Understanding Older Adults' Participation in Design Workshops

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ABSTRACT
Design workshops are a popular means of including older adults in technology development. However, there are open questions around how to best scaffold this participation, particularly in supporting older adults to associate their designs with themselves, rather than designing for an "other older adult." By conducting workshops focusing on envisioning the future of internet of things (IoT) technologies at home, we provide an understanding of how older individuals participate in group activities to conceptualize technology for themselves. We find that at different stages of the design process, individuals shift in who they envision the end user of the technology: at first, they think about common older adult needs, then turn to designing for themselves. Individuals' attitudes towards technology also impact group dynamics along with final design ideas. Our discussion contributes to an understanding of how to support older adults in designing for themselves, new perspectives on aging-in-place technologies, and recommendations for configuring design workshops with older individuals.

Author Keywords
Design workshops; older adults; participatory design; co-design, IoT.

CSS Concepts
• Human-centered computing~Participatory design;
•Social and professional topics~Seniors;

INTRODUCTION
Participatory and co-design approaches have been used as a way to support end users in contributing to technology design. In response to work calling attention to the ways that younger designers might fail to create appropriate technologies for a highly diverse aging population [46,47], older adults have been increasingly involved in designing for themselves through participatory methods [46,47,69,79]. Researchers have used these methods in areas as diverse as banking systems [79] to social virtual reality applications [4].

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From this work to date, we have learned that older adults have much to contribute to the creative design process [13,20,69] and that we benefit from including this population early in the design process [28,46].

Despite the popularity of participatory methods with older adults, there are areas that need further investigation in terms of the dynamics of these workshops and how to support participation. Some past work indicates that in workshops, older adults design for a broad range of others, including grandchildren or aging parents [69], but are not always designing technologies for themselves [47,66,69]. In a five year co-design study, the same individuals who designed a technology did not adopt them when they were built, as they were seen as for "other older adults" [66]. As another aspect of older adults' participation in design research in need of further study, attitudes towards technology are a well-studied topic when it comes to acceptance and abandonment [19,51]. Yet little is known about how older adults' attitudes towards technology play out in the design process itself.

To better understand these open concerns of participatory approaches with older adults, we present findings from a set of workshops on Internet of Things technologies (IoT). IoT is a fruitful area to study how attitudes towards technology affect the design process as until recently, these technologies have been designed to support aging in place by taking forms of various monitoring such as fall detection technologies (e.g., [83]). With the changing landscape of commercial IoT technologies, where smart speakers and smart lights are gaining popularity and adoption by older adults [40,67] and other populations [60,63], there is an opportunity for researchers to examine how perspectives on these different technologies influence design. Open questions include: who do older adults envision as the user of the technology they are designing? How do their attitudes towards technology impact their participation in design activities?

By working with older adults who had traditional aging in place technologies installed in their homes as part of a separate research study as well as experience with commercial IoT, our work provides insights that begin to answer these open questions. We conducted a set of design workshops which included a take home journal activity, as well as pre and post individual interviews. Our findings indicate that at first, participants thought of "other older adults" in an attempt to converge the topic of discussion. Later in the design process, we observed participants

converging to final ideas, except when there were mismatches in terms of attitudes toward technology. Throughout the process, these attitudes, and past experiences with technologies also affected participants' design ideas.

Our work contributes to the growing body of HCI research that seeks to understand how to engage older adults in design (e.g., [46,47]), as well as why older adults at times distance themselves from technology [16,42,56,74]. We extend prior work on older adults' engagement in participatory activities by providing an understanding of how attitudes towards technology affects group dynamics and design ideas. By identifying additional reasons, such as self-stereotyping, that older adults design for others [42,56], rather than themselves, as well as strategies to support older adults in designing for themselves, we contribute to the body of work on examining older adults' distancing themselves from technology. Our discussion contributes recommendations on configuring participation of older adults in design activities, and a preliminary comparison of group dynamics based on our findings with the established theories of creativity.

RELATED WORK

Our work is informed past literature on including older adults in technology design. We also review how IoT technologies have been envisioned for and by older adults.

Older Adults in Technology Design

Efforts to include older adults in designing aging technologies is not new. Traditional methods include surveys, interviews, or focus groups (e.g., [10,24,50]), or evaluating aging-in-place monitoring prototypes with older adults in laboratory or home settings (e.g., [23,61]). Within the last decade in the HCI community, there has been a growing impetus to include older adults in the actual design process through design workshops, where individuals might work independently or in groups alongside researchers and/or practitioners to participate in technology design. Some of these workshops include older adults by eliciting their feedback on materials researchers bring to the activity such as prototypes or scenarios for design, with the goal of using "critique" as a source for design [4,45,77,80]. Another approach involves older adults conceptualizing the technology themselves. This approach typically makes use of office and design supplies such as paper, markers, post-it, colored pencils, (e.g., [33,45]) or modular representations of technology such as paper cut outs of user interfaces and controls or actual devices (e.g., [30,46,47]). In our work, we draw from the latter, but personalize these modular components based on our participants in the study.

In terms of purpose of these workshops with older adults, as might be assumed, the primary focus is eliciting technology needs that will enable researchers to design and build technology. Some examples include getting design requirements for smart health applications [20,30], designing rehabilitation tools [77], creating new banking experiences [79,80], or social virtual reality application [4]. Yet, despite this widespread popularity of including older adults in participatory design, some research calls attention to open issues in engaging older individuals in participatory activities. Past work indicates that older adults [33,46] at times have difficulty due to the open-endedness of the design activities to conceptualize the unknown "future" technology. Analyses of participatory sessions with marginalized senior communities have revealed power imbalances in workshop activities that negatively impact engagement, such as the formation of informal group leaders and attempts to adhere to researchers' expectations due to power hierarchies [33].

