Do You See What I See?: Using Visual Methods to Probe Respondent Understanding[1]

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Abstract

Estimates of household overcrowding are dependent upon respondent understanding of how rooms are defined in the American Community Survey (ACS). Measures of neighborhood quality in the American Housing Survey (AHS) are dependent upon how respondents self-define their neighborhoods. In 2007, research was conducted at the U.S. Census Bureau on the use of two new visual cognitive methods, "visual vignettes" and map-based visualization, to probe how respondents count the number of rooms in their housing units and how they define their neighborhoods.

"Visual vignettes," representing areas within houses and apartments, were created using photographic and computer assisted design (CAD) techniques and used to probe "room" counting in accordance with ACS definitions. "Visual vignette" methodology uses virtual tours as vignettes, representing scenarios respondents are asked to interpret. Vignettes provide a way to assess how intuitive concepts as they are understood by respondents diverge from concepts as they are presented in surveys. Virtual tours, commonly used in real estate advertisements, are 360 degree images that allow the viewer to see a room as if they are located inside the room. Respondents viewed a series of virtual tours and were encouraged to "think aloud" as they applied survey rules and definitions to them. Respondents expressed that the "visual vignettes" were engaging and helped them think through the ACS "rooms" definition. Respondents focused more on room function than room structure in their determination of number of rooms.

In map-based visualization, respondents are presented with maps and asked to define the boundaries of areas as they understand them. Maps were produced of areas around respondents' housing units and were used to probe understanding of "neighborhood" as it is defined in the AHS. We found that neighborhood self-definitions varied widely. Cost effectiveness and application of methods to other research are discussed.

Key Words: cognitive interviewing, pretesting, visualization, measurement error, survey methodology

1. Introduction

Among the housing quality data collected in the American Community Survey (ACS) are number of rooms and number of bedrooms in the housing unit. The number of people in the household is divided by these measures to generate indices of household crowding used by the U.S. Department of Housing and Urban Development (HUD) to determine Community Development Block Grant amounts and provide Emergency Shelter Grants to eligible jurisdictions (U.S. Census Bureau 2004). Overcrowding is defined as 1.01 or more people per room in the housing unit and severe overcrowding is defined at 1.51 or more people per room in the housing unit.

Measurement of both number of rooms and the number of people within the household is crucial to the unbiased estimation of the crowding measure, which affects both yearly estimates and trends in the measure. Cognitive research conducted by Westat (Kerwin et al. 2005) suggests that respondents are more likely to overestimate the number of rooms in their housing unit due to difficulties in counting rooms in line with Census definitions. Overestimation of the number of rooms leads to the underestimation of the extent of household crowding. In addition to overestimation of rooms, miscounting individuals within the household can bias the crowding measure upwards and downwards. Successful counting of household members requires that respondents understand Census residence rules as they are presented in the ACS. Thus, the quality of the measure depends both upon respondent interpretation of the structure of their housing unit and upon broader issues associated with household coverage.

[1] This report is released to inform interested parties of ongoing research to encourage discussion of work in progress. The views expressed on methodological, technical, or operational issues are those of the author and not necessarily those of the U.S. Census Bureau.

2. Research Questions

Cognitive research conducted by Westat for the U.S. Census Bureau identified several problems with the number of rooms measure in the ACS (Kerwin et al. 2005). They found respondents to be more likely to overcount rooms than to undercount. Some respondents counted sections of a room not separated by floor to ceiling walls as multiple rooms if the sections were used for different functions. While the American Housing Survey (AHS) counts rooms in terms of functions, the ACS does not. Other respondents counted sections of a room as multiple rooms if there were different heights to the ceiling in the two sections or different flooring types in the sections. Some respondents counted unfinished basements, laundry spaces, and utility spaces as rooms and others only listed bedrooms when asked for the number of rooms question. Some respondents in efficiency apartments did not know whether to put 1 or 0 as the number of bedrooms in their unit. They are supposed to list 0.

In this paper, I address several research questions related to the prior research on number of rooms and bedrooms, as measured in the ACS:

- Do respondents understand that rooms must be separated by built-in archways or walls that extend out from the wall at least 6 inches and go from floor to ceiling?
- What role does room function play in calculating room counts?
- Do respondents follow ACS room inclusion and exclusion rules?

