THE IMPACT OF COMPUTER ASSISTED TELEPHONE INTERVIEWING ON DATA FROM THE AMERICAN HOUSING SURVEY

Steven D. Leadbetter, Cornette G. Cole, Andrea J. Meier, and Hertz Huang
Steven D. Leadbetter, Bureau of the Census, Washington, D.C. 20233*

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A. INTRODUCTION

The American Housing Survey—National Sample (AHS) was designed to provide a current series of information on the size and composition of the national housing inventory, the characteristics of its occupants, changes in the inventory resulting from new construction, indicators of housing and neighborhood quality, and the characteristics of recent movers. The survey is conducted by the Bureau of the Census for the Department of Housing and Urban Development.

Computer Assisted Telephone Interviewing (CATI) techniques may collect data of even higher quality than those collected from other, more traditional modes of interview. Previously, AHS data were obtained exclusively in the field by field representatives (FRs), through either personal visit (PV) or decentralized telephone interviews, with the later conducted in the homes of the FRs. Using CATI may also help alleviate the effects of the FR staffing retention problems of certain areas by reducing the corresponding field workloads. Therefore, large-scale CATI experiments were implemented in conjunction with the 1987 and 1989 enumerations of the AHS sample to obtain information about the possible effects of CATI on the quality of AHS data. This paper discusses these CATI experiments and presents the findings of these studies. We assess the effects of CATI on the quality of data from the AHS.

Results from the 1981 and 1983 AHS telephone interviewing experiments indicated that decentralized telephone interviewing had slight effects on the data, particularly among financial characteristics, housing and neighborhood quality characteristics, and income item nonresponse rates.

We discuss the design and present the findings of the various aspects of the 1987 and 1989 AHS CATI experiments in the following sections of this paper.

B. DESIGN OF THE 1987 AND THE 1989 AHS CATI EXPERIMENTS

The AHS sample is divided equally into six panels. The data of each panel may be used to derive independent estimates of characteristics of interest. Utilizing this feature, specific panels were assigned to the CATI and non-CATI treatments in both the 1987 and the 1989 CATI experiments. Units assigned to CATI, but due to various reasons, not eligible to be interviewed by CATI, were screened out and sent to the field for either decentralized telephone or PV interview. These screened units included (1) new construction added to the sample since the previous enumeration; (2) previous enumeration units classified as (a) noninterviews, (b) vacants, or (c) "Usual Residence Elsewhere;" (3) units with households of 8 or more members; (4) multi-unit mobile homes; (5) units located in special place segments; (6) units with inconsistencies between address and structure type; and (7) units of households previously interviewed which indicated that they either didn't have a telephone or they specifically requested a PV interview. Units not screened out were the CATI-eligibles.

To create comparable sets of data between the CATI and the non-CATI treatments, the screening criteria were also applied to the cases of the non-CATI treatment panels. This procedure determined the CATI-eligible cases of the non-CATI treatment panels. The non-CATI treatment consisted of decentralized telephone and PV interview cases. FRs were to conduct decentralized telephone interviews for all eligible units whenever possible. Those units for which FRs did not obtain completed PV interviews in the previous enumeration and units that didn't have a telephone were not eligible for decentralized telephone interviews and were assigned to PV interviewing.

1. The 1987 CATI Experiment

Panels 5 and 6 of the 1987 AHS sample were randomly assigned to the CATI interview experiment or treatment. These panels comprised approximately one-third of the total 1987 AHS sample (about 16,000 units). The screening criteria were applied to these units to determine CATI eligibility. Those units determined to not be eligible were sent to the field for either a decentralized telephone or PV interview. The remaining 10,400 units (65% of the assigned CATI sample) were deemed eligible for CATI interview. In addition, some of the CATI-eligible cases were recycled to the field after CATI interview attempts were unsuccessful or determined unit ineligibility. About 6,400 (61.5%) of the eligible cases were actually interviewed by CATI. Since all 10,400 CATI-eligible units were included in the analysis, the CATI treatment panels included cases from all three interviewing modes.

The units of panels 1 through 4 or approximately two-thirds of the total sample were assigned to a maximum decentralized telephone interviewing treatment (i.e., the non-CATI treatment). Within the non-CATI treatment,

about 40% of the units were interviewed by decentralized telephone and 60% by PV.