While past work shed light on these intrinsic tensions related to engaging older adults in co-design activities, less is known about older individuals' rationales behind the actions they take during these design processes. More specifically, who older adults design for and why they do that are still open questions. Participatory activities with older adults reveal they might not always think about themselves in these sessions, often designing for "other" older adults, grandchildren, or others [47,66,69]. This dynamic of designing for others might be traced to older adults abandoning technology that they co-designed with researchers – a method that is presumed to elicit real needs [66]. Together, this work calls for attention to better understand who older adults envision as end users during design activities and what triggers this rationale—something we unpack in our work.

IoT for Older Adults

HCI designers have sought to support older adults in aging in place with connected technologies as the population ages worldwide [25]. Many context-sensing home-based systems have been designed, such as sensor laden environments [5,38,54,71], monitored appliances such as coffee makers [44], augmented clocks [2,64], and notification or reminder systems [17,26,48]. One of the earlier works was the Digital Family Portrait [54,71], which facilitated a caregiver to monitor the day-to-day activities of their older parent through a picture frame using sensor-based information. Supporting health has also been of interest, in areas such as medication adherence [43,44,58], rehabilitation support [3], and health monitoring devices [22]. A common thread between these technologies is the use of sensors to collect contextual information about older adults' homes or daily activities to support aging, often focusing to support caregivers as primary stakeholders [5,68]. Even as researchers investigate these technologies, there appears to be a reluctance by older adults to use many technologies designed for them [9,24,61]. Moreover, research suggests that older adults do not necessarily find such aging technologies useful, at times even rejecting them for reasons such as added work of using them (e.g., [41]) or lack of usefulness or need (e.g., [16,29,39,56]).

In part of an effort to address this reluctance, researchers have begun to examine the context of the home more carefully as the environment in which technologies are being used [1,7,75,78]. Following ethnographic approaches,

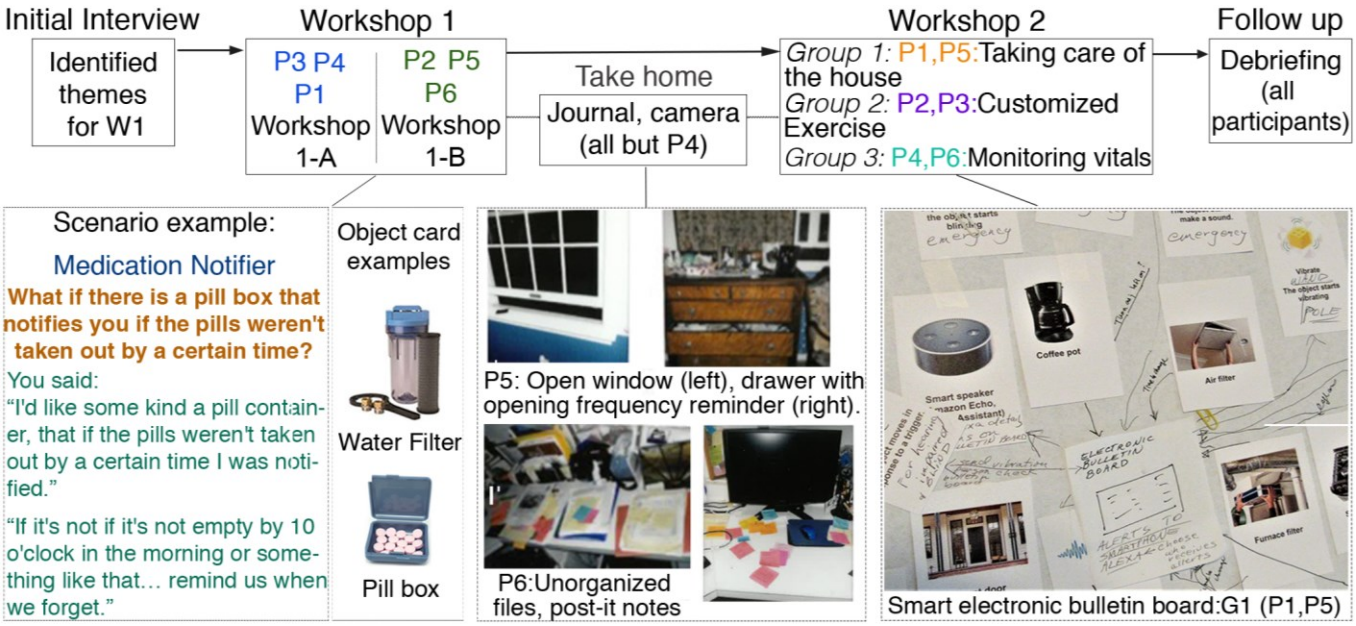

Figure 1. Different study stages and the corresponding outcomes: the scenarios and object cards from W1 (left), photos and written journal entries of take home activity (middle), and the final card activity on big paper from W2 (right).

researchers are working to understand older adults' home environment [1,7] and co-designing customized IoT with older adults in their homes [1]. As an example of a system that integrates an understanding of older adults' routines and the meaning that they associate with objects in their homes, the Messaging Kettle [8] supports intergenerational communication over a distance through an augmented tea kettle. These examples indicate attempts to personalize IoT technologies to older adults' homes and routines. Building upon a body of work that acknowledges the importance of the home context and the specificity of individual needs, we created a set of workshops to elicit older adults' individual needs to envision the future of IoT.

