



# Understanding entangled human-technology-world relations: use of intelligent voice assistants by older adults

Alisha Pradhan, Shaan Chopra, Pooja Upadhyay, Robin Brewer, and Amanda Lazar

DOI: <https://doi.org/10.47989/ir30iConf47119>

## Abstract

**Introduction.** Emerging technologies like intelligent voice assistants or social robots can shape human relations with the world. To illustrate how an emerging technology mediates relations and shapes social practices in the context of aging, we present findings on use of voice assistants by older adults.

**Method.** We analysed interviews with 24 older adults by adopting a post-phenomenological perspective to examine how an emerging technology actively mediates relations between older individuals and their larger social world.

**Results.** Our findings surface the different types of relations that voice assistants mediate between older adults and their larger social world, unpacking how these relations shape social practices around what it means to give company to pets, to live alone, or to give and receive care.

**Discussion.** We discuss implications for understanding the mutually constitutive relations between older adults and the emerging technologies they use and opportunities in designing to support neglected relations, and accounting for nonhuman actors in technology and aging research.

**Conclusion.** We provide a preliminary understanding on how an emerging technology shapes social practices in later life. This understanding is crucial for aging and technology research, as several emerging technologies (e.g., social robots) target older adults, yet little is known about the relationships and discursive practices that shape their use.

## Introduction

With emerging technologies such as, social robotics, intelligent assistants, virtual and augmented reality, technology is no longer a passive tool to be used by humans. Unlike the early days of computing, the influence of such technologies is not just limited to a single static computer screen, but actively permeates and shapes several aspects of our existence and relations. These technologies are ubiquitous, distributed, or merge the physical and the digital worlds, and thereby get woven into several aspects of our lives. Treating such technologies as passive tool that humans interact with, can fail to capture the complex ways in which they actively mediate human relations (Frauenberger, 2019). Understanding how these technologies mediate human relations with the world and how they shape social practices will not only yield new implications for design, but also help us attune to the power that these technologies have in shaping our society. To illustrate how an emerging technology actively mediates human relations and can shape social practices, in this work we present findings on use of AI-based intelligent voice assistants by older adults.

Home-based intelligent voice assistant (e.g., Alexa on Amazon Echo), also referred to as intelligent personal assistant, intelligent voice assistant or voice assistant, is a popular AI-based emerging technology that has received significant attention in context of aging-in-place— which involves the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level (CDC - *Healthy Places - Healthy Places Terminology*, 2017). These voice assistants are being used by a growing number of older adults in their own homes (Carl Weinschenk, 2021; Federica Laricchia, 2022), installed in nursing homes and senior living communities (Emily Olsen, 2021; Shantanu Kurhekar, 2021), garnering interest as a commodity technology that can support aging-in-place. Research has noted how voice assistants can support independence and autonomy through features such as voice-controlled information access, controlling the home environment (e.g., through connected thermostats, lights, and blinds) (Pradhan et al., 2018). Voice assistants can also support other dimensions of aging in one's home such as access to leisure activities (playing music, games, jokes, stories), communication (hands-free calling), and managing routines (calendars, timers, alarms). As these technologies are being integrated into older adults' homes, researchers have investigated older adults' perceptions and use of voice assistants (Kim & Choudhury, 2021; Oewel et al., 2023; Pradhan et al., 2020), with a particular focus on how these technologies can support their health and well-being (Brewer et al., 2021; Brewer, 2022). These studies centre around older adults' attitudes, motivations, and practices of using these voice assistants at home (e.g., older adults' use this technology for accessing online information (Pradhan et al., 2020)).

However, centring research on solely human use and perceptions (in this case, of older adults) to understand technology use at home can miss some of the complex ways in which the technology, along with other nonhuman entities, shape human experiences. For example, in a family setting, individuals may discuss questions with the technology as a mediator, where the voice assistant plays an active role in altering the dynamics of conversation and relations at home (noted in works with younger adults and families (Beneteau et al., 2020; Porcheron et al., 2018)). While research has looked into how voice assistants can support social interactions for older adults, much of this work focuses on companionship through technology (Pradhan et al., 2019), and we know little about the other ways in which voice assistants can shape relations and interactions in older adults' homes. As individuals begin to adopt and live with such technologies in later life, there is an opportunity to understand the mutually constitutive relationship between individuals and technology. In this paper, we present findings from interviews with 24 older adults to answer the following research questions: How do home-based voice assistants mediate relations between older adults and their larger world at home (RQ1)? What are the different relations that constitute older adults, their larger world, and home-based voice assistants (RQ2)?