2. The 1989 CATI Experiment

A second large-scale CATI experiment was conducted as part of the 1989 AHS enumeration to generally confirm that the 1987 CATI experiment results either indicated (1) true CATI/non-CATI effects on the data or (2) random variation. About one-third of the total 1989 AHS sample units were initially assigned to CATI from panels 1 and 5. After screening, approximately 10,500 cases (63%) were determined to be eligible for CATI. About 5,800 (55%) of those eligible were actually interviewed by CATI. The remaining cases were recycled to the field.

Panels 4 and 6 made up the non-CATI panels of the 1989 experiment. Within the non-CATI treatment, 44% of the interviews were completed by decentralized telephone and 56% by PV. Only panel 4 was assigned to the non-CATI treatment in both the 1987 and the 1989 CATI experiments, while only panel 5 was assigned to the CATI treatment for both experiments. Panel 1 switched from 1987 non-CATI to 1989 CATI, while panel 6 was 1987 CATI/1989 non-CATI.

C. CROSS-SECTIONAL ESTIMATES

We analyzed most estimates of various housing characteristics for occupied units from the publication tables of the AHS Current Housing Reports. The estimates analyzed included characteristics from various subdomains defined by structure type, household head and tenure characteristics, and various levels of geography. We compared the CATI and non-CATI treatments using the t-test. We conducted over 22,000 tests using the CATI-eligible data at the 10%, 5%, and 1% level of significance. If there were no differences in the estimates between the CATI and the non-CATI treatments, then because of sampling error, we expected the proportion of significant tests to approximately equal the respective test level of significance. More than the expected proportion of significant tests would support the hypothesis of differences in the estimates between the CATI and non-CATI treatments. Our standard errors were derived from generalized variance functions, which are considered to produce overestimates of the variances of very small estimates, resulting in conservative test results. Table 1 includes a summary of the results of these cross-sectional analyses.

1. The 1987 CATI Experiment Results

We conducted a limited analysis of the 1985 AHS data classified by the 1987 CATI/non-CATI panel assignments to ensure that there was no panel bias. No significant differences were found between the CATI and the non-CATI panels, indicating that there was no panel bias.

The analysis of 1987 CATI-eligible data indicated that there were significant differences between the CATI and non-CATI estimates of various subdomains and characteristics. The subdomains exhibiting non-directional net differences between the CATI and the non-CATI estimates included owner and urban. Some of the CATI estimates for characteristics within these subdomains were

larger than the corresponding non-CATI estimates, while others were smaller.

However, for the moderate physical problems (MPP) and below poverty level subdomains, the differences were directional. Lower CATI reporting levels existed for MPP, while the below poverty estimates were higher for CATI than non-CATI. (See Table 2, which provides average magnitudes of the CATI/non-CATI differences.) The MPP subdomain refers to units that have a problem in at least one of five problem categories, but not to the degree of the severe physical problems. These categories include (1) plumbing, (2) heating, (3) upkeep, (4) hallways, and (5) kitchens. The MPP subdomain is indicative of housing units with general deficiencies.

Characteristics displaying non-directional differences included: lot size, heating fuel, heating equipment, selected deficiencies (e.g., broken plaster or peeling paint), selected amenities (e.g., garage or carport included with home), household characteristics, and mortgage items. The median CATI income estimates of selected characteristics were significantly higher (3-6%) than the corresponding non-CATI estimates.

Further analysis involved tests of approximately 4,500 estimates of the full-panel 1987 AHS-N data by treatment group. These data included all cases from a panel, not just the CATI-eligibles. The findings of the full-panel cross-sectional analysis were similar to those of the study involving only the CATI-eligible data: the same characteristics and subdomains were affected. This indicates that AHS publication estimates would be affected by the inclusion of CATI data.

2. The 1989 CATI Experiment Results

Like the analysis of the 1987 CATI experiment, the 1989 CATI analysis indicated that there were significant differences between the CATI and the non-CATI estimates of the various subdomains and characteristics. The subdomains exhibiting non-directional net differences between the CATI and the non-CATI estimates included owner, MPP, and suburbs in Metropolitan Statistical Areas (MSAs). However, CATI estimates were significantly lower than the corresponding non-CATI estimates for the total occupied and urban subdomains. (See Table 2.)

