28)		(1.57)	(0.36)	
Mother's education	0.88**	0.85		0.90**	0.84	
	(3.03)	(0.89)		(2.98)	(1.22)	
Lived in intact family at age 14	0.76**	1.46	#	1.04	0.97	
	(3.07)	(1.09)		(0.52)	(0.12)	
-2 Log-Likelihood	4010.68	329.43		6015.22	413.22	

Note: Numbers in parentheses are t-ratios
* p<.05; ** p<.01; *** p<.001 (two-tailed tests)
# significant interaction between variable and phase (not shown)

Table 6. Logistic regression predicting ever biologically fathered/gave birth to a child (weighted)

	Men			Women		
	Main Phase (N=4443)	**Responsive Phase (N=319)**	**Significant Difference**	**Main Phase (N=6973)**	**Responsive Phase (N=488)**	**Significant Difference**
Age	1.19***	1.21***		1.21***	1.21***	
	(30.63)	(7.57)		(37.90)	(9.44)	
Race (ref=Non-Hispanic white)						
Hispanic	1.80***	0.90		1.72***	1.81	
	(4.48)	(0.23)		(4.93)	(1.52)	
Non-Hispanic Black	1.55***	1.39		1.57***	1.20	
	(3.55)	(0.66)		(4.71)	(0.48)	
Other	1.02	0.35		1.24	1.16	
	(0.11)	(1.13)		(1.49)	(0.25)	
Education (ref=no high school degree)						
High school diploma/GED	1.47**	0.82		1.57***	1.03	
	(3.13)	(0.43)		(4.19)	(0.07)	
Some college	1.11	0.41		0.89	0.66	
	(0.79)	(1.67)		(1.17)	(0.98)	
College degree or higher	0.77*	0.29*		0.56***	0.34*	
	(1.98)	(2.28)		(5.28)	(2.24)	
Income as % of poverty (ref = less than 100)						
100-199	0.92	0.59		0.90	0.98	
	(0.60)	(0.98)		(1.00)	(0.06)	
≥200	0.54***	0.67		0.37***	0.60	
	(5.07)	(0.80)		(10.69)	(1.33)	
Urban Residence	0.58***	0.38**		0.72***	0.73	
	(6.64)	(2.80)		(4.95)	(1.18)	
Foreign born	0.89	4.93**	#	0.82	1.03	
	(0.92)	(3.21)		(1.90)	(0.08)	
Number of siblings	1.02	1.04		1.02	0.94	
	(1.68)	(0.33)		(1.54)	(0.71)	
Mother's education	0.91*	1.18		0.81***	0.73*	
	(2.23)	(0.84)		(6.16)	(2.28)	
Frequency of attendance at religious services	1.16***	1.53***	#	1.10***	1.19	
	(5.02)	(3.53)		(3.82)	(1.79)	
-2 Log-Likelihood	4277.97	292.91		6366.75	439.72	

Note: Numbers in parentheses are t-ratios

* p<.05; ** p<.01; *** p<.001 (two-tailed tests)

High Fertility. In Table 7 we present models of having fathered/mothered two or more children. Among men, the coefficient of being Hispanic for the responsive phase sample is significant in the opposite direction than for the main phase sample. The effect of being foreign born again follows a pattern of being insignificant among the main phase sample of men and strongly positive among the responsive phase sample of men. So, for both of these coefficients the responsive phase sample produces cases for whom estimated effects are quite a bit different than among the cases in the main study design. For this particular model we also display the consequences of adding males recruited during the responsive phase together with those from the main phase into one overall total sample. In the fourth column we present a model of having fathered two or more children which pools together the main phase sample of men and responsive phase sample of men. Of course the responsive phase sample is such a small proportion of the pooled sample that most coefficient estimates for the pooled sample look very similar to those produced by the main phase sample. But despite its small case base, the responsive phase sample produces coefficient estimates for Hispanic and foreign born that differ enough from those produced by the main phase sample that they change how coefficient estimates appear in the pooled model. For the pooled sample the coefficient of being Hispanic is only about half the size of this same coefficient for the main phase sample. For being foreign born, the coefficient of this parameter is not significantly different from zero for the main phase sample or the pooled sample. However because this coefficient is so overwhelmingly large for the responsive phase sample, it appears to become positive in the pooled model to the unsophisticated eye.

