Web-based Vacant Housing Identification: Original ideas and proof of concept

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Background

- The Center for Applied Technology (CAT) received an idea from a Census Bureau employee about reducing NRFU costs by crowdsourcing the location of vacant housing units.
- Partnered with staff from Decennial and from Research and Methodology areas at the Census Bureau to develop and submit a plan to test this idea.

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CAT Activities

- Met with leaders across the Bureau to determine feasibility and interest
- Developed a web based proof of concept
  - Leveraged Google Street View, Apple Maps and more

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CAT Proof of Concept

- Proof of Concept inputs & outputs
  - User provides home address
  - User submits list of nearby vacant homes
- Open questions for Proof of Concept
  - How can we help users orient themselves on a map to locate nearby vacancies?
  - How should we handle apartment buildings?
  - Is there any additional information we can provide to help users identify nearby vacancies?

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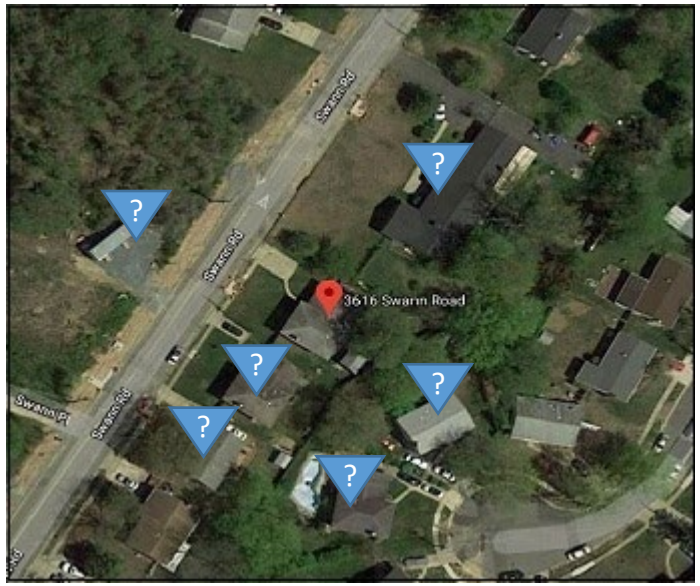
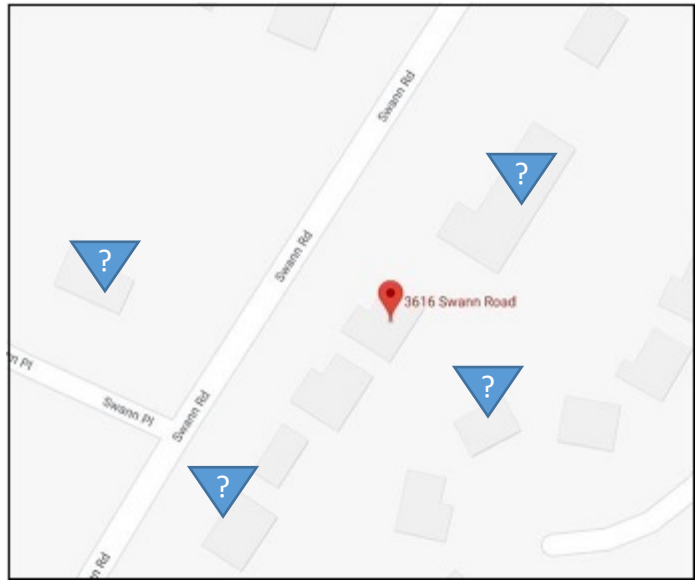
CAT Proof of Concept

- Original Design Concept
  - Present users a map centered on their home address
  - Nearby homes are identified with a “pin”
  - Users select homes that are vacant
- Design Questions
  - How many nearby neighbors should we present users?
  - Should we present users with a satellite map (top) or a road map (bottom)?





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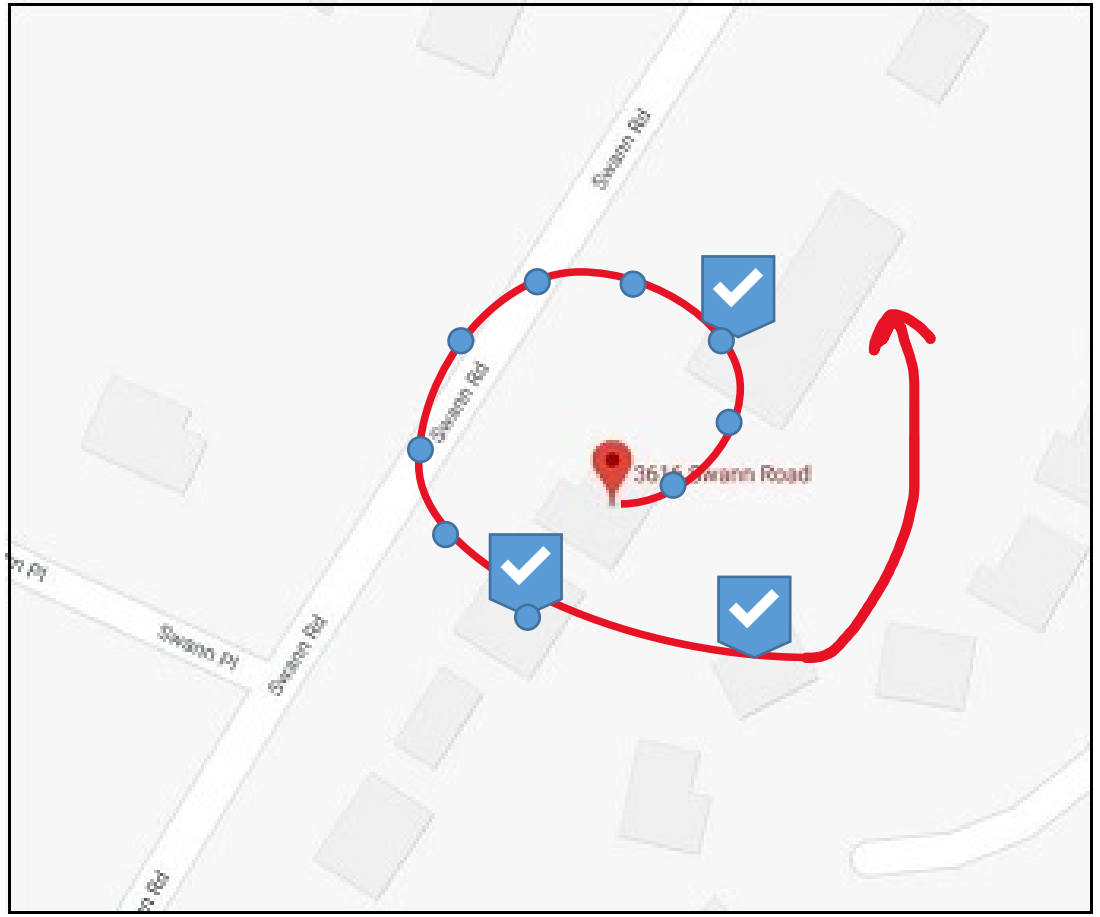
Concept development: Finding nearby neighbors