3. Methodology

The study of which these analyses are a part evaluated measurement error in housing and neighborhood quality questions in the ACS and American Housing Survey (AHS) by examining the cognitive processes respondents go through in answering these questions. A hybrid questionnaire combining CAPI question wording from the 2007 AHS and proposed wording from the 2008 ACS was developed for use in the study. The goal of the study was to uncover cognitive difficulties that respondents encounter in answering the questions and provide data analysts with an interpretive framework for understanding respondent answers. A protocol was developed incorporating concurrent and retrospective probes to explore respondent understanding of the questions. To assess respondent understanding of the ACS room definition, respondents were shown visual vignettes, photographic and computer generated virtual tours of interiors of housing units. While previous studies have used vignettes to probe respondent understanding (Gerber et al. 1996), this study is the first known to the author to present vignettes in photographic and computer generated formats.

Vignettes were chosen to test borderline room definition situations that are thought to pose difficulties to respondents. Photographic virtual tours were created by taking 10-13 overlapping pictures in a circle on a tripod. Pictures overlapped, allowing stitching with ArcSoft Panoramamaker 3 software. Computer assisted interior design (CAD) software (IMSI Floorplan 3d V11) was used to produce virtual tours of interior housing unit spaces[2]. While less realistic than photographic virtual tours, the CAD virtual tour approach increases the flexibility of altering the virtual tour by allowing the user to add and remove furniture and other elements, and reduces costs by removing the need to scout locations to photograph. Respondents were instructed how to navigate the virtual tour with the mouse and answer how many rooms were in the tour (no rooms, one room, or more than one rooms), and to indicate how many rooms if they thought there was more than one room. They were instructed to think aloud during this exercise.

Cognitive interviews were conducted with 30 respondents from the Washington DC / Baltimore Metropolitan Area. Interviews were conducted with 15 low income respondents, with household incomes ranging between $0 and $30,000 a year, 12 middle income respondents, with household incomes ranging between $35,000 and $85,000 a year, and 3 upper income respondents, with household incomes above $100,000 per year[3]. Respondents were recruited from recruiting advertised placed on Craiglist and through flyers placed in supermarkets, convenience stores, and

[2] Use of these software programs in this project does not constitute an endorsement by the U.S. Census Bureau.
[3] Not all respondents could estimate the incomes of all household members. This was especially a problem in households with unrelated roommates and households in which relatives do not discuss financial matters. Income values were not imputed, but rather represent the extent of the information provided by the respondent.

coffeehouses in neighborhoods identified as housing respondents with high and low incomes. Neighborhoods were chosen using Census 2000 information on per capita income, families in poverty, individuals in poverty, household income, housing costs, and number of rooms. Respondents contacted the researcher and were screened into low, middle and high income categories. Interviews were contacted at the Census Bureau and at locations near to respondent's homes. The study was designed to include low, middle, and higher income respondents to make it possible to test both number of rooms questions in small and large housing units as well as test differences other housing quality questions.

The interview protocol contained the latest number of rooms and number of bedrooms questions used on the ACS and the housing and neighborhood quality questions used on the 2007 AHS. The instrument contained demographic questions on age, race, Hispanic origin, education, occupation, respondent and household income, as well as questions on the type of housing unit, owner/renter status, and monthly owner and renter costs of the unit.

4. Area and Respondent Characteristics

In Census 2000, 3.2% of owner occupied units in the city of Washington DC were crowded or severely overcrowded. Within rental housing in DC, 12.7% of rental occupied units were crowded or severely overcrowded. In Baltimore, 2.6% of owner occupied units were overcrowded or severely overcrowded, compared with 6.6% of rental occupied units.

Respondents were chosen to represent different areas of the metropolitan area with both housing quality problems and large housing unit sizes. For this reason, respondents were selected across income levels and in different areas. Half of respondents were female and half were male. All respondents were over the age of 18 and were recruited to be either a renter or owner in the household (with the exception of two respondents).