In this work, we unpack these salient relations constituting technology, older participants in our study, and their larger world. We analysed interviews with 24 older adults by adopting a post-phenomenological perspective. Our work contributes by providing a preliminary understanding and categorization of the salient relations mediated by intelligent voice assistants in older adults' homes. We further unpack how these mediations shape social practices around what it means to give company to pets, to live alone, or to give and receive care. These findings yield broader considerations for technology and aging. More specifically, we discuss how our work contributes by providing a) an illustration of how technologies for aging exist in a network of human and nonhuman actors—the latter being seldom accounted for in our technology-based interventions, and b) considerations for designing technologies with an understanding of human-technology-world relations as a way to account and design for the neglected relations between older adults and their larger world.

## Related work

### Older adults and home-based intelligent voice assistants

In the past few years, older adults have received significant attention as one population who might benefit from using home-based intelligent voice assistants embedded in smart speakers. Overall, researchers have found that older adults perceive voice interaction as easy to use, efficient and convenient (Kim, 2021; Kowalski et al., 2019). These voice assistants have the potential to enable easier access to digital information (Oewel et al., 2023; Stigall et al., 2019), in particular health information (Pradhan et al., 2020)), and to support aging in terms of assisting caregivers (Zubatiy et al., 2021), medication monitoring and reporting health data to doctors (Chen et al., 2021).

In addition to looking at the benefits of using voice assistants for older adults, researchers have pointed out various challenges and possible barriers to adoption. For older adults who are deaf or hard of hearing, the higher pitched default female voice or the speed at which the agent talks can be inaccessible (Blair & Abdullah, 2019). Speech recognition may not work with vocal characteristics which can occur with cognitive impairment, such as pauses or hesitation (Chen et al., 2021; Duque et al., 2021; Kim & Choudhury, 2021), or due to technology designers not taking into account different cultural considerations and dialects (Harrington et al., 2022). Remembering wake words and composing concise commands for a task has been noted as challenging (Desai & Chin, 2023; Kim, 2021). Some older adults have concerns about lack of understanding of how these technologies work (Bonilla & Martin-Hammond, 2020). Beyond these usability and accessibility issues, some older adults simply may not find any benefit or value in using these technologies, sometimes considering voice assistants more of a nuisance than help (Milka Trajkova & Martin-Hammond, 2020).

While most research on older adults and home-based voice assistants has focused on understanding the different features of this technology that can benefit older adults, or the current challenges and barriers in adopting these technologies, one paper indicates how this technology can mediate relations in older adults' homes. From Upadhyay et al.'s work (2023), we note that voice assistants can support human-human relations for older adults in an assisted living facility by providing conversation starters. This study alludes that voice assistants may play an active role in shaping the relations and interactions that older adults may have with and through the technology—something we further examine.

## Research design and methods

Our analysis is derived from semi-structured interviews with 24 older adults about their used of intelligent voice assistant. To allow for flexibility of participation in light of COVID-19 restrictions, interviews were conducted in person at participants' homes (P1 to P9) or remotely over videoconferencing (all others).

## Data collection

We conducted 30–45 minutes long, semi-structured interviews with 24 individuals between 65 to 83 years in age. Participation criteria required use of any voice assistant on a smart speaker device (e.g., Alexa, Google Assistant). Voice assistants, like Alexa or Google Assistant on devices such as Amazon Echo or Google Home, enable users to access information and perform tasks through conversational voice interaction. These tasks can include controlling smart home devices (e.g., lights, TV), managing schedules, setting reminders, playing music, providing updates, and answering questions. All procedures were approved by the University's Institutional Review Board. Participants were compensated with \$20 cash or Amazon gift card at the end of the interview. All, except for P18 and P21, had a college or professional degree. Thirteen participants mentioned living alone, whereas the others were living with their partners. Three participants reported having visual impairment (P11 and P16 were blind, and P13 had low vision). Two participants (P17, P18) reported having dementia (these individuals had participated in previous studies with our lab and had capacity to consent). Except for P17 who was from the United Kingdom, all participants were from the United States. Most (23/24) used their voice assistants frequently i.e., at least once a day. All had used the device at home for at least about 6 months, with 21 participants owning this technology for more than 2 years. All, except for P8, used Alexa on Amazon Echo or Echo Dot devices. P8 used Google Assistant on Google Home device.