- Map was built using Apple Maps webkit
- Used a “spiraling” algorithm (similar to Search And Rescue techniques) to find nearby homes
- Our program spirals outward from the home address and periodically asks:
  - Is this point a new address?
    - If yes, address is added to our list
    - If no, move to the next point along our spiral
  - Have we found our desired number of addresses?
    - If yes, stop and drop a pin on each address found
    - If no, keep searching
- Experimented with spiral size
  - Small enough to find nearest houses in dense urban areas
  - Not optimized for rural settings



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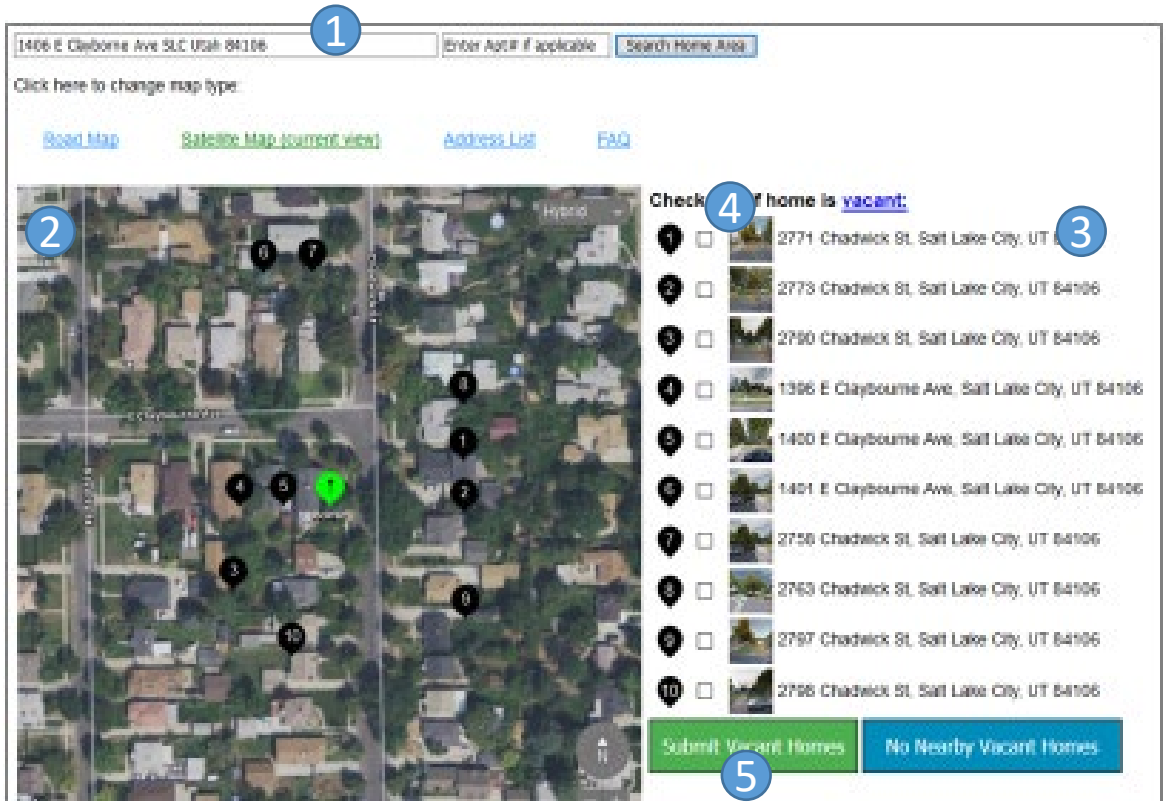
Proof of Concept Interface

1. Users enter their home address in the top text field
   - User's home address would likely be predetermined in a production solution
2. A map with the user's home and nearby neighbors is displayed on the left half of the page
3. The full address of the nearby neighbors is displayed on the right half, with numbered pins corresponding to the map
4. A thumbnail image of the Google street view of that address is next to each pin
   - Clicking on thumbnail will enlarge image
5. To designate a home as vacant, users check the corresponding box and hit "submit" on the bottom of the page



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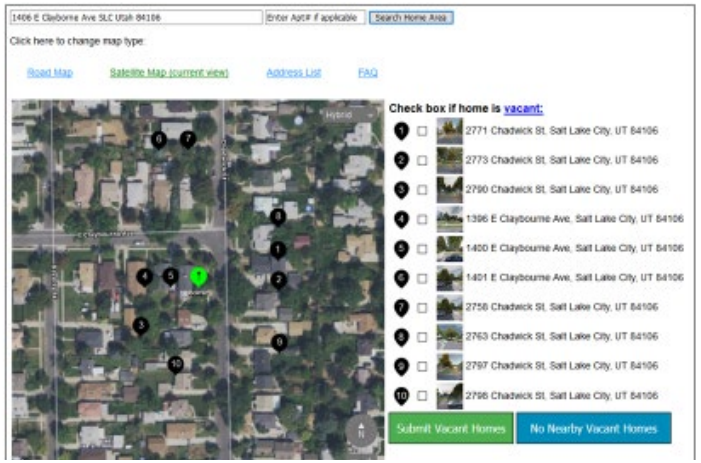
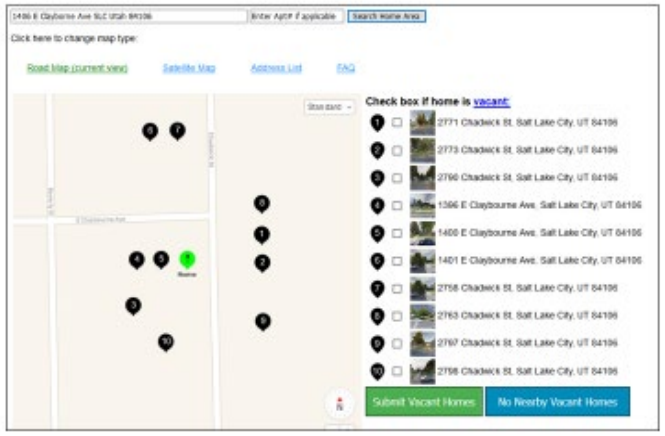
Alternate Variations