METHODS

To understand how older adults with IoT experience would envision designing technologies for themselves, we conducted a set of workshops (W1 and W2) with a take home journal activity between the two workshops. We interviewed participants before the workshops and had an optional interview after the workshops were completed. Each participant was compensated $55 in total.

Participants

We recruited six participants from a longitudinal study that deployed various IoT technologies, such as wearable activity monitors, motion sensors and door sensors, in the homes of retired older adults. Inclusion criteria specified that they must have had these technologies in their homes for at least three months to ensure that they had experience with them beyond a novelty period. Participants were between 65 to 76 years in age, identified as females, and lived independently in their homes. All but P2 had a college degree.

Though participants were recruited from researcher-installed IoT testbeds, some of them also owned commercially available IoT technologies that they purchased outside the study, such as smart speakers (Echo Dot, P1 and P3), smart plugs/outlet (P1), and a smart doorbell (P3). While some participants did not own any commercially available IoT, they were aware of many available technologies and had formed their own perceptions about these devices.

Workshop Planning

Below we describe our planning and structuring of the workshops, where we iteratively personalized the design prompts and materials presented to participants (Figure 1).

Interviews

We conducted one-hour remote, semi-structured interviews over video conferencing with participants before the workshops to understand their overall experiences of living in a home fitted with sensors and using the wearable tracker as part of the longitudinal research study they were in. We also probed their perceptions and usage of commercially available smart home technologies. In these initial interviews many participants mentioned they do not think that the technologies deployed in their homes in the longitudinal study *"fulfills a need that I had necessarily"* [P6]. Instead they thought that these technologies are *"for more sedentary, people with mobility issues who are more isolated, and worrisome health conditions. And I'm not somebody who's like that. I'm really healthy, strong, independent person"* [P4]. These statements, which mirror statements made in prior research (e.g., [29,56]), informed our approach to tailor workshops in attempt to match participants' actual needs.

Workshops and Design Activity

Workshop 1 was a 1.5 hour focus group. Due to scheduling constraints, we conducted two W1s (W1-A, W1-B) with groups of three people in each. The goal of W1 was to brainstorm scenarios of daily activities that are meaningful and important to participants. In order to tailor the first workshop to the needs and preferences of participants, we identified the activities that participants discussed in the initial interviews by open coding [37] transcribed interviews to capture all the activities participants mentioned. The research team then met to cluster these activities into themes to determine which were the most prevalent. The themes that had the most mentions overall were health and hobbies. These two themes were presented to participants as possible topics for discussion in workshop 1, as described below.

In the first half of W1, we asked participants to choose whether to focus on health or hobbies (the two themes identified from interviews) for the workshop. Based on the theme selected, they were asked to share specific activities of interest, motivations behind them, associated frustrations, and whether and how they might like to do these activities differently (if any). In the second half of W1, we posed an "off the wall" question to the participants as a way to start considering opportunities for the home without getting into the specifics of technology: *"if your house could talk and tell you anything, what would you want your house to tell you?"*

At the end of first workshop, participants were given an optional take home journal activity with a polaroid camera (based on prior works indicating camera as a successful probe [12,33]), film, and a paper journal with prompts. Prompts in the paper journal related to selecting activities they want to focus on, what parts of the house would know about those activities and what the house would sense about them (e.g., see/ hear/ smell), anything they want their house to tell them, and anything they did not want their house to know or tell. Participants could answer with words, drawings, or pictures taken with the Polaroid camera. All participants completed the journal, except for P4. Figure 1 (middle) shows photos from the paper journal of P5 and P6. Participants had at least 24 hours in their homes for the journal activity between the two workshops.

The second workshop was also tailored to the participants in our study. To identify scenarios that we could present to them for design activities, audio recordings from the first workshops were spot transcribed and then open coded along with researcher observation notes [37]. We clustered the codes within our research team and created six "what if scenarios" [31] contextualized by actual participant quotes from W1. Figure 1 (left) shows one of the "what if scenarios". Other scenario cards included nudges for staying active and healthy, taking care of your house, taking care of your garden, customized exercise, and monitoring vitals.

In order to further tailor the design activity in workshop two, we adapted an existing IoT card deck often used when brainstorming IoT technologies [53]. We printed human action (input) and feedback (output) cards from this set, adding a voice card to the "feedback" deck due to the growing popularity of current IoT technologies controlled by voice. Instead of using the default object ("things") cards in the pack, we created 25 object cards based on the scenarios and common objects mentioned in W1 and initial interviews. Example of object cards include bed, smart speaker, oven, and television, each represented by a picture of the object and its name (Figure 1-left). We also had blank cards for participants to use if the ones we provided did not match their interests or needs. Our rationale to use cards was informed by prior success of cards in workshops with older adults due to visual images on them [1,80].

The second workshop (W2) was a 2.5 hour session, with all six individuals participating in the same session. This workshop focused on supporting participants in envisioning and designing technologies that they might like to use in their homes. The session itself was structured as follows. After a reflection on the take home journal, participants began the card-based design activity. Each individual was given a set of six "what if" cards that depicted scenarios. With an intention that participants brainstorm IoT technologies that they wanted for themselves (rather than designing for another older adult or saying they might use it when they were older), we asked individuals to choose two or three scenarios that they were most excited about: "*Think about how important the activity mentioned in the scenarios 'for you' and if a technology is designed for that scenario today, would you want to use it? would you want to live with it in your house?"* Based on the scenarios selected we split participants into three groups such that each of them had at least one scenario in common. Three groups were formed- G1 (P1, P5), G2 (P2, P3), G3 (P4, P6). Upon grouping individuals, participants could choose any scenario to focus on. Participants also had the flexibility of creating their own scenario cards, object cards, or action/feedback cards during the activity using blank cards.