Among women, the results in Table 7 demonstrate the largest number of differences in coefficient estimates between the main phase sample and the responsive phase sample. The responsive phase incorporates respondents who produce significantly different coefficient estimates for eight different model parameters – age, other racial group, income between the poverty level and twice the poverty level, income at least twice the poverty level, living in an urban area, number of siblings, mother's education, and frequency of attendance at religious services. In some cases (other racial group, living in an urban area) effects appear stronger among the

responsive phase sample, whereas in other cases (age, both income categories, number of siblings, mother's education, and frequency of attendance at religious services) effects seem to be reduced among the responsive phase sample. Unfortunately we cannot fully explain why so many model parameters work differently for predicting high fertility among respondents recruited during the responsive design phase. However, our results clearly imply that responsive phase samples have the potential for altering substantive conclusions. Furthermore, Tables 4 through 7 have shown that many model parameters (e.g. age, racial groups, being born outside the United States, frequency of attendance at religious services) consistently produce different coefficient estimates between main phase samples and responsive phase samples across models predicting a variety of demographic outcomes.

Multiple Partner Fertility. In our final analysis section we explore the recently emerging topic of multiple partner fertility – that is having fathered children with more than one woman. Research is beginning to document both the prevalence of multiple partner fertility and factors associated with it (Guzzo and Furstenberg 2007; Manlove et al. 2008). Because we have thus far found differences in models of other parenting behaviors such as becoming a father or fathering two or more children for the responsive versus main phase samples, we expect differences in models of multiple partner fertility as well. Multivariate models of this particular demographic outcome stratified by sample phase, however, are the most limited in statistical power due to the very small number of men in the responsive phase sample who have fathered two or more children (n = 76) and are therefore at risk of multiple partner fertility. Nevertheless in Table 8 we present models predicting the likelihood of multiple partner fertility as an exploratory exercise. Results demonstrate one significant difference in the coefficient estimates for an intact family background between the main phase sample and the responsive phase sample, although this result must be interpreted with caution. However, the significant differences between samples in coefficient estimates for models predicting other parenting behaviors suggest that examining patterns of difference in models of multiple partner fertility will be a fruitful avenue for future research as more respondents are recruited through responsive design phases.

Table 7. Logistic regression predicting fathered/mothered two or more children (weighted)

	Men				Women		
	Main Phase (N=4443)	**Responsive Phase (N=319)**	**Significant Difference**	**Both Phases Pooled (N=4762)**	**Main Phase (N=6973)**	**Responsive Phase (N=488)**	**Significant Difference**
Age	1.18***	1.21***		1.18***	1.19***	1.16***	#
	(27.09)	(6.91)		(27.89)	(37.50)	(8.62)	
Race							
(ref=Non-Hispanic white)							
Hispanic	1.85***	0.32*	#	1.39*	1.43***	2.19*	
	(4.43)	(2.26)		(2.48)	(3.31)	(2.11)	
Non-Hispanic Black	1.24	1.24		1.18	1.10	0.88	
	(1.64)	(0.41)		(1.34)	(0.98)	(0.33)	
Other	1.04	0.64		0.94	0.84	3.76*	#
	(0.23)	(0.44)		(0.33)	(1.12)	(2.27)	
Education							
(ref=no high school degree)							
High school diploma/GED	1.10	1.21		1.11	0.95	0.62	
	(0.70)	(0.40)		(0.87)	(0.48)	(1.22)	
Some college	0.94	1.05		0.94	0.71**	0.37*	
	(0.48)	(0.09)		(0.47)	(3.28)	(2.50)	
College degree or higher	0.88	0.65		0.85	0.56***	0.23***	
	(0.91)	(0.77)		(1.17)	(5.33)	(3.39)	
Income as % of poverty							
(ref = less than 100)							
100-199	0.99	0.31*		0.86	0.70***	0.48*	#
	(0.08)	(2.27)		(1.17)	(3.63)	(1.97)	
≥200	0.35***	0.16***		0.31***	0.28***	0.51	#
	(8.35)	(3.71)		(9.67)	(14.04)	(1.95)	
Urban Residence	0.67***	0.64		0.67***	0.82**	0.37***	#
	(4.62)	(1.22)		(4.72)	(2.91)	(3.89)	
Foreign born	0.85	7.73***	#	1.14	0.77*	0.76	
	(1.20)	(4.02)		(1.05)	(2.56)	(0.77)	
Number of siblings	1.01	0.90		1.01	1.02*	0.86	#
	(1.00)	(0.87)		(0.91)	(2.03)	(1.90)	
Mother's education	0.91*	0.80		0.90*	0.84***	0.94	#
	(2.16)	(1.04)		(2.42)	(5.17)	(0.46)	
Frequency of attendance at religious services	1.14***	1.29*		1.15***	1.17***	1.09	#
	(4.21)	(2.17)		(4.78)	(6.77)	(0.97)	
-2 Log-Likelihood	3940.47	264.15		4242.67	6631.86	501.87	