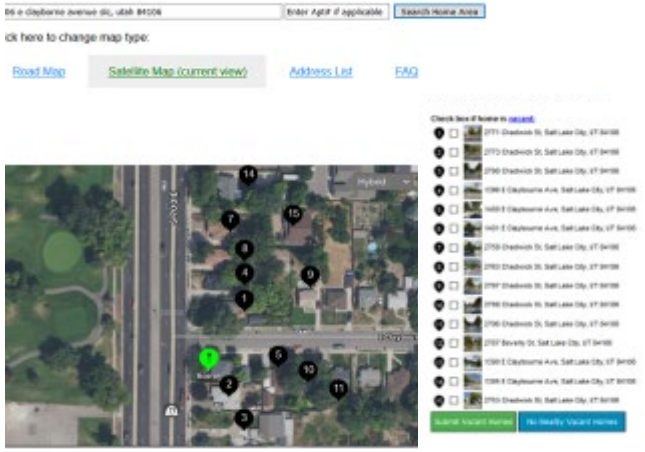
Satellite View – 10 homes



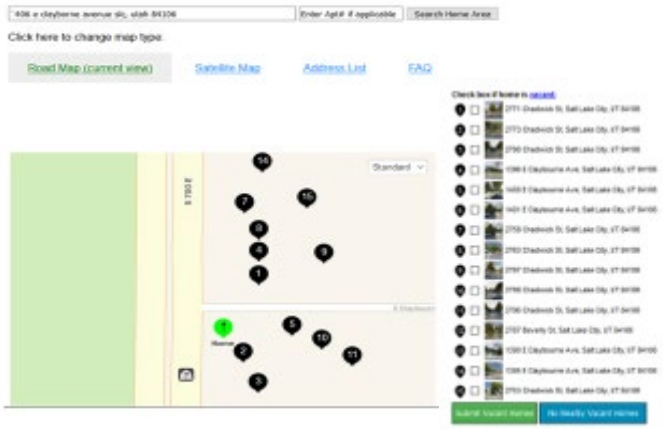
Road View – 10 homes



Satellite View – 15 homes



Road View – 15 homes



*not respondent data

Future Considerations

- Finding nearby neighbors
  - Our spiraling method was effective for our proof of concept, but not optimized for widespread use
  - Could production solution be built using tiger maps or Census address data?
- Title 13 Concerns
  - Sharing Census data with respondents run into Title 13 issues
  - Must be responsible with external API calls (e.g. to Google or Apple)
    - “Salting” data is a common approach

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Usability of a crowdsourcing survey instrument for identifying vacant homes

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Nonresponse Followup is expensive

- Identifying vacant housing in major household surveys is a crucial field operation for reducing nonresponse
- This operation is currently being carried out by sending interviewers to the field to identify vacant units
- But this is costly
  - The 2010 Nonresponse Followup (NRFU) operation was the most expensive operation in the 2010 Census
- How can we reduce NRFU costs?

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Crowdsourcing

- One proposal to reduce fieldwork costs is through the use of *crowdsourcing*
- Information contributed by the general public via the internet
  - "The practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers" (Merriam-Webster)
- Ask the public to help report vacant units in their neighborhood
  - Identify vacant housing units sooner in the census and survey lifecycle
  - Save costs with fewer field workers needed

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That’s not so easy

- In order to do this, a person must
  - be able to find themselves and their neighbors on a display of some kind (e.g. map or address list)
  - be able to accurately identify units around them that are vacant
  - and be willing and able to report that information

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How?

- How should we ask respondents to report vacancy information about their neighbors?
- One potential method: Ask the public to report vacant units in their neighborhood using an interactive online map

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User map preferences (Holzberg et al, 2019)

- How familiar are you with this type of map?
- How accurately do you think you could locate your home and your neighbors' homes on this type of map?

Satellite

Road

- Ps familiar with both the satellite and road style maps
- Ps believe they can use them accurately for this type of task

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Usability study

- Purpose: to test prototypes of map-based crowdsourcing survey instrument for identifying vacant homes

Research Questions

- Which type of address display (satellite map or road map) and with how many residential units (10 or 15) allow participants to most accurately identify vacant housing units?
- Which display type do participants *prefer* (satellite map, road map, address list only) and how many units do they prefer be displayed (5, 10, 15)?

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Methods

- Location: all sessions conducted in the usability lab at U.S. Census Bureau Headquarters
- Participants (*n* = 23)
  - Gender: 14 females, 9 males
  - Age: *M* = 44.6 (*SD* = 13.7) years
  - Race: 39% White; 35% Black; 9% Asian; 17% Two or more races
- Survey instrument (address display)
  - *Map Type*
    - Satellite
    - Road
  - *Number of Units*
    - 10
    - 15

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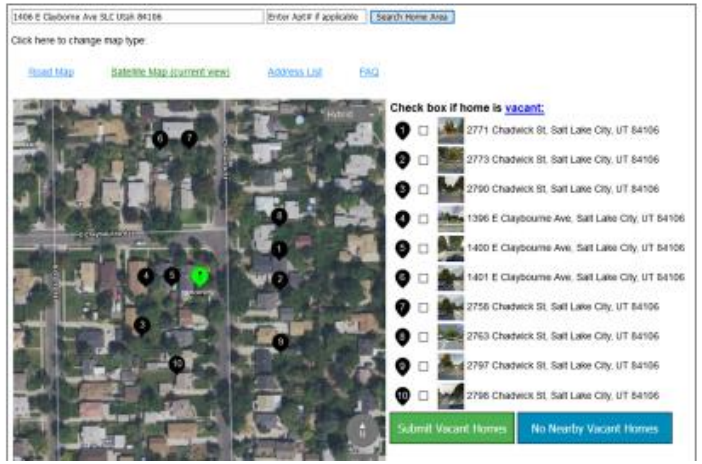
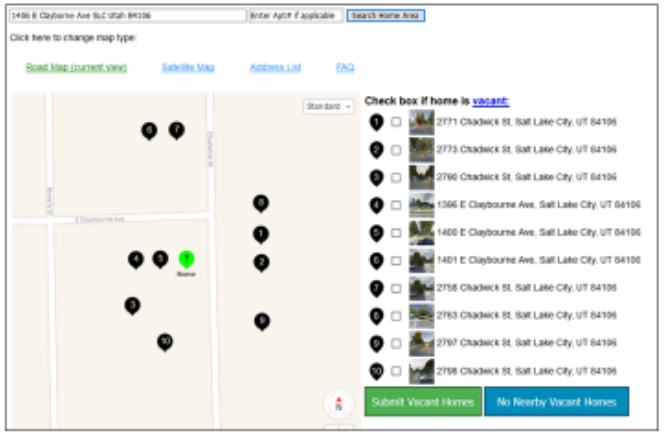
Displays