Scenarios that were selected included "taking care of your house" (G1), "customized exercise" (G2), and "monitoring vitals" (G3). The group that selected the latter also created two additional scenarios: "sound system throughout house" and "organizing of files and ideas [on paper or post-it notes]." Using an example, researchers explained the cards and how to use them for brainstorming a technology for a chosen scenario. Participants spent 30-40 minutes (with an optional 10 minute break) on the brainstorming activity using the cards, followed by debriefing of ideas by each group (40 minutes), and reflection on the workshop (20 minutes).

Follow up interview

After completion of the workshop, we noted that the designs created in the second workshop were very different from the topics discussed in the first workshops, prompting us to conduct follow up interviews. Remote semi-structured individual interviews (20-30 minutes) with participants over video-conferencing helped us better understand their

experiences of the workshop and any critical feedback they had for us. Examples of interview questions include thoughts about being paired in the activity, rationales for taking certain design decisions, and suggestions on doing the activity differently. Though it was optional, all participants took part in this follow up interview.

Data and Analysis

We followed a constructivist grounded theory approach to analysis [37] because it allowed us to build a conceptual framework grounded in data through an inductive approach [37]. Data includes full transcripts (including re-transcription of previously spot transcribed W1 sessions) from 16 hours of audio recordings, which includes initial interviews, workshops, follow up interviews, completed diaries, researchers' observation notes from the workshops, the final designs (output of the card activity on big paper- Figure 1-right), and the take home journals of five participants.

We began by open coding one-third of the transcripts of workshops 1 and 2, a transcript of one group's interactions during the card-activity, and one follow up interview. Next, we focus coded the remaining transcripts. Examples of our initial open codes include "emerging tensions during card activity", "living alone causing worry", "building upon each other ideas", "choosing health as common topic", and "realizing possibilities". After open coding the data we became interested in the different kinds of knowledge that participants readily applied to discussion or design activity, such as their past experiences with technology – this concept emerged as a sensitizing concept for us [37]. Going back and forth between our own data and our understanding of gaps in past work that suggests older adults often share ideas of what "others" might need, led to the emergence of the other sensitizing concept—"For whom older adults are designing in workshops" (this approach, of relating inductive findings from data to past work is a feature of constructivist grounded theory [37]). Based on a set of codes that we selected, we focus coded the remaining transcripts. Ongoing discussions within our team informed the emerging themes such as "trying to converge" as we related codes with each other and constant comparison with the data through an iterative process of memoing and theorizing. Through this process, we ended up theorizing less on the use of technology that people describe and more on their workshop participation including arriving at design ideas, engagement with others, and how individual values revealed at different points of study relate to this engagement.

Limitations

Older adults as a population are so broad, in terms of age, education, and other factors [82], that it is useful to reflect on the specifics of our sample as they affected our findings in this study. First, participants were tech-savvy users, which represents a growing demographic of the older adult population [52]. Second, participants were recruited from a longitudinal technology study – an approach used in other HCI studies (e.g. [6,79,80]) which is likely to have contributed in part to the firm grasp participants had on their preferences towards technology. Although working with this sample enabled us to understand how attitudes towards technology impacts design workshop participation, similar to other in-depth qualitative work with a small sample size, our findings are not intended to be generalizable [36,49].

FINDINGS

Below is a high-level summary of our initial observations and impressions from the two workshops.

In the first workshop, when participants were given the option to focus on health or hobbies, health emerged as the topic that received the most interest. All but one participant raised or affirmed medication reminders as a topic they would be interested in discussing. The discussions following predominantly focused on health-related topics, including preventing falls [P6], increasing exercise [P3], accessing synthesized health information of self [P5], and measuring blood pressure or cholesterol levels "without the invasive procedures or the appointments" [P4, W1].

Though medication reminder was the most popular topic of interest in the first workshop, none of the groups chose that scenario for the design activity of second workshop. Examples of final designs from second workshop included a smart electronic bulletin board that connected to and informed residents about issues with wiring, fires, utility consumption, whether the door was unlocked, indoor and outdoor air quality and more, and was interoperable via wearable tracker and smart speaker (G1); a voice or furniture-driven exercise prompter (i.e., a recliner that pushes you out of a chair) (G2); and a house and car that automatically monitors vitals, communicates with healthcare providers, and ensures that the prescriptions are delivered in a timely manner (G3). Based on the interactions and discussions, it was evident that participants were speaking of own needs and designing for themselves. Even with the many ideas that came out of the workshop, we noticed that some ideas were dropped while others were not.

This high-level summary of the initial impressions revealed three observed phenomena that were initially not understandable to us: 1) the overwhelming focus on medication reminders in the first session was not mirrored in the second, 2) that some ideas were dropped while others made it through to the end, and 3) why some participants overemphasized currently used IoT devices in their new designs, whereas others did not. The following analysis helps explain these observations.

Below, we describe how participants shift between designing for common older adult needs to designing for themselves, attitudes towards technology disrupts participants' attempt to converge and also influences certain design decisions.

From Stereotyping to Designing for Themselves

Between the first and second workshop, we observed that participants shifted from thinking primarily about people

other than themselves as the end user to designing for themselves.