Note: Numbers in parentheses are t-ratios

* p<.05; ** p<.01; *** p<.001 (two-tailed tests)

significant interaction between variable and phase (not shown)

Table 8. Multiple Partner Fertility: Logistic regression predicting whether men who have fathered two or more children fathered them with more than one woman (weighted)

	Main Phase (N=943)	**Responsive Phase (N=76)**	**Significant Difference**
Age	1.06***	0.98	
	(4.03)	(0.29)	
Race			
(ref=Non-Hispanic white)			
Hispanic	1.33	3.27	
	(1.07)	(1.38)	
Non-Hispanic Black	3.19***	4.63	
	(5.26)	(1.70)	
Other	1.49	–	–
	(1.12)		
Education			
(ref=no high school degree)			
High school diploma/GED	0.76	1.22	
	(1.22)	(0.28)	
Some college	0.90	1.78	
	(0.45)	(0.64)	
College degree or higher	0.38***	–	–
	(3.78)		
Foreign Born	0.52*	0.56	
	(2.29)	(0.70)	
Lived in intact family at age 14	0.47***	1.17	#
	(4.32)	(0.20)	
Mother was a teen at first birth	1.60**	1.88	
	(2.87)	(0.96)	
-2 Log-Likelihood	1001.55	53.46	

Note: Numbers in parentheses are t-ratios

Measures of other race group and college degree omitted due to sample size

* p<.05; ** p<.01; *** p<.001 (two-tailed tests)

significant interaction between variable and phase (not shown)

Before leaving the results, note the pattern across the various multivariate models presented here. Though we chose models of only five different outcomes, those outcomes span the important dimensions of partnering and parenting at the core of NSFG measurement – sexual partners, marriage, childbearing, having many children, and bearing children with multiple partners. There are many other topics represented in the NSFG as well. It is now well-documented that nonresponse bias of respondent-based estimates varies greatly over different estimates in the same survey (Groves and Peytcheva 2008). However, across the five different dimensions of NSFG measurement we repeatedly see that responsive design draws reluctant respondents into the study who are not only different from main study respondents (Tables 1-3), but also change our understanding of the factors associated with each of the five outcomes (Tables 4-8). Each multivariate model is based on previously published work on the topic using the NSFG and each model is relatively parsimonious. We also estimate the five models separately among men and women, for a total of ten different models. In all but one of the models we find that some coefficients are significantly different among the responsive phase respondents than among the main phase respondents. The majority of the coefficients we estimate are either unchanged among these respondents, or not significantly changed. Most of the significant changes are still in the same direction as among the main phase respondents; this means that adding responsive phase respondents may change estimates of the magnitudes of effects but will not change the substantive interpretation of hypothesis tests that only rely on the direction of the estimated association.

However, in some cases, the coefficients estimated among responsive phase respondents are not only significantly different, but also in the opposite direction than among main phase respondents. These cases would lead to opposite conclusions about the direction of association. Moreover, the pattern of these differences does not appear obvious or easily predicted. Models of men and women often produce different results for the consequences of the responsive phase additions. Sometimes the additions produce greater change in models of men's outcomes and sometimes they produce greater change in models of women's outcomes. Together this body of results

demonstrates that responsive design has the potential to substantially alter the substantive conclusions we reach from analyses of survey data on demographic topics across a range of topics. The results also suggest our understanding of these consequences of adding cases through responsive design will require investigation of each specific topic we study, even within the same survey.