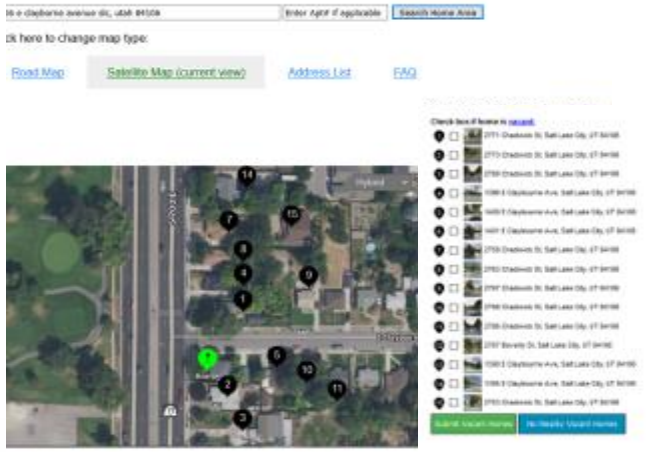
Satellite View - 10



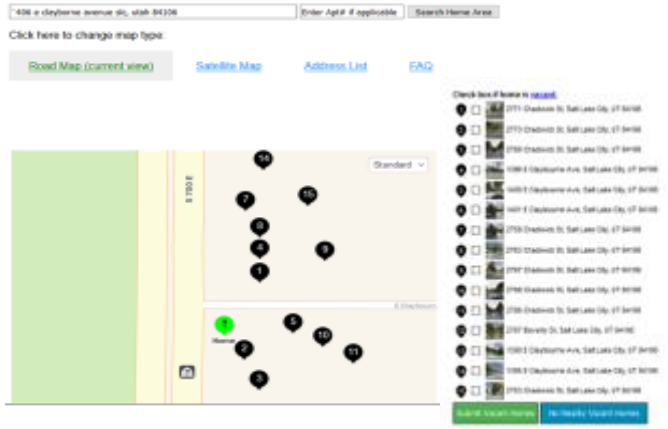
Road View - 10



Satellite View - 15



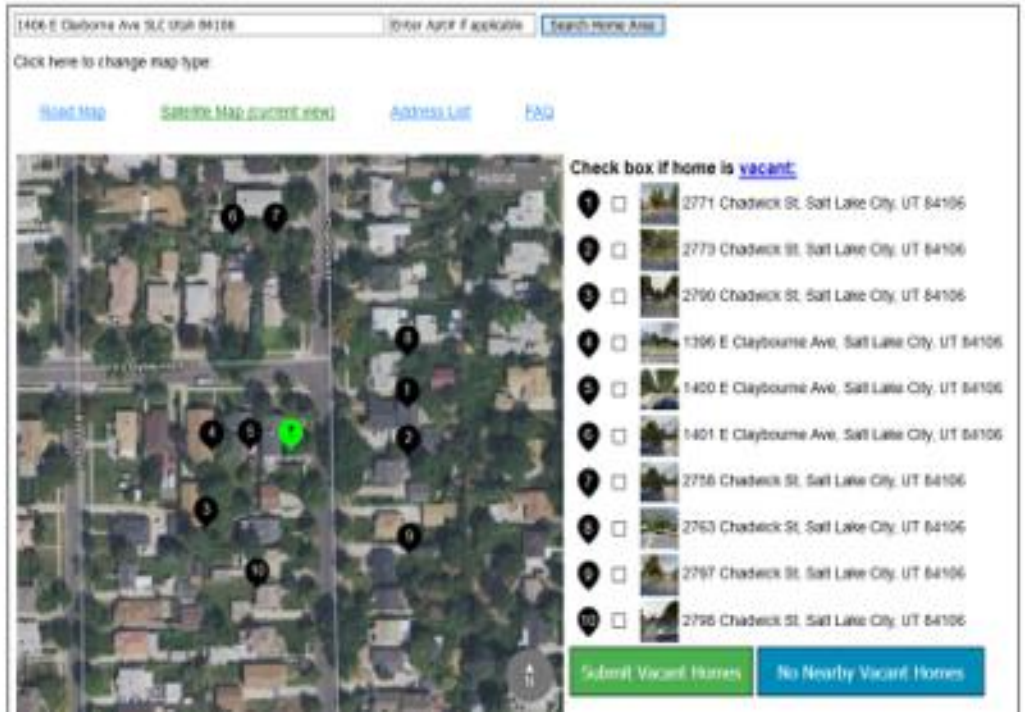
Road View - 15



*not respondent data

Instrument features

Example Display



Features

- Pins to mark P's and neighbors' homes
- Corresponding address list next to map
  - Thumbnails
- Toggle links (to change map type)
- FAQ
- "Check box if home is vacant" instruction
  - Hyperlink opens Census Bureau definition of vacant as pop-up
- Buttons at bottom to submit response:
  - Submit Vacant Homes
  - No Nearby Vacant Homes

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Procedure

- Ps were randomly assigned to one of 4 conditions and seated in front of laptop computer
  - Eye-tracking calibration for some Ps
- R completed background questionnaire (demographic questions)
- Test administrator (TA) opened survey app on the computer
- TA instructed P to read the instructions on the computer screen
  - We are gathering information about vacant homes near where you live.
  - You will be provided a list of addresses in your community. You will be asked to identify vacant homes from that list based only on what you currently know about your neighborhood.
  - Completing this study does not involve walking around your neighborhood, researching public databases, or talking to your neighbors.

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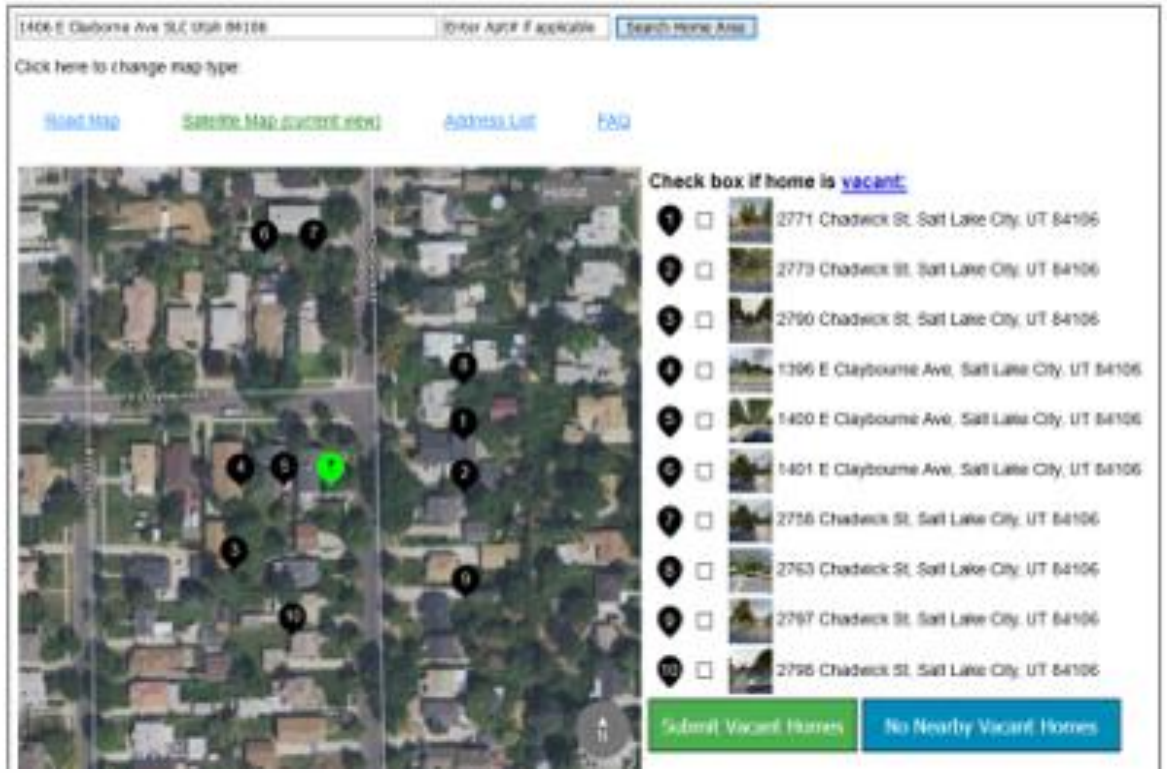
Procedure: Tasks

Ps completed tasks while *thinking aloud*

Example display



Tasks

- Task 1: Identify and select the vacant homes.
- Task 2: Identify and select the house/apartment unit that is two units away from yours. Now imagine that house is vacant. What would you do?
- Task 3: Identify the homes with three or more people living there. Now imagine those same homes are vacant. What would you do?
- Task 4 (if applicable): Imagine that there are no vacancies in your neighborhood. What would you do?