In the first workshop, the discussion centered on what older adults in general need. Though we asked participants to *brainstorm scenarios of daily activities that are meaningful and important to them* participants repeatedly moved the discussion to consider what older adults "in general" might need. For example, while deciding whether to focus on health or hobbies, P6 described how *"generally [for] older adults health is the issue…* [this topic] *would be more in common, probably between all of us."* Adding to this discussion P5 generalized as well, how *"elder health becomes increasingly an issue*" [P5, W1].

In the above quotes and other instances, the intention appears to be to ensure a common interest between the participants for the ensuing discussions.

On the surface, these attempts to ensure a common interest by defaulting to the needs of the stereotypical older adult seemed to result in a topic – medication reminders – that was raised and affirmed as a topic of interest, generating a significant amount of discussion in the first workshop. But when we conducted follow up interviews, we found that this discussion did not reflect real needs for all participants. P4 tried to *"relate to people [others in her group]*" by sharing difficulty she had remembering a new medication from a drug trial research study after P1 asked if anyone had issues remembering their medications. However, she had no issues with her "normal meds." P6, who actually initiated the discussion of medication reminders in the workshop she was in (W1-B), confessed in follow up interview: *"I wasn't very excited about it in the first day…I thought it would be a good idea and useful. I took care of my elderly mother who had lots of medications."* [P6, follow up].

Rather than thinking about what she might need or want, P6 approached the first workshop discussion in terms of what might be useful for other older adults – in this case, her own elderly mother. Instead of stemming from a real need or personal interest, participants in the first workshops thought about what might be appropriate for *older adults as a population.*

In people's take home journals and the second workshop, however, we observed participants raising their own needs. For example, P1, during the second workshop said "*for my house I would want to have a bulletin board… especially the electrical wiring, plumbing leak...I want one of these electronic bulletin boards like now. Don't you, [P5]?"* Here, P1 indicates that the bulletin board was based on her current needs, which is further ascertained by tracing it through her journal where she mentioned desire of a smart notification system in her bathroom (Figure 2-left).

Similarly, P4 and P6's file organization scenario was based on their own needs. P6 described how she envisioned to have organization "my style". Currently, she explained, *"in my house…my kitchen counter is cluttered, my desk is cluttered, mostly I use post-it notes to help me anything I think of, I write it down and then put it there in case I forget"* [P6, W2] (Figure 1, P6's journal photos).

With this motivation, P4 and P6 designed *"a projection screen of some sort that could come down and go back. So you don't have to see them the whole time, it's just that when you want to look at your little ideas, you can pull it back down."* [P6, P4, W2]. P6 further described how exactly she wanted this technology to fit in her house:

> "It would be more of a presence in my house. I'm thinking of it under my kitchen cabinets, it would come down, instead of my kitchen counter where I have all these things…it would be something that would be available to me where I am. And there might be more than one and they would be connected… I could have one in my car and little one on my phone." [P6, W2]

In addition to designing technologies that meet their current needs, participants also envisioned how the technology might adapt to meet their own future needs. In past work, saying that one might use a technology when they get older is a strategy some participants use to distance themselves from technologies designed for older users (e.g., [29,56]).

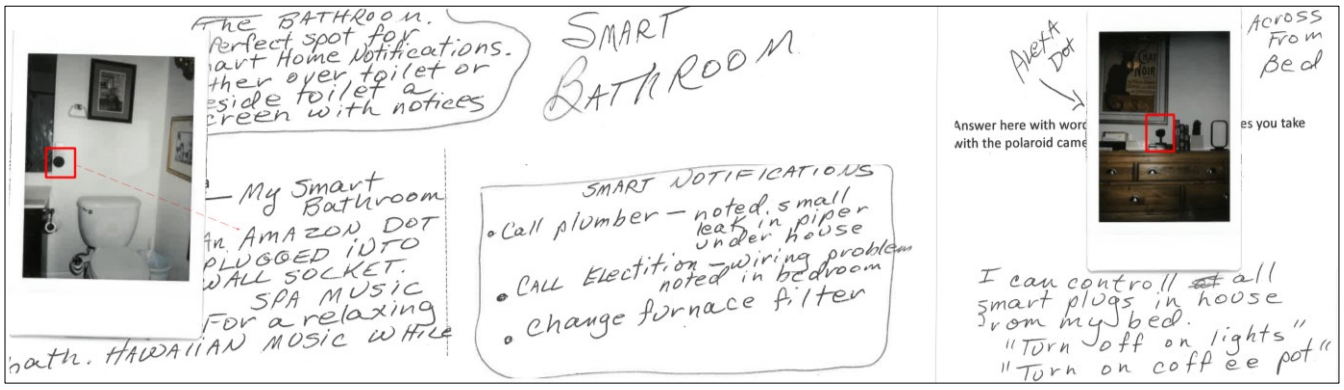

Figure 2. (Left) P1's journal showing her "smart notification system" idea detecting leaks in pipe, wiring problem etc. She envisioned placing it in her bathroom (over toilet or beside). The picture shows along her Echo Dot [red square] fixed to the bathroom wall. (Right) P1's Echo Dot in bedroom [red square] to control lights and coffee maker via smart plugs.

But participants in the second workshop envisioned specific customizations of their designs based on own needs that they linked to their potential futures. For example, in the design activity, P1 wanted an additional mode for interaction beyond voice – she envisioned a "vibration stick", since she had *"a bad hearing problem…it probably will get worse as I get older"* [P1, W2]. Similarly, P5's desire for having alternative form of interaction in addition to voice was primed by thinking of her future self: *"but what if in the future…my voice has changed and I can't communicate with this thing via voice anymore, any longer. It would be helpful to have alternate methods of input."* [P5, follow up].