The findings are consistent with the growing body of evidence from survey methodological research, which shows that for some estimates in a survey nonresponse bias can be fatal; for others, it remains a minor issue (Groves 2006; Keeter et al. 2000). In fact, this same evidence demonstrates that nonresponse bias varies greatly across measures within the same survey. This means that at any one level of overall survey nonresponse, different measures will suffer from different levels of nonresponse bias. A key implication of this finding is that the overall survey response rate actually tells us very little about the level of nonresponse bias in any particular measure (Groves 2006). The value of the responsive design phase sample in the NSFG is that the researcher is alerted to the variation in nonresponse bias sensitivity across key estimates of interest. Knowing this, the researcher can then use paradata to guide interventions to target efforts that increase response rates in specific subgroups to reduce nonresponse bias in those key measures of interest. This process does not eliminate nonresponse bias, but uses the information to reduce nonresponse bias.

RECENT ADVANCES IN RESPONSIVE DESIGN AND PROSPECTS FOR DEMOGRAPHIC DATA COLLECTION

Greater reluctance to participate in surveys appears here to stay. Reluctance has been growing among all types of surveys, including both phone surveys and face-to-face surveys, which are the mainstay of demographic research (de Leeuw and de Heer 2002). We have no reason to expect that reluctance to participate in surveys will begin to decline. This growing reluctance substantially increases the costs of creating survey data with the same basic nonresponse properties. Survey data collection is always characterized by fundamental cost-error tradeoffs (Groves and Couper 1998).

Methodological decisions in survey design and execution are fundamentally efforts to either reduce costs at a given level of quality or improve quality at a given level of costs. In the face of increasing nonresponse and the potential for increasing nonresponse bias in survey results, responsive design is an essential tool for balancing control of survey data collection costs with control of potential nonresponse error and bias.

Responsive design clearly has the potential to improve the representation qualities of surveys by bringing other people into a study, people who are different from those who participate in response to the main study protocol. Using analyses of NSFG Cycle 6 data that compare main phase respondents to responsive design phase respondents, we demonstrate that responsive design adds respondents who are more likely to be older, working full time, foreign born, highly educated and from specific racial groups. In reference to the core topics of NSFG measurement, these responsive design phase respondents are also likely to have had large numbers of sexual partners, to have been married, and to have had children. Respondents added during the responsive design phase even have significantly different attitudes, at least with respect to some attitude domains. Many of these differences among those added in the responsive design phase fit theories of nonresponse that hypothesize those people facing the most time pressure in their daily lives will be the least likely to accept requests for survey interviews (Groves and Couper 1998). But other factors may also be keeping people from agreeing to participate. Responsive design, however, is an essential tool for adding significantly different groups of people into a survey.

Not only are these new additions to the survey different, but adding these cases to our multivariate models of demographic behaviors has the potential to alter the substantive conclusions we reach from analyzing those models. Estimating a series of different multivariate models using data from the NSFG Cycle 6, we find numerous statistically significant differences among coefficients estimated on respondents added to the study during the responsive design phase. Sometimes these differences are big enough to produce sign changes in the estimated coefficients that would dramatically alter substantive conclusions based on these multivariate analyses. Because our

investigation was constrained by the relatively small size of the NSFG Cycle 6 responsive design phase sample, we are only able to detect the very largest of these differences. As efforts to use responsive design to control nonresponse bias increase, the numbers of respondents added in responsive phases are likely to grow, and as responsive design protocols become more effective, the differences between the responsive phase respondents and main phase respondents may also grow. Thus we have every reason to expect the consequences of responsive design for estimates of substantive models of demographic behavior will only grow in the future.

In fact the NSFG is both using and improving responsive design in Cycle 7. Cycle 7 of the NSFG reflects a substantial design change relative to all previous cycles of the NSFG, called continuous interviewing. Like the Census's American Community Survey, the continuous interviewing NSFG is always in the field collecting data that can be cumulated over time into large data sets that continuously span historical time. The NSFG Cycle 7 rotates across primary sampling units (PSUs) on an annual basis to provide lower sampling error when aggregated across larger units of time. Within each annual set of PSUs the sample is worked in four replicates that provide quarterly sampling units and a fresh work flow four times a year. Within each quarter the study is conducted in two phases, a main phase and a responsive design phase. The replicate study design allows lessons learned from previous replicates to be applied in each new replicate, so that responsive design based interventions can be continuously adapted to changing social conditions and can provide continually improving responsive design effects. As a result responsive design has been extraordinarily effective at maintaining high response rates and highly balanced samples across key sub-groups in the NSFG sample design (Groves et al. 2005).