Respondents spanned the age spectrum. Two respondents were in their teens, eleven respondents were in their 20s, two respondents were in their 30s, five respondents were in their 40s, eight respondents were in their 50s, and two respondents were 60 or older. Twenty respondents were Black or African-American, eight respondents were white, one respondent was both black and white, and a final respondent was Asian. Sixteen respondents lived in either apartments or basement apartment, nine lived in houses, two lived in townhouses, and two lived in rowhouses. Respondents lived in housing units with between one and twelve rooms and in households with one to seven people. Most housing units were not crowded. Only one unit was moderately crowded and four units were severely crowded according to HUD standards. Respondents spanned the area with seventeen living in DC, ten living in Maryland, and three living in Virginia.

5. Number of Rooms and Bedrooms Measures in the American Community Survey (ACS)

As mentioned above, the persons per room measure is calculated as the number of people in the household divided by the number of rooms in the household. After the Westat cognitive study of the ACS housing questions and the 2006 ACS content test, a decision was made to include a question on efficiencies and studio apartments on the CAPI version on the instrument, in an attempt to address problems with overcounting of rooms and bedrooms in the efficiencies and studios. In the ACS CAPI instrument, an efficiency or studio is recorded as one room with zero bedrooms. The series of questions measuring number of rooms and bedrooms begins with the following question:

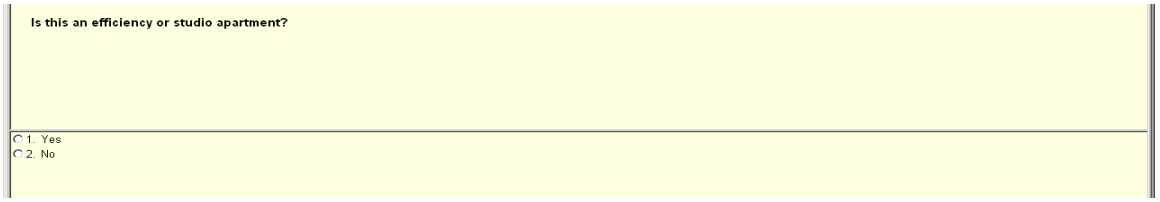

Figure 1: Efficiency Question, Screen Capture from ACS CAPI Instrument

In this study, I asked all respondents this question, but then proceeded to ask them to number of rooms question to determine how many rooms they thought were in their housing unit. Respondents who lived in neither efficiencies nor studio apartments found this question confusing, as it sounded like an "either/or" question. They answered "efficiency" or "studio" or "neither" instead of the answer categories "yes" or "no." Three respondents lived in units they defined as efficiencies or studios. While two respondents were living in one open room, the other respondent indicated that there were multiple rooms in her unit. Two of these rooms were counted erroneously, but this still leaves open the possibility that some units called efficiencies have more than one room if there are built-in archways or wall extending out six inches from floor to ceiling dividing them. Requiring all efficiencies and studios to skip the number of rooms question could lead to overestimates of crowding within these housing units.

In the ACS CAPI instrument, if a respondent answers "no" to the efficiencies or studio apartments question, they are then asked the following question:

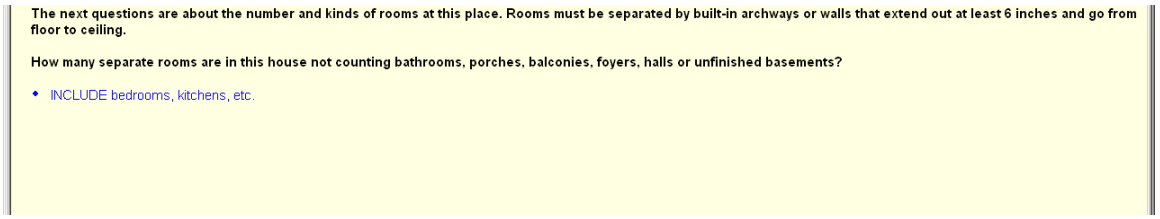

Figure 2: Rooms Question, Screen Capture from ACS CAPI instrument

This question has two important parts to it. The first part indicates how rooms are separated from each other. The second part indicates what types of spaces are excluded and included under the ACS rooms definition. The text in blue indicates something that should be read if a respondent asks whether those rooms should be included. The blue text was not read during the cognitive interviews.