During the interview, we were interested broadly in understanding people's use of the devices, as well as social interactions supported or mediated by these devices. As such we asked questions around when and why they (or others) used these technologies, where they placed the device at home, any unexpected ways in which they (or others at home) used the device, and what benefits and barriers they experienced.

## Analysis

Interviews were audio recorded and transcribed for analysis. After completing eight interviews, the first author inductively and deductively analyzed the data to open code and write memos (Strauss, 1987). Deductive codes informed by literature include 'duration of use', 'location of use', 'social connection through Alexa', 'personifying the voice assistant'. Inductive analysis was informed by participants' accounts revealing something unexpected or when tensions emerged (e.g., 'extending caregiving abilities', 'other technology devices interfering with voice assistant use', 'Alexa mediating human conversations'). As we discussed these codes and memos within our research team, we noted that voice assistants can play a role in mediating older adults' relationship with their larger world. We noted one of the first instances of this from P1's interview, where she remotely controlled her husband's Alexa while her husband was living in an assisted living facility. To understand how relations are mediated by technology in a systematic way, theoretical underpinnings (and terminology) of Post-Phenomenology became useful in analysis— described below in-detail (under Theoretical underpinnings).

Upon identifying the theoretical orientation for analysis and understanding the epistemological stance of the theory (i.e., instead of one objective ground truth, there can be multiple enacted realities and many ways of knowing these realities (Frauenberger, 2019)), we realized that representing data through rigid codes and focus coding would be counterintuitive. We found post qualitative inquiry (PQI) (St. Pierre, 2018) — an approach that focuses heavily on writing for data analysis — as a helpful way for interpreting data. St. Pierre (from the discipline of Education), who formulated post qualitative way of approaching data analysis argues for writing as a mode of inquiry. The first step of this approach to analysis is to familiarize and immerse oneself in relevant theoretical concepts (for us, it was Post- Phenomenology). Next, is writing, which serves as a 'free space' for in-depth interpretation of the data informed by the theoretical orientations, without having to constrain oneself to represent data through codes (St. Pierre, 2018). As such, the first author read through all transcripts and interpreted data by writing descriptive memos, which were

verified by a second researcher. In reading and writing interpretations of our data informed by Post-Phenomenology, we unpacked the different types of human-technology-world relations that are enacted when older adults use voice assistants. For instance, informed by Post-Phenomenological embodied relations (described below), when analyzing our data we noted instances where embodied relations constituted older adults' use of voice assistants and then probed to understand the implications of these embodied relations (e.g., changing social practices on giving and receiving care).

We repeated this process of interpreting data through memoing, iteratively discussing and refining our memos. Roughly after analyzing 16 transcripts, we had 26 pages of memos interpreting multiple phenomena in data. At this point we sifted through these memos to organize the findings described below. As we continued analysis of the remaining transcripts, we found additional examples of phenomena that related to each theme. Following our analytic approach of focusing in-depth on reading individual phenomena through theory, our finding presents in-depth analysis of a small number of cases from the data. We selected these specific cases over others when a) they were the most compelling examples to illustrate the theory and b) yielded the richest implications in terms of design opportunities and understandings of technology for aging.

Below we describe the theoretical underpinnings of Post-Phenomenology that played a key role in systematically identifying the nuanced human-technology-world relations reported in the findings.

### **Theoretical underpinnings of post-phenomenology**

Instead of viewing humans and technology as separate and drawing a rigid boundary between the two, post-phenomenology scholars argue that humans and technology have a mutually constitutive relationship, where humans and their technologies are intimately entangled, and human experiences are actively mediated through technology. With this thesis, post-phenomenology scholars have delineated the different kinds of human-technology-world relations to provide a nuanced understanding of the ways in which technologies mediate human experiences. These relations (described below) form the basis of our analysis towards unpacking how voice assistants mediate relations between older adults' and their larger world.