At the same time, the tools to implement responsive designs continue to improve. The computerization of survey data collection continues to improve through the creation of newer and more capable automated systems for the centralized management of large scale, geographically dispersed survey data collection operations (Cheung 2007). These improvements continue to fuel the creation of more and more paradata, giving survey methodologists more and more information to use in building

management models for responsive design that draw on paradata to improve the efficiency of data collection (Couper and Lyberg 2005). Greater applications of these tools across the internet allows paradata to flow to centralized managers continuously, greatly improving the speed of analysis and the speed of adjustments to data collection protocols. All indications are that these technical breakthroughs will continue to occur at a fast clip. From this we expect greater use of paradata to design more effective responsive design strategies, greater use of responsive design in large scale data collections, and more effective implementations of responsive design so that the resulting survey data are more and more shaped by these approaches.

Finally, although the technologies and methods needed for responsive design are most prevalent in the United States, Canada, and few rich countries of Western Europe, we have every reason to expect this approach to survey data collection will quickly spread worldwide. The technology for using responsive design, including both computerized data collection and internet based management of geographically dispersed data collection staff, are spreading worldwide quickly. In fact, in some poor countries with large populations in rural areas, electronic data collection is frequently being proposed to overcome other logistical barriers. For example, China is currently launching its first large scale national survey data collection using CAPI technologies and electronic tools for centralized management of a national field staff. As computerization and internet access spreads, not only will it be possible for other countries to implement responsive designs in survey data collection, but it will also be possible to engage in centralized management and coordination of international data collections across many different countries. Technical and sometimes legal barriers may impede free flow of survey management data across national borders, but eventually the efficiency gains and improved scientific quality of such coordination is likely to produce this outcome.

Thus we introduce responsive design here fully expecting it to be a central aspect of demographic data collection for decades to come. Based on our analysis of NSFG Cycle 6 data we argue that responsive design has enormous potential to improve the representative qualities of demographic data while at the same time controlling the

costs of producing the most scientifically advanced data possible. However we also caution that consequences of responsive design include the possibility of fundamentally altering the substantive conclusions we reach from analyses of complex multivariate models. In fact, these consequences are not only likely to differ across studies, but they are likely to differ across topics, models, and even coefficients within the same study. So, careful attention to the consequences of these responsive design advances will also likely become a fundamental component of demographic analyses of survey data.

REFERENCES

Bloom, D.E. and N.G. Bennett. 1990. "Modeling American Marriage Patterns." *Journal of the American Statistical Association* 85(412):1009-1017.

Botman, S.L. and O.T. Thornberry. 1992. "Survey Design Features Correlates of Nonresponse." Pp. 309-314 in *Proceedings of the Section on Survey Research Methods*. Alexandria, VA: American Statistical Association.

Cheung, G.-Q. 2007. "Mixed-Mode Sample Management System: An Early Glance." Presented at International Blaise Users' Conference, Annapolis, MD.

Couper, M.P. 1998. "Measuring Survey Quality in a CASIC Environment." Presented at the Survey Research Methods Section of the American Statistical Association.

Couper, M.P. and L.E. Lyberg. 2005. "The Use of Paradata in Survey Research." Presented at Proceedings of the 55th Session of the International Statistical Institute, Sydney, Australia.

Darroch, J.E., D.J. Landry, and S. Oslak. 1999. "Age Differences Between Sexual Partners in the United States." *Family Planning Perspectives* 31(4):160-167.

de Leeuw, E. and W. de Heer. 2002. "Trends in Household Survey Nonresponse: A Longitudinal and International Comparison." Pp. 41-54 in *Survey Nonresponse*, edited by R.M. Groves, D.A. Dillman, J.L. Eltinge, and R.J.A. Little. New York: Wiley.

Finer, L.B. and S.K. Henshaw. 2006. "Disparities in Rates of Unintended Pregnancy in the United States, 1994 and 2001." *Perspectives on Sexual and Reproductive Health* 38(2):90-96.

Goyder, J. 1985. "Face-to-Face Interviews and Mailed Questionnaires: The Net Difference in Response Rate." *Public Opinion Quarterly* 49(2):234-252.

Groves, R.M. 1987. "Research on Survey Data Quality." *Public Opinion Quarterly* 51(2: 50th Anniversary Supplement):S156-S172.