6. Visual Vignettes

Six virtual tours were constructed as visual vignettes to explore respondent understanding of ACS room definitions and to test the viability of visual vignettes as an aid to cognitive interviewing. The first three vignettes were photographic virtual tours and the last three vignettes were virtual tours constructed using CAD interior designing software. The virtual tours allowed respondents to see spaces inside houses and apartments in full 360 degree view and gave them a chance to think out loud about their definitions of a room and the ACS definition.

Respondents were shown how to use the tours first, by holding the arrow in the middle of the picture, holding the left click down, and dragging the arrow to the left or the right. All but two respondents were able to navigate the virtual tours. I operated the virtual tour for these two respondents and provided additional instruction to respondents who stopped holding the left click down or clicked outside of the tour box. A few respondents indicated that they needed their reading glasses or would have to put on their reading glasses to use the tours.

For each of the tours, I asked the respondent to answer the following question:

How many rooms do you see?

No rooms
1 Rooms
More than 1 room. If more than 1 room, how many rooms do you see?

I included the "no rooms" option because I did not want to bias the respondent toward thinking there was at least one room in every virtual tour. I wanted them to know there was the possibility that what they were seeing was not a room. Respondents were asked to answer this question and think aloud while they were answering it.

The virtual tours displayed the following room situations:

VT1: Three rooms. A living room separated from a dining room by a built-in archway extending from the wall at least 6 inches, and a kitchen separated from the dining room by a hallway. The tour also showed an archway leading from the living room to a hall and several closed doors. I indicated in some interviews that respondents should not speculate about rooms behind the doors.
VT2: No rooms. An unfinished basement (on ACS's exclude list)
VT3: One room. Taken from the inside of a walk-in closet connecting a bedroom and a bathroom. Only the bedroom counts as a room.
VT4: One large room. From the front door the room opens onto a long foyer (on ACS's exclude list). At the end of the foyer is a grand room that functions as a living room and a dining room. The spaces are not separated by any built-in archways or walls.
VT5: One room. A large kitchen (on ACS's include list).
VT6: No rooms. A bathroom (on ACS's exclude list)

6.1. Results of Virtual Tours

VT1: Twenty out of thirty respondents correctly identified the space as three rooms, although some had to be told not to speculate about potential rooms behind door. Three respondents did not count the kitchen. Two respondents counted the back hallway. Five respondents had higher counts because they counted behind closed doors and one respondent thought it was not a room, because he only considers bedrooms rooms.
VT2: Almost all respondents correctly identified the space as an unfinished basement, but only nine correctly said it was not a room. Sixteen respondents said it was one room. One thought a basement could be considered a bedroom. Four respondents counted more than one room, referring to framing and columns blocking off a utility area and other areas.
VT3: Only nine respondents correctly identified the bedroom as the only room. One counted the closet as the only room. Three counted the bedroom and the closet as two rooms. Seven counted the bedroom and the bathroom as two rooms. Six counted all three spaces as rooms. The other four listed more than one room, but didn't indicate what the rooms are.
VT4: Eleven respondents correctly identified the unseparated living room / dining room area as one large room. Almost an equal number of respondents (10) identified the space as containing a separate dining and living room. Four respondents classified the room as three rooms, including the foyer. Three respondents classified the space as a large room and a foyer. Two considered extra rooms behind doors.
VT5: An overwhelming twenty eight respondents correctly identified the tour as one room, a kitchen. The other two respondents did not consider kitchens rooms.
VT6: Only five respondents correctly identified the bathroom as not a room. One respondent noted that it might be because the word bathroom has "room" in it. Twenty three respondents classified the bathroom as a room. Two respondents who had either worked in jail or been to jail classified the space as a room because it was large enough to be a cell.

6.2. Reactions to Visual Vignettes

Only two respondents needed assistance in running the virtual tours. One respondent was afraid of breaking the computer and erasing the data. Adjectives respondents used to describe the tours included cool, fun, interesting, different, interactive, artistic, creative, self-explanatory, good, great, well done, and easy to navigate. A couple respondents had some problems with VT4 because the 360 view distorted the room at the edge. They preferred the photographic format. Respondents expressed that the tours helped with their thought process and helped them think through what a room is and what we considered a room. The technology seemed to work well overall, but may pose challenging for use with elderly populations and those with limited computer experience.