Tensions in Attempts to Converge

During the second workshop where participants engaged in design activities in pairs, we find that participants at times converge on final design ideas with their partners. At other times, particularly when attitudes towards technology comes into play, they diverge, centering their own preferences.

One way that individuals converged on a final design even when they came in with different preferences or ideas was by introducing customization. From the take home journal, we traced P1's preference of placing a smart bulletin board in her bathroom (Figure 2-left), whereas P5 wanted to keep it *"in the kitchen or in the hallway near the kitchen"*. As a way to allow for both options, they decided to allow the user to decide the location of the board. Another example of allowing customization took place when this group decided that their bulletin board would *"give a variety of output...given as a blink, a voice, or text or sound. And you can choose which of those, or all of them*." This solution emerged as a way to address P1 and P5's disagreement as whether to use voice interaction or other methods of input.

While converging on a final design led to increased flexibility in the above cases, at other times, it led to some ideas being dropped. For example, in G1's card activity, P5 had the idea if her *"bed could say, we detected that you haven't changed the sheets on your bed in two weeks you think you might want to get around to that."* But P1 felt *"that would be good for some people but I routinely do that [change sheets]*" and wanted to focus on *"major problems that we can't see."* Here, different individual preferences led to tensions in converging. P1 even said that *"the sheets and stuff are secondary to me",* signaling her disinterest in the idea. To maintain a commonality for the card activity, P5 dropped the idea, although it was a need for her that she had also noted in her journal. Individuals also used the design materials to gain awareness of each other's preferences, then adjusting their own ideas in order to converge. In the follow up interview, P3 explained how she had arrived at her set of object cards during W2's card activity:

> "We just kind of looked at them [cards] separately and she started laying different ones down, different ones than I did... And after I saw what she had put down, some of them that I had taken out...I put back, I thought this isn't going to work with this." [P3, follow up]

P3 ended up not using some cards that she initially wanted to after seeing the cards P2 had shortlisted, to ensure that her partner's ideas would work with hers.

The above examples show how participants converged on their final ideas when they had different needs and preferences by either allowing customization or dropping ideas. However, when there were differences in attitudes towards technology, this kind of convergence was not achieved. As an example, in G2 during the card activity of second workshop, P2 described herself as a "*low tech person*" and said *"when things get too smart, I feel like it's taking the power away from you."* Though P3 responded, "*Oh, I am basically low tech",* later she expressed how their varying attitudes led to dissatisfaction.

> "P2 and I were looking at two different things...she was more concerned about...her furniture, her recliner and things like that, whereas I was thinking of other ways to utilize what I had with technology. She isn't into that much technology that I'm aware of." [P3, follow up]

This inability to converge affected their group dynamics and the coherence of their final design. In group debriefing, P2 started by segregating what were her ideas versus P3's: "*these are mine. Those were all hers."* In the follow up interview, P3 felt that their final output "*was different than anybody else's"*, in part because the scenario they chose and their final design, "*didn't really connect like it should have."* In follow up interview, she further explained her frustration in terms of a mismatch in attitudes towards technology, due to which she didn't feel quite matched with her partner, saying "*seems like the other two groups were more paired than [P2] and I."*

> "I think that if we both kind of were coming from the same path with the same things in mind, it would have been a lot different. Like the other ones…if one wouldn't do something, the other one knew a way to come into it...but, we didn't connect like that." [P3, follow up]

For P2 and P3, it appears that the mismatch between both participants' attitudes towards technology contributed to these tensions in convergence. Another example of similar tensions on converging due to attitudes towards technology was also observed in G1, when P1 brought up the idea of a smart toilet to monitor *"urine and feces",* but P5 described aversion to the idea of such monitoring every day. Here, P1 and P8's different preferences regarding monitoring led to tension in accepting this as a common idea.

The above examples depict tensions in converging on ideas when there are differing attitudes towards technologies. Yet, when there was a lack of knowledge of one's own needs, rather than a negative attitude towards technology, the outcome was different: Initially for P6, she did not *"know how to regard including technology, inserting it into my life"* [P6, follow up]. Looking at the final design produced, although the initial need for organization was raised by P6,

P4 ended up sharing that she had a need for this as well, and contributed extensively during the design process. In the follow up interview she clarified how, *"building on ideas that other people have, actively trading ideas back and forth"* contributed to her registering her own needs.

In summary, we see the strategies participants used to converge on final design ideas with their partners – customization and dropping ideas – and how differences in attitudes towards technology caused disruptions in the ability of the group to come up with a coherent final idea. Below, we reveal further ways that attitudes towards and experiences with commercially available technology affected the final design ideas.

Influence of IoT Technologies

Past experience using various commercial IoT systems or the researcher installed IoT devices impacted participants' design ideas in the card activity of second workshop. In the second workshop, P1 and P5 each wanted to access the interactive bulletin board that they designed based on technology that they were familiar with: P5 through the wearable tracker that she was given as part of the research study from which we recruited participants, and P1 through using her smart speaker assistant "Alexa", as *"I know how convenient this is...I'm biased about it."* [P1, W2]. This was also replicated in her journal (Figure 2).

In the follow up interview, P1 revealed how it was not just the convenience of the smart speaker, but also the associated "image" of technology that played a role towards her personal preferences. For example, she described how she distanced herself from the use of assistive technology marketed specifically for older adults because of the association with the "image" of frailty.

> "Before now, all you heard about for senior citizens was the clapper to turn on lights [a device used to turn on and turn off lights by clapping]. And it made you think, I never want to be in the position to have to use the clapper. And also there's another one... I've fallen and I can't get up. And it shows this real elderly woman in the bathtub hanging out, you know, and all broken." [P1, follow up].