Characteristics exhibiting non-directional differences included: lot size, other (additional) heating fuel, heating equipment, water leakage, monthly housing costs as percent of income, housing ownership shared by "person not living here," utilities paid separately, owners with a mortgage, and routine maintenance costs. Selected CATI median income estimates were significantly higher (10%) than the corresponding non-CATI estimates.

Additional 1989 CATI analysis included comparisons of 1989 full panel data between the CATI and non-CATI panels. The third set of comparisons of cross-sectional estimates used the CATI-eligible data from the fixed or consistently-treated CATI/non-CATI panels (i.e., panels assigned to the same treatment group for both 1987 and 1989: non-CATI panel 4, versus CATI panel 5). Finally, the fourth set of comparisons made were for the 1989

within-CATI treatment of CATI-eligible data (i.e., CATI panels 1 versus 5). These panels were not treated consistently between the 1987 and 1989 CATI experiments. Panel 1 was in the 1987 non-CATI treatment, while panel 5 was in the CATI treatment for both 1987 and 1989.

We limited the scope of these additional analyses to the specific publication data tables with the greatest proportion of significant CATI/non-CATI differences of the CATI-eligible data (i.e., panels 1 and 5 versus panels 4 and 6). We made approximately 4,500 comparisons in each analysis group, including characteristics on the size of the lot, selected equipment and plumbing, and housing quality. We calculated the proportions of significant tests of the initial CATI-eligible analysis group using only the items included in the limited scope of study for comparability with the results of the additional analysis groups. Table 1 summarizes the results of all sets of 1989 cross-sectional analyses.

In general, we found that the estimates of the same subdomains and characteristics from the full panel data were significantly different between the CATI and the non-CATI treatments as in the CATI-eligible data. This indicates that even when considering all interviewing modes of the full panels, irrespective of CATI eligibility, the CATI effects are still significant.

Similarly, the proportion of significant tests between the CATI and non-CATI fixed panel estimates was also greater than what could be explained by random variation alone. This indicates that the common CATI/non-CATI panels between the 1987 and the 1989 CATI experiments consistently indicate CATI effects on the data. There is no evidence to suggest that the continued application of CATI diminishes observed CATI/non-CATI differences.

However, the within-CATI treatment results indicate a lower proportion of significant tests than expected due to random variation alone. This indicates that the two sets of CATI estimates, produced separately from the two panels assigned to the CATI treatment, do not differ significantly. There is no evidence of an effect of the 1987 treatment on the 1989 results. The panel assigned to CATI for both the 1987 and 1989 experiments does not produce different estimates than the panel assigned to CATI in 1989 only. Both panels are contributing equally to the overall observed CATI effect on the data.

3. Comparison of the 1987 and 1989 Results

The results of both the 1987 and the 1989 AHS-N CATI experiments were compared to assess the impact on data quality. Both the 1987 and the 1989 CATI experiments revealed that the owner, urban, and MPP subdomains as a whole exhibited higher than expected proportions of significant differences between CATI and non-CATI estimates. Only the 1987 CATI experiment results indicated significant differences in the below poverty subdomain, while only the 1989 CATI experiment results showed significant differences in the total occupied and suburbs (in MSAs) subdomains. Some of the subdomains exhibited directional differences in one CATI experiment and non-directional differences in the other CATI

experiment. The owner subdomain had non-directional differences in both the 1987 and 1989 experiments, while MPP and urban differences were directional in one of the CATI experiments and non-directional in the other.

To measure the magnitude and direction of the CATI/non-CATI differences indicated by the proportions of significant tests, we calculated both mean net difference rates and mean gross difference rates (mean NDRs and mean GDRs) across characteristics within selected subdomains. These measures are CATI/non-CATI differences relative to the corresponding non-CATI estimates. In this context, we considered the non-CATI estimates as controls. We used the mean NDRs as directional indicators, while the mean GDRs served as nondirectional measures of magnitude of the CATI/non-CATI differences. A significantly positive mean NDR indicates larger CATI estimates, while a significantly negative mean NDR indicates smaller CATI estimates than non-CATI. If the mean NDR is not significant, but the mean GDR is significant, then the CATI/non-CATI differences are significant, but non-directional.

Table 2 provides the mean GDRs and the 95% confidence intervals for various subdomains and general characteristic groups. General housing characteristics include: tenure, race and ethnicity of householder, units in structure, condominiums, year structure built, place size, and various Census geography items. Housing quality characteristics include: selected amenities and deficiencies, water leakage, availability of vehicles, overall opinion of structure, and selected physical problems (both severe and moderate).