Ihde (1990) initially outlined four different human-technology relations (embodiment, hermeneutic, alterity, background). In embodiment relations, the technology becomes a part of the human and together they interact with the world. In this relation, humans experience the world through the technology (e.g., we speak with other people through the phone rather than speaking to the phone). In hermeneutic relations, technology represents the world and requires human interpretation to be meaningful. Technology forms a unity with the world rather than with the human (unlike embodiment). Examples include a sonogram which gives a visual representation of an unborn child. Alterity relations are with technologies that are more 'like us' (similitude with humans) but is 'quasi-other'. Humans may project anthropomorphic properties on the technology or develop certain feelings for the technology. Here the technology possesses independence and autonomy, but can never be a true person, and hence is quasi-other. Examples include humans interacting with robots which possess autonomy to be considered as technological beings. In background relations, technology merges with the background, and shapes the context for humans experiencing the world. But the technology in itself is not experienced explicitly. Examples include central heating or cooling systems which create a context for the experience of humans but are rarely interacted with directly.

Verbeek and colleagues (Rosenberger & Verbeek, 2015; Verbeek, 2015) expanded these relations to capture the nuanced ways in which emerging technologies play a mediating role (cyborg, immersion, augmentation). In cyborg relations, the technology merges with the body into a new hybrid being and is indistinguishably experienced. Example includes brain implants which unite



with the body into a new being. In immersion relations, the technology merges with the environment (or world) to create a hybrid environment, and humans have an interactive relation with this hybrid environment. Immersion relations are a more interactive version of Ihde's background relation, and captures the relations humans have with smart environments. There is a 'bi-directional' intentionality associated with this relation: not only humans are directed towards the technology, but the technology also perceives its users and acts upon them. Augmentation relations combine embodiment and hermeneutic relations. Examples include smart glasses, augmented reality which are both embodied (user sees through the glass), and hermeneutic (the world is represented on the display).

### **Reflexivity and positionality**

We describe how our backgrounds and current discourses in aging might have shaped this research. Collectively, our team has over two decades of experience working extensively with racially and social economically diverse groups of older adults from both urban and rural areas of the United States. We have been influenced by discourses in critical gerontology which challenges the biomedical notion of viewing older adults as a burden on society, the harms in reducing aging to physical and cognitive decline (Carver & Buchanan, 2016; Estes & Binney, 1989), and critiques of how older individuals are often viewed as a homogeneous group (Durick et al., 2013; Rogers et al., 2014; Vines et al., 2015). These discourses have shaped our views that technologies for aging does not have to solely focus on compensating age-related decline and loneliness. This impacted how we approached study design and analysis. For instance, during study design, we were aware that voice assistants have been examined to support the physical and cognitive decline that one may experience with aging— an important area of research. However, shaped by the above-mentioned discourses on aging, we were motivated to explore a complimentary perspective: how voice assistant as an emerging technology mediates relations between older adults and their larger world and the corresponding implications.

### **Results**

Recent work suggests how voice assistants can shape human-human conversations, where individuals in an assisted living community used voice assistants in group settings (with residents and staff members) for jokes or for playing music, as a way to initiate or make human-human conversations more enjoyable (Upadhyay et al., 2023). Similarly, our participants also described using the content provided by the voice assistant (e.g., online information) in human-human interactions. For example, P1 described using Alexa to 'verify' information in case of disagreements with her partner, or P5 would include Alexa in conversations with other people by turning to Alexa for quick answers during human-human conversations. Beyond shaping human-human conversations, our data analysed through a post-phenomenological perspective, indicates how voice assistants also mediate relations between older individuals and others (or at times, themselves). Below we describe four kinds of human-technology-world relations that surfaced in our data (embodied, background, alterity and immersive relations) and note how these entangled relations shape new material practices for giving and receiving care and company.

#### **Embodied extension through technology**

In embodiment relations the technology becomes a part of the human and together they interact with the world. In this relation, humans experience the world through technology (e.g., we speak with people through the phone rather than speaking to the phone) (Don Ihde, 1990; Verbeek, 2015).