Yet, she did use commercial technologies for both the above use cases i.e., smart plugs in her bedroom to control lights and an Echo Dot in her bathroom (Figure 2) for emergency calling purpose in case of falls, calling them "*a real slick technology... to overcome*" the image of aging technologies [P1, follow up]. This describes why some participants preferred commercial technologies and how these personal preferences affected the final design ideas.

Participants' attitudes towards technology also played a significant role in the design decisions that they made. In particular, we saw privacy emerge as a factor. For example, the participants who included a smart speaker and the wearable in their new designed technology's ecosystem mentioned throughout the different phases of the study not

Figure 3. P2's manual exercise prompter where she wanted a physical "tap" to activate the chair "lift".

having privacy concerns. P5 considered herself as *"a pretty open person. And I don't mind that people are tracking my activity [through the wearable tracker]"* [P5, initial interview]. Similar P3, who wanted a voice-controlled exercise prompter through her Alexa did not have any privacy concerns of using it: *"I don't care who knows."* [P3, W1]). P1, who did not have privacy concerns further argued that media is responsible for inflating privacy concerns amongst older adults: *"I think that the privacy issue is so ingrained in all of us…because it's young journalists trying to make a name for themselves. And they do not think about what they're doing to the older people that don't really understand technology that much. And it's just kind of ingrained into society."* [P1, W1].

On the other hand, P4 and P6 did not include any commercial IoT in their designs, consistent with the privacy concerns they revealed in the first workshop (e.g., *"they [smart speakers] spy on you…that's my impression… I wouldn't want one."* [P6, W1], *"I just feel like all of my data [is] online...it's vulnerable to anybody*" [P4, W1]). As another example, P2, who rejected smart technologies as taking *"the power away from you,"* [P2, W2] had a final design idea that didn't use digital technology at all. Instead, she wished to initiate the input of her tilting recliner to motivate being active: *"just tap it or do it physically, pull a lever or so."* [P2, W2] (Figure 3).

Together, these instances indicate how knowledge accumulated by usage and familiarity of available technologies, and attitudes towards those technologies become knowledge that is accessible to participants and affect the ways in which participants engage in design.

DISCUSSION

This work extends the growing body of HCI research that considers older adults as having much to contribute to the creative design process (e.g., [21,33,46,69,80]). Our findings provide insights into how participants engage and contribute to participatory design activities. Informed by these findings we reflect on: a) how researchers can overcome the long standing issue of older adults distancing themselves from technologies built for them, b) share implications for

designing for a generation of older adults who are familiar and at times comfortable with commercial IoT, and c) examine the need to revisit configuring participation with the changing technology landscapes as new technologies emerge which are increasingly adopted by older adults. Acknowledging that design thinking and brainstorming is a creative process, we discuss how psychological modeling of group creativity theories apply in context of older adults.

Shifting Vision of the "End-user"

Participants assumed different "end users" in different stages of the design process of this study: a stereotypical older adult in the first workshop, and themselves in the second workshop. Massimi et al. found similar groupings in their workshops—for "me" (personal use), "them" (the general population of older adults), and "us" (the older adults engaged in the design activity) [47]. In particular, the phenomenon of older adults designing for "other" older adults, or claiming that a technology is appropriate for other older adults, but not themselves, is not new (e.g., [29,41,51,69]).

Our work reveals several considerations as to why older adults shift between designing for others and themselves. During the first focus groups, when asked to generate areas for design, individuals drew on their readily accessible knowledge of a "stereotypical" older adult. HCI researchers are increasingly calling attention to the ways that predominant stereotypes and assumptions of older adults creep into the design process via the research team [42,82]. We find that *stereotyping by the end user* themselves may have led to the predominance of medication reminders described in the first workshop, which at times might extend to other members of the workshop but not necessarily themselves. This implies that as researchers, listening closely to participants is not enough to evade stereotypes of aging. Techniques from creativity research such as "nominal grouping" methods [65], where each team member works separately and their responses are aggregated, could be one approach that may be useful here to support divergent thinking and needs to be further explored.

Reflecting on our approach of grouping participants, we see that although pairing individuals at times leads to higher quality ideas, it also leads to more convergence in ideas. This might be undesirable if the goal is to maximize divergence, specifically in in context of older adults, where users are at times likely to stereotype themselves and may need help in breaking out of conventional ideas. Future work can explore the tradeoffs of different variations of design workshops in terms of divergence and convergence.

Designing for a Tech-savvy Aging Population

Emerging research [40,62,73] and popular press articles [11,35,67,86] suggest an uptake of commercially available IoT technologies by older adults. Yet, aging technology research often focuses on smartphones, tablet, social media, and internet usage, with less attention paid to commercial IoT use—likely because it is an emerging market. Our work indicates that IoT use and exposure should be considered, as it may influence what older adults desire from future smart home technologies. Some participants' design ideas were intricately woven with the IoT technologies that they already used, such as wearable devices and smart speakers, due to their comfort using them or their attitudes towards them. For example, one participant preferred commercial technology due to its "image" that did not perpetuate her fear of ageism or being identified with aging specific technologies. Such users might distance themselves from future technologies that reflect other forms of ageism. Understanding such nuanced preferences and values can help us design technologies that older adults are more willing to adopt.