Photographic vignettes are more realistic than the CAD vignettes and circular photographic virtual tours are inexpensive to produce. They do, however, require location scouting. Spherical tours are the most realistic of the photographic virtual tours, but software to create them has a steep learning curve and is expensive. CAD vignettes offer increased flexibility of removing and adding furniture and features, are inexpensive, and do not require location scouting. They, however, look less realistic than photographic vignettes.

Substantively, the technique showed how respondents encountered problems in defining rooms based upon ACS separateness criteria and exclusion and inclusion lists. The tours showed the extent to which respondents were looking for extending walls and built-in archways and the types of areas respondents consider rooms, but that the ACS does not classify as rooms. These include walk-in closets, bathrooms, unfinished basements, and utility rooms. In virtual tour 4, almost as many respondents used function to differentiate rooms as used the "6 inch" rule. Most respondents thought kitchens were rooms, in line with the ACS definition. Suggestions for changing question wording should focus on either emphasizing the separateness rule and include/exclude lists or on changing room definitions to more closely align with respondent definitions of rooms. Include/exclude lists could be presented as a flashcard in the CAPI version of the instrument or in the advance letter in the CATI version. A picture of a dividing archway or wall could be presented on the question, flash card, or advance letter, depending upon survey mode. The American Housing Survey (AHS) collects information of specific room types. Focusing on room function in the ACS, allowing respondents to answer yes/no questions about the presence of different types of rooms in their homes, may help standardize interpretation across respondents in a way that separateness rule does not.

7. Conclusions

In this paper, I examined housing quality measures from the American Community Survey (ACS). Attention was focused on the overcrowding measure, calculated as a function of people per room. I analyzed respondent understanding of the ACS room definition. In developing visual vignette methodology, I was able to further explore respondent definition of rooms and their divergence from ACS definitions.

Overall, the visual vignette methodology was a success. Respondents indicated that navigating the tours was fun and that they helped them visualize and think through what rooms are. All but two respondents were able to use the virtual tours on their own. The two respondents who required assistance had minimal computer experience with one expressing a fear that she would break the computer and erase material on it. For these two respondents, I operated the virtual tour for the respondent while they thought aloud about how many rooms they saw. Respondents who operated the tours on their own experienced minimal problems, including not holding the left click on the mouse down and clicking outside of the tour window. For the most part, respondents limited their observation to visible rooms, but some tried to speculate on the existence of rooms behind closed door. This required additional instruction to focus only on the rooms visible that were not behind doors. This problem could be addressed in future tours by either removing doors from the tours or by linking tours, allowing respondents to look behind doors.

Through both probing and the tours, I found few respondents to pay close attention to the "6 inch separation" rule provided in the room definition. Respondents indicated that they heard the instruction, but many did not pay attention to it in counting the rooms in their house or apartment. Instead they focused on what they thought a room was. Virtual tour 4 tested the distinction between room function and the separation rule. The tour includes a long front foyer connected to a grand room that is split into a living room area and a dining room area. Since there are no built-in archways or walls dividing the areas the area is classified as one room. Many respondents classified the tour as two rooms, identifying a dining room and a living room, and ignoring the "6 inch separation" rule. In this case, ignoring the rule increases the number of rooms in the house or apartment and would lead to underestimating the overcrowding index.

Another visual method used in this study was map-based visualization. Several questions on neighborhood quality on the AHS refer to the respondent's self defined neighborhood. In this study, respondents were asked how they defined their neighborhood, whether their neighborhood had a name, and to draw their neighborhood on a map. Neighborhood diameters ranged widely from a half mile to 2.3 miles. The average neighborhood was 1 miles in diameter (stnd dev. .54 miles).

Future applications of visual methodologies can incorporate "hot spots" into virtual tours to allow respondents to explore areas behind closed doors. Spherical tours could be incorporated with virtual reality technology, making respondents feel they are actually within the housing unit or whatever surroundings are being examined. Maps can be incorporated not only into the cognitive analysis of survey questions, but also into the instruments themselves to define the specific areas the questions address.

It is my hope that these methods and findings will contribute to discussions of measurement error in housing and neighborhood questions in the ACS and AHS.

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