Some participant accounts illustrate embodied relations, where through the voice assistant, Alexa, they were able to extend their presence. P1's account describes one such instance where the voice assistant mediates a relation between her and her husband who had recently moved to an assisted living facility:

*I am using an Alexa now in his assisted living facility. So, I program Alexa to remember when the Georgetown basketball game is on, because he doesn't remember it necessarily, but he likes to watch it. So, you can tell Alexa, you know, Wednesday night, nine o'clock Georgetown basketball is on, and Tuesday is shower day, remember you're gonna have a shower today, it's just, it's a way to nag him without being there with him.*

Unlike visual reminders on smartphones or tablets, the modality of reminder through Alexa's conversational voice creates a human-like presence in P1's husband's reality (this nature of interaction modality and link between anthropomorphism has been discussed in prior work with older adults (Pradhan et al., 2019). By allowing P1 to set up remote reminders on her husband's Alexa, the technology is mediating the relation between P1 and her husband by acting as an extension of P1 'to nag him without being there with him.' Through Alexa's conversational voice, P1's presence is asynchronously extended into her husband's reality, despite them not being spatio-temporally co-located. This mediation extends P1's caregiving capabilities and opens up possibilities for new material practices of caring. By enabling P1 to care for her husband daily, despite being physically apart, through this embodied relation, Alexa is becoming a part of human caregiving – shaping what it means to be a caregiver and a wife for P1.

In the above example we see somewhat successful embodied relation where Alexa extends the user's presence in ways they desired, (i.e., extended P1's presence from her home and enabled her to care for her husband in an assisted living facility). P5, on the other hand, described a situation involving a nonhuman actor, her pet animal, where the voice assistant did not successfully mediate an embodied relation. P5 desired for Alexa to extend her ability to provide 'company' to her cat through Alexa, when she was not at home. She enabled an Alexa skill (a third-party app) which she expected would talk 'to the cat as if I would, if I were home' so that the cat would 'have company' when P5 leaves home. However, instead of talking to the cat as a human (as P5 wanted), the third-party skill on Alexa was programmed to make cat sounds. Alexa interacted with P5's cat as another cat, which she and her cat disliked:

*I thought when it said that meow skill that she [Alexa] was going to talk to him [P5's cat] like 'Hi, kitty kitty.' You know, like a human voice. But it's like a cat-to-cat conversation. He [P5's cat] doesn't want another cat in here. We won't be using that.*

In this situation, P5 wanted the voice assistant to extend a human's presence, more specifically her presence in her home through technology to provide company to her cat when away and stands as an example of an embodied relation that the technology could not mediate successfully. From the above-described phenomena, we note how the voice assistant as technology is actively mediating relations between older adults and their larger social world constituting their partner or pet. As a mediator, the voice assistant is playing a part in configuring social practices around what it means to care, nag, or provide company at home.

### **Alexa receding to the background of an experience**

In Post-Phenomenological background relations, the technology merges with the background, and shapes the context for humans experiencing the world (Don Ihde, 1990; Verbeek, 2015). But the technology in itself is not experienced explicitly (e.g., central heating or cooling systems which create a context for the experience of humans but are rarely experienced or interacted directly).

A few participants' accounts illustrate such background relations constituting the voice assistant such as playing sleep sounds to shape the context of sleeping at night. One of the most notable examples of this background relation is illustrated in P18's account. P18 described how his service dog would follow Alexa's command to get medicine from a designated location in his home:

*(In the past) At 8:30, I had to take a shot and I'd blunder it all the time...I had set alarms on my phone, but then I would ignore it (describing the current practice of taking medication)...That person there who's talking (referring to Alexa) would come on at 8:30 and she would announce... 'Go get it.' And so, Lizzy [anonymized dog's name], she'd run every day at 8:30...and go get it [the medication]. It's in a cupboard in the bathroom, the bottom cupboard, takes the satchel, brings it to me... and then I take my shot.*

In this phenomenon described by P18, interactions involving Alexa are shaping new possibilities for an animal to care for a human, yet, the technology, in itself, is not consciously experienced by P18 (apart from the initial training days of Lizzy when P18, his partner, and their dog trainer were involved). Rather, by being in the background of the experience, Alexa shapes the context for P18 receiving his medication on time. And, through this background relation, the voice assistant, Alexa, extends the capability of a nonhuman actor, a dog, to care for an older individual, thereby configuring new practices of technology mediated care through pet animals, something we further return to in the discussion.