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Procedure

- After each task, Ps answered two questions on paper: certainty-in-accuracy and satisfaction
  - On a scale of 1-5, where 1 is very certain and 5 is not at all certain, how certain are you that you accurately [selected all vacant homes]?
  - On a scale of 1-5, where 1 is very easy and 5 is very difficult, how would you rate this task?
- Once they had finished the tasks, the TA asked a series of debriefing questions
- TA presented images of each map type and unit-number display
- Ps were asked which map type and how many units they would prefer for finding their home and their neighbors' homes

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Outcome measures

Qualitative

- ***Cognitive-behavioral feedback*:** Behavioral observations, spontaneous verbalizations during live session, and verbal commentaries during debriefing

Quantitative

- ***Effectiveness:*** Success or failure of selecting a housing unit specified in each task and number of attempts to select unit(s) of interest
- ***Satisfaction:*** Ps ratings of task difficulty on a five-point scale (1 = very easy, 5 = very difficult)
- ***Certainty-in-accuracy*:** Ps rating of confidence in their task-based accuracy on a five-point scale (1 = very certain, 5 = very uncertain)
- ***Preference:*** Ps overall preference among each of the map prototypes (satellite, vector, list only) and number of units displayed (5, 10, 15)
- ***Eye-tracking data:*** Heat maps and other metrics (e.g., fixation counts, duration)

Analytic approach (and limitations)

Qualitative:

- Reviewed behavioral observations and verbalizations to identify task performance problems and reviewed additional spontaneous and probed feedback on map designs

Quantitative:

- ***Effectiveness:*** No validating information to determine task success with a purely quantitative approach
  - Used Certainty-in-Accuracy (CIA) as proxy
  - Reviewed Ps comments and requirements of the task
- ***Satisfaction and CIA*:** ANOVA to determine whether display type affected self-reported task difficulty and confidence in response accuracy
- ***Preference:*** Frequencies of map and unit number preference
- ***Eye-tracking:*** Heat maps and fixation data generated for the map page
  - Limitations due to the nature of the application and the length of the interview (captured for 5 Ps via a screen recording)

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Results: Effectiveness

- Most Ps did not take more than one attempt to select the housing unit(s) of interest
  - Task failure: One R selected the house next door when asked to select the home two away from their own
- Most Ps who used the *road map* expressed more difficulty during the think-aloud
  - E.g., “I know my block visually but if I can’t fully see it then this could be anyone's home. I can give a clear example across the street. It's vacant and has been for 2 years. But I don’t know the number so this map would be confusing”
  - E.g., “I can’t tell which home is which home from this map”

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Satisfaction and Certainty-in-accuracy (CIA)

Ps rated the tasks as easy and were certain in their accuracy (lower scores reflect greater satisfaction and certainty)

Task	N	M (SD)
1 Satisfaction	23	2.09 (1.31)
1 CIA	23	2.43 (1.50)
2 Satisfaction	23	2.22 (1.20)
2 CIA	23	1.74 (1.10)
3 Satisfaction	23	2.30 (1.30)
3 CIA	23	2.09 (1.34)
4 Satisfaction	12	1.33 (0.65)
4 CIA	12	1.58 (1.17)

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Satisfaction and CIA

- No difference in satisfaction ratings or certainty-in-accuracy ratings for any of the tasks based on condition, $p > .05$
- Collapsed across number of units and across map type
- Effect of map type (identifying vacant units)
  - Ps in the satellite conditions
    - rated the task as easier ($M = 1.55$) compared to Ps in the road conditions ($M = 2.58$)
    - were more certain on their task-based accuracy ($M = 1.73$) than road map Ps ($M = 3.08$)
- Effect of unit number (select home two away from theirs)
  - Ps who saw 10 units
    - were more certain that they accurately selected the unit two away from theirs ($M = 1.27$) compared to Ps who saw 15 units ($M = 2.17$)

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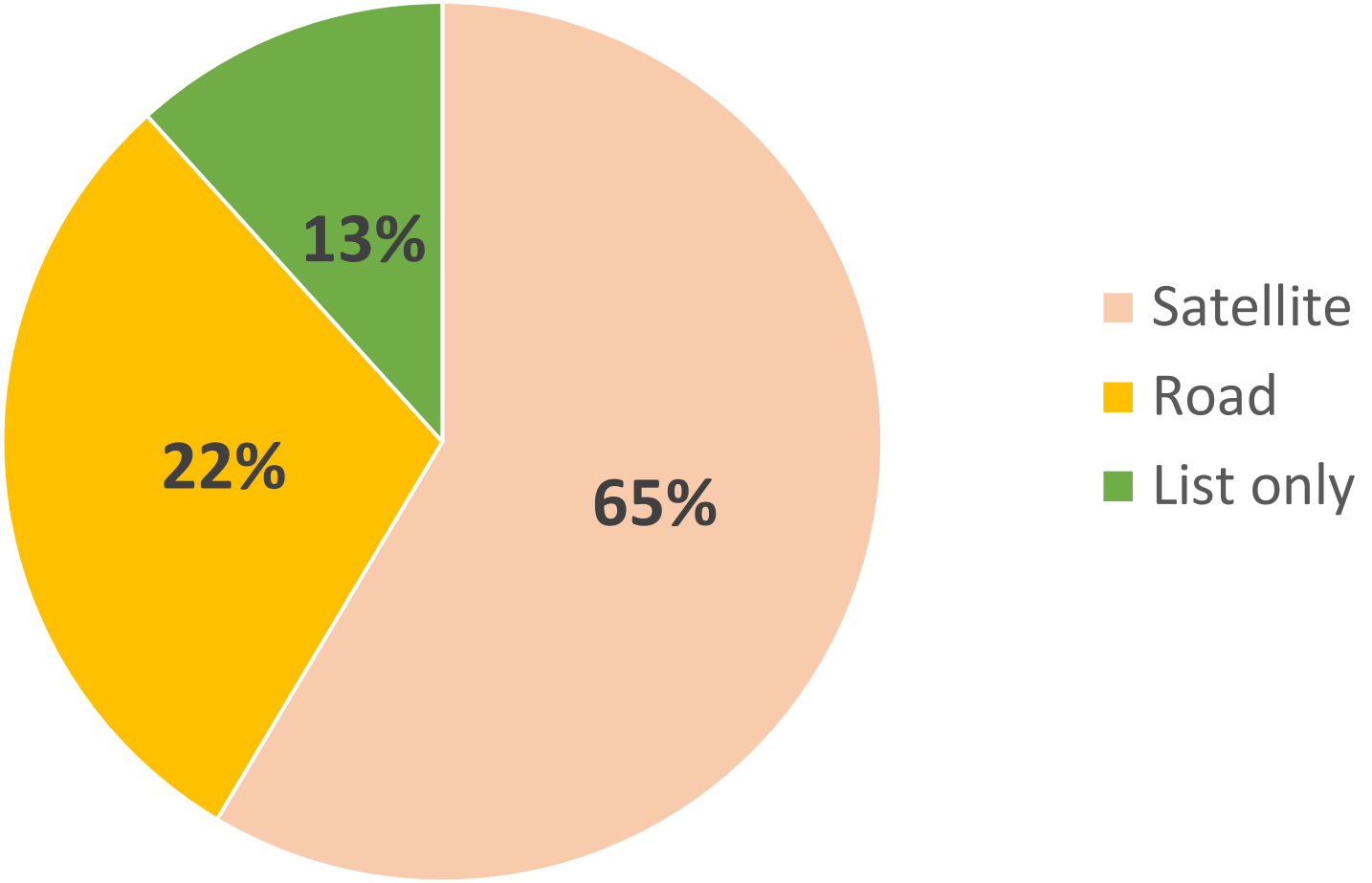
Preference: Map type