Table 3 provides mean GDRs for income and income-related characteristics and the corresponding 95% confidence intervals for the owners with a mortgage and owners without a mortgage subdomains. The specific characteristics include income, monthly housing costs, home value, real estate taxes, mortgage payments, and type of mortgage items. Except for the 1987 mortgage subdomain, the GDRs indicate CATI/non-CATI differences at the 5% level of significance. However, the 1987 mortgage subdomain differences are significant at the 10% level.

D. AHS CATI RECONCILIATION STUDIES

Reconciliation studies were included in both the 1987 and the 1989 CATI experiments. Data from the prior enumeration for all CATI-eligible cases were stored in the CATI facility for selected items. Current interview responses for these items were not always consistent with the previous enumeration responses. We did not require the same respondent as the previous enumeration for each household. We accepted between-enumeration proxy respondents. Inconsistent responses were due to (1) true status change or (2) an incorrect response of either the current or the previous enumeration.

When previous and current responses were discrepant, reconciliatory questions were asked about the particular items at the end of the CATI interview. The respondent was then asked to explain the reasons for the differences. If the difference was due to a wrong answer and not true

status change, then the respondent was specifically asked which answer was wrong, the current or previous enumeration response. These two sets of responses were independent because the CATI interviewer did not have the previous enumeration response available until after the current enumeration CATI response was permanently recorded.

Reconciliation may also be used to estimate response bias. We used the proportions of current enumeration responses indicated as wrong to total CATI responses as indicators of the response bias. Larger response biases indicate reporting difficulties associated with the respective items.

1. The 1987 AHS CATI Reconciliation

A reconciliation study involving nine items was conducted as part of the 1987 CATI experiment. Among the 6,400 CATI-interviewed cases, 3,500 (55%) of the respondents were asked at least one of the reconciliatory questions. However, the individual item reconciliation rates varied considerably. The heating equipment item required reconciliation from 19% of all CATI-interviewed cases, compared to about 2% for both the tenure and monthly rent items. Table 4 provides the individual item reconciliation rates by reason.

The incorrect response cases were fairly evenly divided between the incorrect 1985 responses and incorrect 1987 responses. These findings were a bit surprising as the general belief is that respondents tend to indicate that the previous response was wrong, not the current response. Respondents did not appear to hesitate to admit if they were wrong as about only 1% of the reconciled cases were assigned "don't know" responses. The balance of the reconciliation cases reflect actual status changes between 1985 and 1987.

The incorrect response rates were highest for the heating equipment and basement items for both the 1985 and the 1987 responses, indicating the respondents' difficulty in reporting these items correctly. Alternatively, respondents had relatively little difficulty reporting the tenure and rent items correctly. The home value item had the highest rate of true status change.

2. The 1989 AHS CATI Reconciliation

A second reconciliation study was conducted as part of the 1989 CATI experiment. Only six of the nine 1987 reconciliation study items were used. Of the 5,800 CATI-interviewed cases, 55% required at least one reconciliatory question. Table 5 lists the individual item reconciliation rate breakdowns. Total reconciliation rates vary from 20% for the heating equipment item to 9% for the bathrooms item. The distribution of item total reconciliation rates listed in this table parallel those of the 1987 CATI reconciliation study. About 57% of the reconciled responses indicated that either the 1987 or the 1989 response was incorrect. Of these cases, more respondents indicated that the previous interview response was wrong (57%), than indicated that the current response was wrong (43%). These results are more consistent with what one would expect from the reconciliation than from the 1987 results. Another 30% of the reconciliations

indicated that there was a true status change between the 1987 and 1989 interviews. "Other" reasons and refusals comprise the remaining 10%.

The home value item had more status changes than wrong answers. The type of heating equipment and presence of a basement item reconciliations were more likely to involve incorrect responses than true status change.

E. SUMMARY AND CONCLUSIONS

Analysis of the 1987 CATI experiment demonstrated that there were significant CATI/non-CATI differences in the estimates of various subdomains and certain characteristics of the AHS. Some of these differences were directional; others were non-directional. The 1989 results indicated that the general findings of the 1987 study were valid. Therefore, one can conclude that there is evidence of CATI/non-CATI differences in the AHS estimates.