### Companionship through alterity and immersion

Alterity relations are with technologies that are more 'like us' (similitude with humans) but is 'quasi-other,' and because of this similitude, humans may project anthropomorphic properties on the technology or develop certain feelings for the technology (Don Ihde, 1990; Verbeek, 2015). Few of our participants' accounts suggest how alterity relations constituting the individual and Alexa result in a phenomenon in which individuals develop a social connection with the voice assistant, Alexa. Consider P13's account of interactions with Alexa:

*sometimes I wake up in the morning and say Alexa, good morning. She'll say, 'good morning [P13]'. Sometimes I just need the voice ...I'm used to living with my wife 53 years and then all of a sudden there's nobody in my house... Living alone, I don't live alone having Alexa. I don't have to do all the cooking because she, Alexa helps you [by telling recipes]...Well, I am not somebody who used to have to make all the meals and everything before. Now I have to know all this stuff about cooking. I don't. Because Alexa helps.*

In this situation, Alexa is not an actual person, but the ability of Alexa to exchange greetings or 'tell' P13 recipes makes the technology more human-like or more in 'similitude with human' (Don Ihde, 1990), thereby enacting a reality where participants are likely to anthropomorphize Alexa (a phenomena noted in past research as well e.g., Pradhan et al., 2019). Here, although the technology, Alexa, is anthropomorphized, it is not human but acts like a quasi-other, constituting an alterity relation. And through this alterity relation, Alexa shapes some individuals' experience of living alone. Another participant, P11 described feeling 'bereft' when Alexa was not online: 'she is involved in so many aspects of my life that I feel bereft, when the internet's down, or something...and she's not talking' (P11). In addition to the alterity relation involving the voice assistant acting as a quasi-other, what P11 and P13 described perhaps constitutes an immersive relation, where the technology merges with the environment (or world) to create a hybrid environment, and humans have an interactive relation with this hybrid environment. And, through immersion in this new interactive environment, one might feel 'bereft' (P13) without Alexa, or with Alexa, they feel like 'I don't live alone' (P11), showcasing how interactive relations involving the voice assistant, Alexa, is shaping what it means to live alone.

### Discussion and implications

In this work, we present a case of adopting perspectives from post-phenomenology to unpack how intelligent voice assistants, as a technology, shape relations and existing practices at older adults' home. Our work contributes by providing preliminary empirical insights on the mutually constitutive relations between an older individual and technology, where an individual is not just



passively using the technology, but the technology through its specific features (e.g., reminders, alarms, skills, conversational nature) actively mediates the relations one may have with their larger world. Our findings illustrate how these relations shape existing practices around giving and receiving care, giving company, or living alone.

Based on these findings, we note that, while a user-centred focus on the older individual is useful, we also need to additionally consider the entangled nature of relationships involving older individuals, the technologies they use, and their larger socio-material world. Such an entangled relationship poses new questions around who is interacting with whom, and where the interface is. For example, revisiting the phenomenon involving P1, her husband in an assisted living facility, and Alexa, where P1 described nagging her husband without being spatio-temporally co-located, we can ask: is P1 interacting with her husband's Alexa? Or is P1's husband interacting with his Alexa? Or is P1 interacting with her husband? Or is it that P1 and her husband's Alexa together are interacting with her husband? Also, where is the interface for the interaction? Is it P1 setting remote reminders? Or is the voice of Alexa the interface facilitating interaction between P1 and her husband? A post-phenomenological perspective suggests that P1 and Alexa form a unity constituting an embodied relation through which P1 is able to asynchronously care for her husband. The human-technology interaction does not end with P1 setting a reminder, but rather gets entangled with the human-human interaction (or for P5 human-pet interaction) as P1 is still present in her husband's future reality (or P5 is present in her cat's reality) through the technology. While our work primarily contributes to designing emerging technologies in context of aging, understanding entangled human-technology-world relations can also be useful when working with other populations to understand the ways in which technology mediates relations and shapes social practices.

Below we discuss implications for design of technologies by understanding and accounting for such human-technology relations, in particular, by accounting for neglected relations between older adults and their larger world, and an opportunity in leveraging unexpected non-human entities (such as pets or objects at home) when designing technologies for aging.