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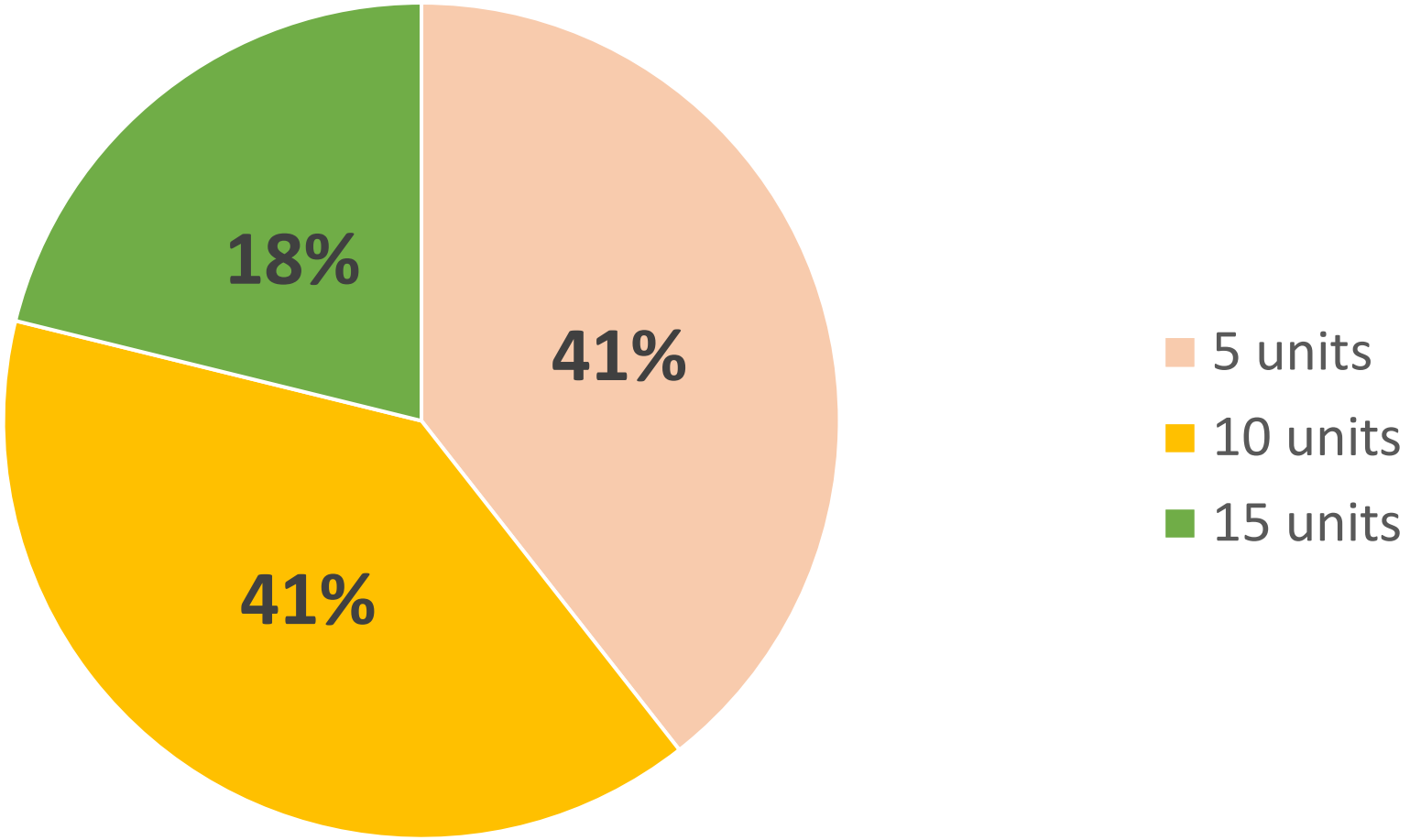
Preference: Number of units displayed



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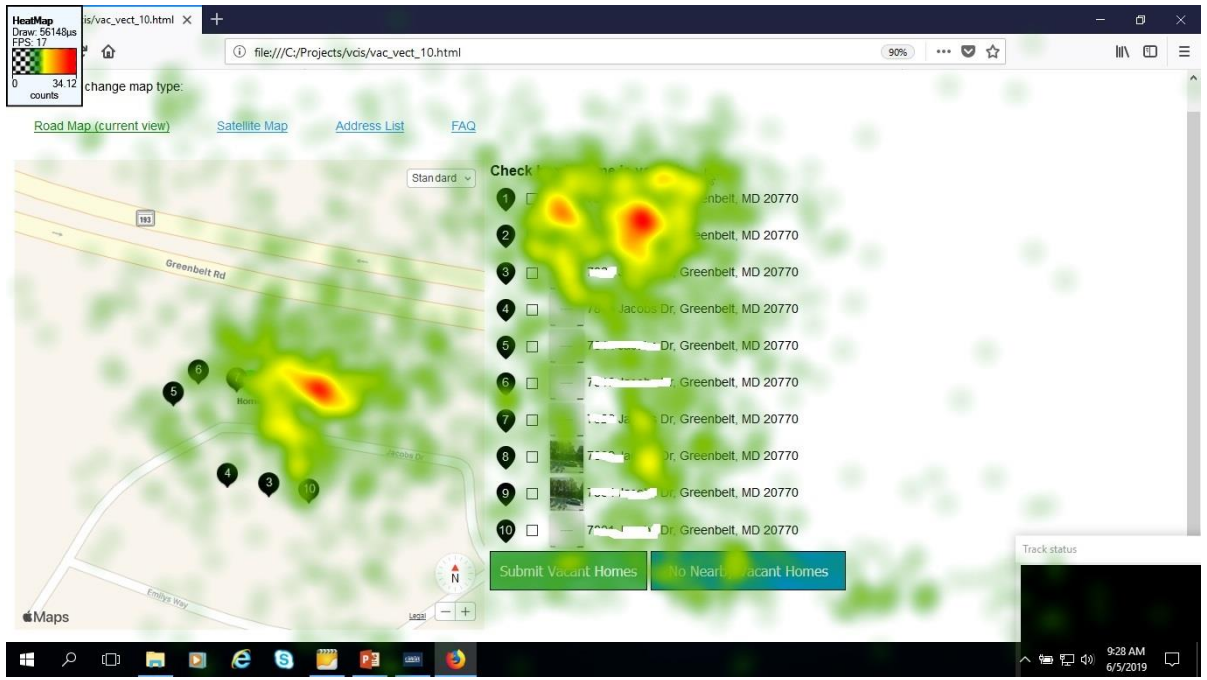
Eye-tracking (n = 5)

Quantitative

- Ps attending to list and map
- List
  - Higher fixation count
  - Longer duration
  - Shorter time to first fixation

Qualitative

- E.g. “The map allowed me to spatially orient myself. And the list was…where I needed to look to figure out the house number that corresponds to each bubble”
- E.g. “I used the list but oriented myself with the area using the map”
- Debriefing Qs
  - Most Ps prefer to have both to complete tasks
  - Most Ps who saw *road map* said they used the list more to complete tasks