The results indicate that CATI respondents report higher incomes than non-CATI respondents. It is not known which treatment provides better data overall, but it is speculated that CATI income estimates are probably better than non-CATI because the CATI instrument tends to ensure that all appropriate income questions are asked.

CATI respondents report lower levels of general deficiency items. We believe that the non-CATI estimates for general deficiency items are more accurate than the CATI estimates because it seems unlikely that respondents would tend to over-report items which may have a negative connotation (e.g., water leakage).

The CATI reconciliation studies have shown that about half of all respondents gave at least one discrepant response compared to the previous interview. Reported values for items such as heating equipment and basements were consistently subject to response bias. Since all previous (1985) responses were completed by PV interview for the 1987 CATI study, and many of the 1987 CATI incorrect responses were from the previous enumeration, this bias indicates general reporting difficulties rather than any CATI treatment effect. Other items such as home value and bedrooms also experienced high reconciliation rates. However, discrepancies in reported values for these items are largely due to true status changes.

Since the reconciliation was independent, these responses are our best estimates of the "true" values. If the current responses are identified as incorrect, they may be changed in the CATI instrument. Lacking comparable reconciliation and not changing incorrect responses for the non-CATI cases, we may conclude that the CATI data of the reconciliation items have the potential for higher quality than the corresponding non-CATI data. If current responses are identified as incorrect, interviewers may change them in the CATI instrument.

Possible reasons for some of the CATI/non-CATI differences have been proposed. These reasons include:

(1) CATI had a larger proportion (40-50%) of inexperienced interviewers than FRs in the field (5-10%). The probing skills of the CATI interviewers may not have

been as effective as those of the more experienced FRs. It has been hypothesized that CATI interviewers have differences from FRs in their understanding of survey concepts.

(2) A larger proportion of non-CATI panel cases (56-60%) were completed by PV than CATI panel cases (45%). The ability of the FRs to make personal observations may help to reduce potential prestige bias problems and partially explain differences between CATI and non-CATI estimates.

(3) Higher medians for certain income items in CATI is probably due to the automated questionnaire of CATI, which helps to ensure complete coverage of income questions. Centralized monitoring helps to minimize any forced skipping of income questions.

F. FURTHER RESEARCH: THE 1991 AHS CATI EXPERIMENT

This section discusses the future research analysis plans associated with both the 1987 and 1989 AHS CATI experiments. It also provides a brief discussion of the design plans for the 1991 AHS CATI experiment.

1. Further 1987 and 1989 CATI Experiment Analyses

To provide evidence of reasons for differences between CATI and non-CATI estimates, we will evaluate gross change estimates of longitudinal data in the near future. We will use the GDR to evaluate gross change over time. Since only PV interviews were conducted for the 1985 enumeration of the AHS, all 1987 CATI-eligible cases of both the CATI and non-CATI treatments correspond to 1985 PV interviews for the 1985-to-1987 GDRs. We also plan to calculate 1987-to-1989 and 1985-to-1989 GDRs.

Many characteristics did not include specific "don't know" or "nonresponse" categories in the publication tables. For these characteristics, data were allocated or imputed for item nonresponse. Among subdomains and characteristics that displayed large proportions of significant differences between the CATI and non-CATI estimates in the cross-sectional analyses, we will compare the CATI and the non-CATI allocation rates.

2. The 1991 AHS CATI Experiment

Census personnel have decided to implement a split-panel CATI experiment design for the 1991 AHS instead of the originally-planned design of maximum CATI in all 6 panels of 94 PSUs. They recommend that panel 4 continue to be assigned to the non-CATI treatment since it is the only panel that has never been previously assigned for CATI interviewing. Panels 5 and 6 will be assigned to CATI and panels 1 through 4 to non-CATI. For cases with discrepant 1989-to-1991 responses, we plan to conduct reconciliations and actually correct the current responses for selected items.

Using a CATI panel that was previously non-CATI (panel 6) will help to avoid a potential dampening of measured differences that may result from consecutive enumerations of CATI interviews. To this end, the panel 6 CATI assignment for 1991 was non-CATI in 1989. We hope that this additional research will provide useful results in identifying specific causes of CATI/non-CATI differences. Such information would assist in making

informed decisions about future data collection procedures to improve overall data quality.