Groves, R.M. 1989. *Survey Errors and Survey Costs*. New York: Wiley.

Groves, R.M. 2006. "Nonresponse Rates and Nonresponse Bias in Household Surveys." *Public Opinion Quarterly* 70(5):646-675.

Groves, R.M., G. Benson, W. Mosher, J. Rosenbaum, P. Granda, W.G. Axinn, J. Lepkowski, and A. Chandra. 2005. "Plan and Operation of Cycle 6 of the National Survey of Family Growth." in *Vital Health Statistics*. Hyattsville, MD: National Center for Health Statistics.

Groves, R.M. and M.P. Couper. 1998. *Nonresponse in Household Interview Surveys*. New York: Wiley.

Groves, R.M. and S.G. Heeringa. 2006. "Responsive Design for Household Surveys: Tools for Actively Controlling Survey Errors and Costs." *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 169(3):439-457.

Groves, R.M. and E. Peytcheva. 2008. "The Impact of Nonresponse Rates on Nonresponse Bias: A Meta-Analysis." *Public Opinion Quarterly* 72(2):167-189.

Guzzo, K.B. and F.F. Furstenberg Jr. 2007. "Multipartnered Fertility Among American Men." *Demography* 44(3):583-601.

Hapuarachchi, P., M. March, and A. Wronski. 1997. "Using Statistical Methods Applicable to Autocorrelated Processes to Analyze Survey Process Quality Data." Pp. 589-600 in *Survey Measurement and Process Quality*, edited by L. Lyberg, P. Biemer, M. Collins, E. de Leeuw, C. Dippo, N. Schwarz, and D. Trewin. New York: Wiley.

Hayford, S.R. and S.P. Morgan. 2008. "Religiosity and Fertility in the United States: The Role of Fertility Intentions." *Social Forces* 86(3):1163-1188.

Keeter, S., C. Miller, A. Kohut, R.M. Groves, and S. Presser. 2000. "Consequences of Reducing Nonresponse in a National Telephone Survey." *Public Opinion Quarterly* 64(2):125-148.

Laumann, E.O., J.H. Gagnon, R.T. Michael, and S. Michaels. 1994. *The Social Organization of Sexuality: Sexual Practices in the United States*. Chicago: University of Chicago Press.

Manlove, J., C. Logan, E. Ikramullah, and E. Holcombe. 2008. "Factors Associated With Multiple-Partner Fertility Among Fathers." *Journal of Marriage and Family* 70(2):536-548.

Manlove, J., E. Terry-Humen, and E. Ikramullah. 2006. "Young Teenagers and Older Sexual Partners: Correlates and Consequences for Males and Females." *Perspectives on Sexual and Reproductive Health* 38(4):197-207.

Rindfuss, R.R., S.P. Morgan, and C.G. Swicegood. 1988. *First Births in America: Changes in the Timing of Parenthood*. Berkeley: University of California Press.

Scheuren, F. 2001. "Macro and Micro Paradata for Survey Assessment." Presented at the United Nations Work Session on Statistical Metadata, Washington, D.C.

Singer, E. 2002. "The Use of Incentives to Reduce Nonresponse in Household Surveys." Pp. 163-178 in *Survey Nonresponse*, edited by R.M. Groves, D.A. Dillman, J.L. Eltinge, and R.J.A. Little. New York: Wiley.

Smith, T.W. 1992. "Discrepancies Between Men and Women in Reporting Number of Sexual Partners: A Summary from Four Countries." *Social Biology* 39(3-4):203-211.

Thornton, A., W.G. Axinn, and D.H. Hill. 1992. "Reciprocal Effects of Religiosity, Cohabitation, and Marriage." *The American Journal of Sociology* 98(3):628-651.

Thornton, A., W.G. Axinn, and Y. Xie. 2007. *Marriage and Cohabitation*. Chicago: University of Chicago Press.

Tourangeau, R., L.J. Rips, and K.A. Rasinski. 2000. *The Psychology of Survey Response*. Cambridge: Cambridge University Press.

Traugott, M.W., R.M. Groves, and J.M. Lepkowski. 1987. "Using Dual Frame Designs to Reduce Nonresponse in Telephone Surveys." *Public Opinion Quarterly* 51(4):522-539.

Zhang, L. 2008. "Religious Affiliation, Religiosity, and Male and Female Fertility." *Demographic Research* 18:233-262.

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