Toggle links

- Located at top of page
- Only one participant spontaneously toggled to a different map view

Debriefing Qs

- Most Ps did not notice the toggle links (corroborated by heat map)
- Ps were aware of toggle link functionality
- Ps suggested that the links be placed inside the map, with images, as seen in Google maps

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Vacancy hyperlink and definition

- The word vacant was presented as a hyperlink in the instructions, “check box if home is vacant”
  - When clicked, a pop-up with a definition appeared
- Few Ps commented on link and clicked during tasks

Debriefing Qs

- Some Ps did not notice hyperlink
- Some noticed but were not aware it could be clicked
- Most Ps preferred to have definition displayed on screen if not too cluttered

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Summary: Mixed Methods

- Ps overwhelmingly preferred the satellite map to the road map
- Ps who used the satellite map reported less difficulty identifying vacant units in their neighborhood and were more confident in their accuracy
- Ps preferred the maps to display 10 units rather than 15
- Ps who saw 10 also reported greater confidence in their task-based accuracy
- Gaze patterns corroborate Ps' comments about using both the map and the address list next to the map in order to identify housing units of interest

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Instrument to identify vacant homes: Recommendations

- **Use the satellite map as the default map shown**
  - Ps generally prefer satellite over road or list only
  - Ps who used satellite map reported having an easier time identifying vacant units in their neighborhood and were more confident in their accuracy
- **Do not display 15 or more housing units**
  - Ps prefer 10
  - Ps who saw 10 were more confident in their accuracy for one of the tasks
- **Include an address list alongside the map**
  - Ps use the list next to the map according to the eye-tracking heat map
  - Ps commented that they used both to complete the tasks

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Additional recommendations

- Toggle links to other map types should be located inside the map, with icons (e.g., Google maps)
- Thumbnails in the list should be larger or have enlargement capabilities
- Enable zoom capabilities if possible and allow for more interaction between the list and the map (e.g., Zillow)
  - some Ps tried to click on the pins

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Limitations

Application issues (it's a prototype)

- Sometimes a home right next to the R's would not show up on the map, but homes several streets away would
- Thumbnails were also missing for new housing developments
- Likely not exactly what a final product would look like if fielded
  - Road map was bare, with no other outlines or markers (e.g. buildings or landmarks)
  - Only tested displays with 10 and 15 housing units
- Apartment dwellers were not able to select units in same building

Eye-tracking (only 5 Ps)

- Could only examine gaze on the map area of the screen without separating by map type
- Ps needed to look at the address list in order to complete the tasks
  - gaze patterns may not be robust indicator of preference or general utility

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Conclusions

- Crowdsourcing may be a viable way to acquire information about vacancies in people's neighborhoods
  - reduces follow-up fieldwork
  - saves costs
  - saves time
- Using a map-based survey instrument has a lot of potential
  - A satellite map with a 10-unit display
  - An adjacent address list

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Thank you!

Contact: shelley.b.feuer@census.gov

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Developing messaging about identifying vacant homes for a crowdsourcing instrument

Jonathan Katz

Center for Behavioral Science Methods

U.S. Census Bureau

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Issue and Solution

- Issue: Create letters and postcards that encourages participation in this crowdsourcing study
- Question: What messages in the mailing materials will motivate the public to go to the website and identify neighboring vacant addresses?
- Solution: The presentation shares what we learned through cognitive testing different messages in mailing materials

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Proposed mailing pieces

Developed four mailings the sampled household would receive to ask them to participate in the study

- Two letters and two postcards

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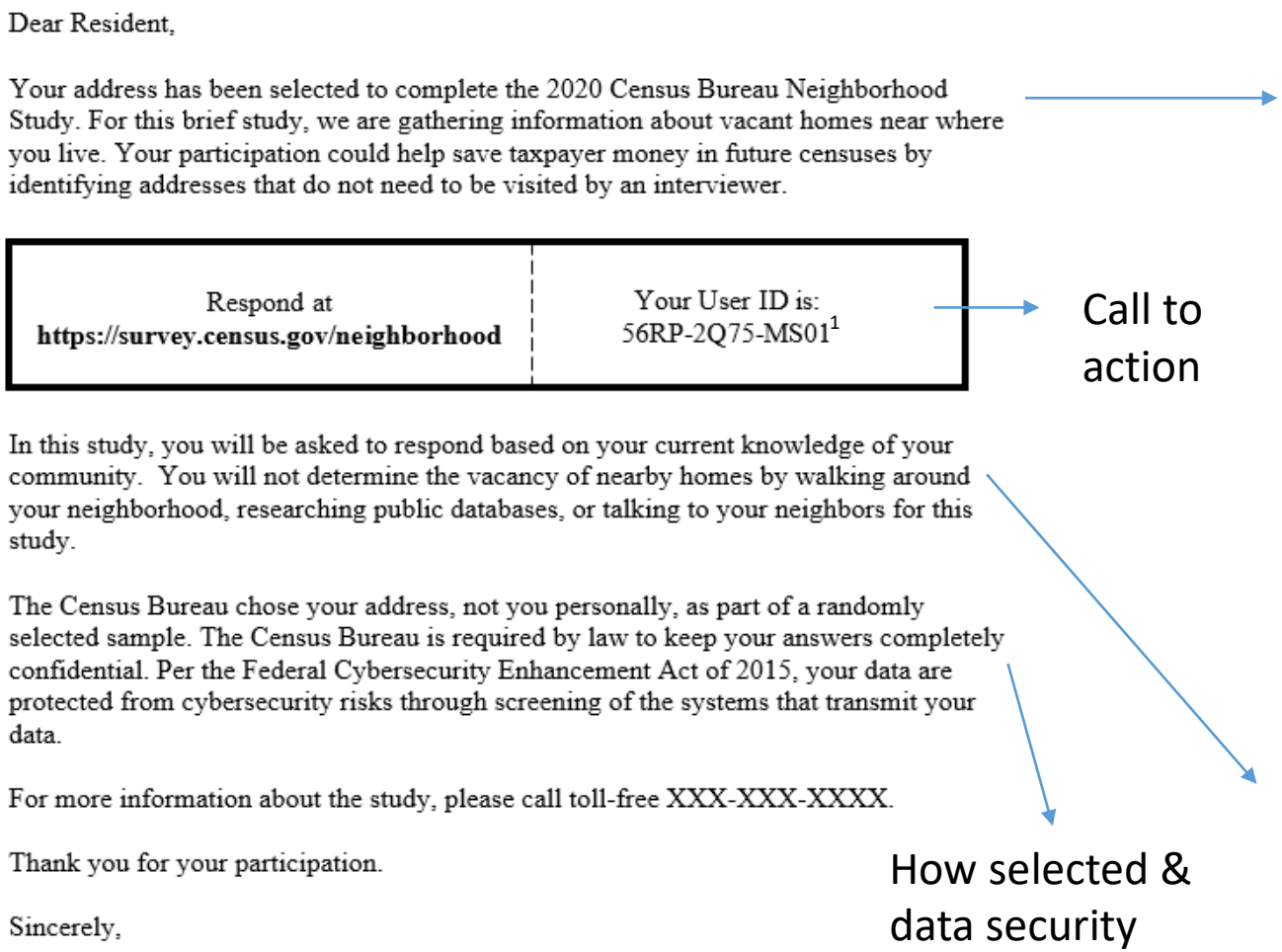
First Mailing (Letter)



Dear Resident,

Your address has been selected to complete the 2020 Census Bureau Neighborhood Study. For this brief study, we are gathering information about vacant homes near where you live. Your participation could help save taxpayer money in future censuses by identifying addresses that do not need to be visited by an interviewer.