Attending to the final design ideas of participants also reveal values associated with technology, an area of interest in HCI in general [15] and specifically with older adults [45]. Our findings suggest that both IoT users' and non-users' perspectives could be influenced by public opinion, which raises the need for future work to understand older adults' attitudes as the technology landscape, and surrounding cultural attitudes, change. Our findings also provide insights in terms of extending what we include when we discuss aging-in-place technologies. Although participants explicitly said that health is important to them and would like technology to help them live longer, none of them pursued the medication reminder or other health monitoring technologies, which make up the bulk of the HCI literature on aging. Yet participants did design for health, selecting scenarios of monitoring vitals and customizing exercise – topics that are indeed of interest in health HCI but primarily in the context of relatively younger adults and less in context of older adults (with some exceptions such as [18,55]).

Revisiting Configuring Participation

Past work urges researchers to reflect on the beneficiaries of research [81]. In addition to the researchers predictably learning from participants, both workshops contributed to participants' take-home knowledge. Knowledge was shared between peers [84]: P1 decided on buying a smart doorbell after learning its use from P3, and P5 decided to buy a smart speaker upon learning how P1 used it. Though participants' knowledge expanded, we were not encountering blank slates in these workshops – we recruited individuals who were already participating in a longitudinal study related to technology. While this past experience was essential to our uncovering how experiences with technology influences perceptions, and is a common practice in HCI and aging research (e.g., [79,80]), it is essential to acknowledge the knowledge and experiences that our participants bring with them, especially when comparing findings from different studies on older adults. It is equally important to note that participants take knowledge and perceptions from their research participation with us into their next experience with research or decision making around technology.

Despite our attempts to give participants all the information that they needed to engage in design activities, as observed

in past work [33], individuals at times raised concerns about the intent of the activities, e.g., purpose of the journal or how to proceed in supposedly open-ended card activity. Reflecting on these dynamics, we recognize that repeating the purpose of each activity was not really what participants were looking for. Rather, we and other researchers may be neglecting to fully communicate the "spirit" of creative thinking and what it entails [76]. The lack of this scaffolding explains some of the dynamics in our workshop where some participants dismissed design ideas calling them "minor" problems, in the pursuit of focusing on "major" problems. This raises important questions for configuring such workshop activities that future work needs to address: Do we need to train older adults based on the outcomes we want, as workshops are more successful when participants have past experience of working with creative methods [32]? If so, what should be included in such trainings – design thinking, information about current technologies? How much information about projects should researchers share with participants and how does that affect participation? How do we avoid these measures leading to idea fixation?

In addition to these open questions, we suggest the following recommendations based on our findings.

a) Pairings in design activities. Our approach of pairing participants, while leading to compromise and cohesive design ideas for some, was difficult for others. A major factor determining whether there could be compromise appeared to be whether attitudes towards technology aligned. An approach to create better pairings might use scales to measure and group people by their attitudes towards technology (e.g., attitudes towards technology [70], or trust towards companies' data handling practices).

b) Choosing design materials. Some of the approaches we used to customize the object cards based on scenarios and associated objects mentioned by participants' themselves were useful in helping people design for themselves than others. Our initial interviews, though they helped us parse participation later on (e.g., in terms of attitudes towards technology), led to categories so vague – health and hobbies – that we were not able to evade the "designing for others" that we saw in the first workshop. On the other hand, customizing object cards to common things that people described using, and including people's own quotes, appeared to help focus on their own needs. We recommend that when confronting participants designing for others, researchers should try to personalize design materials to prompt people to design for themselves.

Group Creativity in Context of Older Adults

We reflect on our findings in the context of established theories of group creativity, which have yet to consider older adults. Unsurprisingly, a finding that aligns with creativity theories is that group creativity is indeed affected by individual perspectives [59]. Here, participants' attitudes towards technology and the knowledge they brought in contributed to group level information processing and idea sharing. Similarly, findings indicating that ideas from others in a group affecting brainstorming sessions e.g., dropping off of some ideas aligns with past work examining the influence of the "group" over the mind in decision making [57].

Although the influence of an individual's knowledge and social arrangements (i.e., presence of others) of participation aligns with established theories of group creativity, theories stressing that diversity and familiarity foster better decision making [34,59,85] appear to be less applicable to the dynamics revealed in this study. These prior theories argue that longer the group members have known each other, the greater is the trust and cohesion between the individuals [14], resulting in psychological safety for members to feel free in expressing ideas [27]. This was not always evident in our workshops. Although P2 and P3 had quite diverse opinions and had known each other for long as friends, during their interactions in card activity it was evident that P3 did not feel the "psychological safety" of expressing her opinions and preferences (e.g., not feeling comfortable to show P2 the object cards she had initially selected), which in turn resulted in dissatisfaction with the pairing in itself. In this case, tensions in individual values and attitudes towards technology received precedence over familiarity in creative brainstorming, an area that merits further research.

Given the small sample size of this study, we do not claim that our work challenges these creativity theories: however, it illustrates how studying creativity in the specific context of aging HCI may not only improve aging HCI research, but also extend theories of creativity. There is much to learn by reexamining established theories of creativity in the context of aging HCI. For example, prior research on facilitating creative ideation through network rotation [72] suggests that shifting people within teams can be a possible solution to maintain both diversity and familiarity within individuals during a group design activity.

CONCLUSION

By conducting a set of design workshops with older adults, we provide an understanding of how these individuals approach designing technologies in group settings. We identify 1) how older adults shift in who they identify as the end user, at times stereotyping themselves, 2) participants' attempts for convergence can either lead to customization of technology, or tensions within the pairs when they have differing attitudes towards technology, 3) comfort and the attitudes individuals associate with current technologies is a factor that affects older adults' design ideas. We provide suggestions on configuring participation of older adults in design activities with changing technology landscapes, and discuss the group dynamics of our workshop findings in context of prior works on group creativity.

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