G. LIMITATIONS

The 1987 and 1989 AHS CATI analyses were subject to various limitations due to either the nature of the data or to feasibility restrictions. We discuss these limitations and caveats below.

The specific characteristics tested in the cross-sectional analyses were subject to various dependency problems. The subdomains tested were not always independent. For example, home owners in cities were represented in both the owner and the urban subdomains. Items were also correlated within subdomains (e.g., the number of rooms and the number of bedrooms items). Finally, correlations also exist among categories within items. However, the tests we conducted correspond to the universe of AHS published estimates. In addition, as previously indicated, the estimated standard errors that we used are conservative for small estimates. Consequently, these estimates may be subject to comparable, yet undetectable, CATI/non-CATI differences.

AHS cases in the CATI experiment were interviewed by one of three modes: PV, decentralized telephone, or CATI. For many aspects of the research, it was not possible to use strictly CATI-interviewed data for appropriate comparisons between the CATI and non-CATI treatments. Instead, we analyzed CATI-eligible data, which included cases from all three interview modes. The PV and decentralized telephone interview cases of the field were not discerned.

The reconciliation studies are currently restricted to the CATI-interviewed cases. Consequently, there are no benchmarks against which we may compare the CATI results. Although currently not available for AHS, there is the potential for analogous reconciliation data from the field via Computer Assisted Personal Interviewing (CAPI). Using CAPI, previous responses could be stored to facilitate reconciliation during the regular interview.

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Table 1. Summary of the Percent of Significant t-Tests from the 1987 and 1989 CATI Experiments

Analysis Group	Level of Significance		
	$\alpha = .10$	$\alpha = .05$	$\alpha = .01$
1987 CATI-Eligibles (All)	11.1	6.2	1.9
1989 CATI-Eligibles (All)	11.8	6.8	2.3
1989 Limited Scope:			
CATI-Eligibles	13.0	8.0	3.0
Full Panels	12.8	7.3	2.7
Fixed Panels	11.2	6.4	2.1
Within-CATI	7.5	4.0	0.8

Table 2. Mean Gross Difference Rate Percentages of Various Subdomains by Characteristic Group

Subdomain	Year	General Housing			Housing Quality		
		Mean GDR	95% CI		Mean GDR	95% CI	
			L	U		L	U
Owner	1987	3.5	1.0	6.0	18.9	11.2	26.6
	1989	5.1	2.3	7.9	21.4	13.5	29.3
MPP	1987	19.0	11.7	26.2	23.6	13.4	33.7
	1989	20.8	8.4	33.3	27.3	15.9	38.7
Urban	1987	2.9	1.2	4.7	11.6	6.8	16.5
	1989	3.4	1.6	5.1	14.2	9.0	19.5
Below Poverty	1987	12.3	7.0	17.5	23.4	15.3	31.5
Total Occupied	1989	3.5	2.0	5.0	13.8	8.4	19.1
Suburbs (In MSAs)	1989	6.0	2.4	9.5	18.1	11.0	25.1

Table 3. Mean Gross Difference Rate Percentages of Income and Income-Related Characteristics for the Mortgage and No Mortgage Subdomains

Year	Mortgage			No Mortgage		
	Mean GDR	95% CI		Mean GDR	95% CI	
		L	U		L	U
1987	9.0	-0.2	18.1	23.3	17.0	29.6
1989	15.2	4.8	25.6	16.7	10.9	22.5

Table 4. Percent of All 1987 CATI-Interviewed Cases Requiring Reconciliation by Item and Reason

Item	Total	Wrong Response		True Status Change
		1985	1987	
Heating Equipment	19	6	8	6
Home Value	19	1	2	14
Bedrooms	12	2	3	8
Basements	12	5	6	2
Heating Fuel	10	2	2	5
Bathrooms	8	2	2	2
*Rent	3	0.2	0.2	2
Tenure	2	0.7	0.7	1

* The Monthly and Yearly Rent items were combined due to the small number of Yearly Rent cases.

Table 5. Percent of All 1989 CATI-Interviewed Cases Requiring Reconciliation by Item and Reason

Item	Total	Wrong Response		True Status Change
		1987	1989	
Heating Equipment	20	7	8	3
Home Value	18	3	2	12
Bedrooms	12	3	2	6
Basements	12	6	4	0.1
Heating Fuel	10	4	2	5
Bathrooms	9	5	2	1.5

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