Respond at	Your User ID is:
https://survey.census.gov/neighborhood	56RP-2Q75-MS01[1]

In this study, you will be asked to respond based on your current knowledge of your community. You will not determine the vacancy of nearby homes by walking around your neighborhood, researching public databases, or talking to your neighbors for this study.

The Census Bureau chose your address, not you personally, as part of a randomly selected sample. The Census Bureau is required by law to keep your answers completely confidential. Per the Federal Cybersecurity Enhancement Act of 2015, your data are protected from cybersecurity risks through screening of the systems that transmit your data.

For more information about the study, please call toll-free XXX-XXX-XXXX.

Thank you for your participation.

Sincerely,

Call to action

How selected & data security

Topic: Gathering information about vacant homes near where you live
Motivator: Participation could help save taxpayer money by identifying addresses that do not need to be visited

Preparation: Respond based on your current knowledge of your community
Disclaimer: Do not determine the vacancy of nearby homes by walking around your neighborhood, researching public databases, or talking to your neighbors

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1 This is a fictional User ID and was only displayed for the purposes of testing.

Second Mailing (Postcard)

Dear Resident:

Recently, you should have received a request to participate in the 2020 Census Bureau Neighborhood Study. By answering a few simple questions about the vacant homes near where you live, future censuses could be less costly for taxpayers.

If you have already responded, we thank you. If you have not responded, please do so now:

Respond at:
https://survey.census.gov/neighborhood

As a reminder, for this study you should use only your current knowledge of nearby homes. You should not walk around your neighborhood, research public databases, or talk to your neighbors to get information for your responses.

The U.S. Census Bureau is required by law to protect your information. Your answers will remain completely confidential.

For more information about the study, please call toll-free XXX-XXX-XXXX.

Topic: Answering a few questions the vacant homes
Motivator: Save taxpayer money

Preparation: Respond based on your current knowledge of nearby homes
Disclaimer: Do not walk around your neighborhood, research public databases, or talk to your neighbors

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Research Questions

- Did participants understand the topic, call-to-action, and the task?
  - How did participants understand the different phrases and sentences about identifying vacant homes on the letters/postcards? Did this help with understanding that the study would be about vacant homes?
- Are they motivated to complete the task?
  - What messages increased or decreased their motivation
  - Did participants express any reservations about identifying vacant addresses in their neighborhood?

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Methods

- Cognitive testing of the mailing materials was conducted prior to the usability task
- Protocol
  - Participants shown four mailing materials one at a time
  - Combination of think-aloud and retrospective probing
  - Retrospective probing included questions about the meaning of specific terminology and sentences
  - Debriefing questions after all four mailing materials shown

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Participant Characteristics

- Participants were from the Washington, D.C. metro area
- Gender: 9 female, 4 male
- Age: Ranged from 23 years old to 58 years old
  - 5 were under 40
  - 8 were 40 and above
- Race: 3 White, 6 Black, 4 Other
- Education: 4 less than Bachelor's degree, 9 Bachelor's degree or more

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Results – Understand the topic

- Participants generally understood the term “vacant” to mean no one is living in the home
- Participants also seemed to interpret that the phrase “near where you live” was a few blocks radius around the home
- Both these seemed to help participants understand that this study was either about vacant homes or their neighborhood/community

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Results – Understand the call to action

Reaction to call-out box with URL

- Call to action was clear to most of the participants
- Participants easily found the call-out box with the URL
- Determined that URL was too long
  - Modified the word “neighborhood” to “area” in the extension for later testing

Call-out with URL from the letter:

Respond at **https://survey.census.gov/neighborhood**	Your User ID is: 56RP-2Q75-MS01[1]

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1 This is a fictional User ID and was only displayed for the purposes of testing.

Results – Understand the task

- Only a couple of participants were able to correctly describe that the study would ask them to identify specific addresses that were vacant
- Varied descriptions of what they would see and be asked to do
  - For example,
    - Awareness of addresses being vacant
    - How many addresses were vacant in the neighborhood
    - How long specific addresses have been vacant
    - The number of “for sale” signs
    - Any “for rent” signs
    - Any “boarded up” homes

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Results – Understand the task

Sentence to not walk around, research public databases, or ask neighbors on information about vacant homes

- Was in all four mailings
- This sentence was very problematic throughout testing
  - A couple participants overlooked this message in the mailing materials and said they would walk around the neighborhood to identify vacant units
  - A few participants wondered how were they supposed to identify vacant units in the neighborhood if they were told not to take any extra steps
- Recommended removing this sentence from all letters and postcards since participants were not familiar with the task they would have to complete

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Results - Motivation to participate

Did participants express any reservations about identifying any vacant addresses in the neighborhood?

- The majority of participants did not express any negative reactions about identifying any vacant addresses in the neighborhood
- The idea of completing a study about vacant homes in their neighborhood did not seem like a turn-off
- Based on what participants understood, most of them seemed willing to participate in this kind of study

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Results - Motivation to participate

Motivating sentence that participation in the study could save taxpayer money

- The saving taxpayer money sentence was used in all four mailings.
- Mixed reaction to saving taxpayer money as a motivator.
  - Some participants seemed to understand that if they completed the study, interviewers would not have to visit these unoccupied homes
  - However, a couple participants found this sentence confusing or did not find this motivating at all
- This underscores the importance of testing different motivational messages in different mailings

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Results - Motivation to participate

Reaction to selection & data security messages

- Many participants did not express issues with this paragraph
- A couple participants did mention concerns if the data would actually be protected
- Standard language might or might not motivate response
  - Difficult to determine in cognitive testing

Letter text:

The Census Bureau chose your address, not you personally, as part of a randomly selected sample. The Census Bureau is required by law to keep your answers completely confidential. Per the Federal Cybersecurity Enhancement Act of 2015, your data are protected from cybersecurity risks through screening of the systems that transmit your data.

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Conclusions

- Most participants interpreted that the topic area of this study was about vacant homes or their neighborhood/community
- However, participants struggled to understand what type of survey questions would be asked/what the task would be
- Participants did not seem hesitant to report on vacant homes (if they understood the task)
- The call-out box with the URL and the confidentiality language are sufficient
- Repetitive messages across all the materials may not be motivating
- Overall, there is promise to design messages to motivate the public to participate in a crowdsourcing study

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Future Research

- Future research should evaluate different motivational messages to ask respondents to participate in a crowdsourcing study
  - Vary messages in each mailing
  - One recommendation is to test the idea of “citizen science”
- Add to mailing materials and conduct additional cognitive testing
  - How long the task will take
  - Consider FAQs to try to inform about the task
- Test different lengths of the URL
  - Shorter could be better as there could be less risk for a mistake to be typed

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Thank you!

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