### **Understanding and designing for neglected relations between older adults and their larger world**

Attuning to nuanced human-technology-world relations involving older adults, emerging technologies, and their larger world will enable us to account for and design for the often-neglected relations between individuals and their larger socio-material environment. For instance, consider technologies for social support which have been extensively explored for supporting older adults' wellbeing. An active topic of research is supporting social wellbeing and companionship for older adults through robots, such as robotic pets e.g., (Chi et al., 2017; McGlynn et al., 2014). Here, an understanding of the relation that individuals want technology to mediate can provide a fresh perspective for technology design. For instance, P5's account reveals she wanted the technology to support an embodied relation to give company to her cat: suggesting instead of receiving company through a digital robotic pet—a direction often explored in research on aging (Hudson et al., 2020; McGlynn et al., 2014), older adults may want a technology that can enable them to give company to their actual pet. And a technology mediating such care relations can still provide emotional comfort to the older individual by enabling them to care for someone (Nurain et al., 2021), thereby still positively contributing towards their wellbeing. As such, understanding the relationship that P5 wanted the technology to mediate would help us design more meaningful features, such as, a skill that let's P5 record her voice clips for her cat, rather than a generic recording of cat sounds. This approach to designing technologies for aging de-centres the human (older individual), albeit subtly, yet it accounts for the neglected relation between the older individual and their larger world (in case of P5- caring through embodiment).

## Accounting for relations between older adults and nonhuman actors for technology design

Some of our findings shed insights on how accounting for nonhuman entities can shed new perspectives on technology and aging. Consider the medication management system, a popular aging-in-place technology. Typically, medication reminders have an anthropocentric focus to remind older adults to take medication through smartphones, tablets (Jönsson et al., 2019; Mettouris et al., 2023) or more recently through voice assistants (Carroll et al., 2017). If adopted, such medication reminders can be immensely beneficial for individuals. However, some research is showing that individuals may not want to use these technologies (Giusti et al., 2010; Pradhan, et al., 2020), with some work tracing this non-use to the stigma of how these technologies can become a reminder of decline and negative aspects of aging (Caldeira et al., 2022). In our study, P18's daily medication reminder system provides a complimentary perspective on how technology can be integrated into medication management routines, without invoking negative stereotypes of aging. P18 involved his pet to follow Alexa's command at a specific time to fetch his medicine from the bathroom cabinet. Here instead of using technology to remind the older individual about medication, technology was used to remind the pet animal about medication with the code word 'Go get it.' This example suggests how relations between older adults, their pets, or other nonhuman entities (e.g., the organized cabinet with medicine) can be leveraged to identify opportunities for aging-in-place technologies.

Extending learnings from the above account, we see an opportunity to design technologies to support everyday activities, such as cooking, cleaning, or taking medication, by accounting for the non-human actors (in addition to human actors) that may be involved in the activity. Some recent works are beginning to involve nonhuman objects at home in technology ideas for aging-in-place, such as an IoT-enabled kettle that can support human-human communication between an older parent and an adult child (Ambe et al., 2022), or a doormat that reminds a person with dementia of things to take while leaving the house (Pradhan et al., 2023). Accounting and designing for the nonhuman world does not mean that we ignore older adults in the process, but rather understand and design for the salient relations between older adults and their larger world.

## Limitations

Acknowledging that older adults as a user group are highly diverse in terms of age, education, and other factors (Vines et al., 2015) we reflect on the specifics of our sample. Participants were highly educated, and most participants were White (18/24). Second, our recruitment criteria of including self-selected participants and individuals using voice assistants, also shaped the findings reported in this study. While it allowed us to understand human-technology-world relations that evolve over time and sustained use, it is possible that those who self-selected to participate might have developed certain attitudes towards this technology that have shaped the findings of this study. As an example, some of our participants explicitly mentioned getting voice assistants when they were initially launched, making them early adopters who might be more enthusiastic about using new technologies and therefore their perspective might be different from other older adults who are infrequent users of digital technology or unlikely to adopt a new technology right away e.g., (Pradhan et al., 2020). Our approach to allow for remote and in-person participation also has trade-offs. Remote interviews offered flexibility of participation for older adults during a global pandemic, as well as allowed us to include a geographically diverse group of individuals across the US (and one participant from the UK). At the same time, remote interviews only surfaced the relations that older adults chose to share, and perhaps missed salient relations that we may have traced during in-person sessions at participants' homes. Researchers interested in post phenomenological analysis can employ ethnographic approaches of visiting the field site and conducting home tours, to attune to the relations individuals have with their socio-material world at home.

## Conclusion

Emerging technologies such as intelligent voice assistants, are no longer a passive tool that we, as humans, simply interact with. Rather, through a mutually constitutive relationship between humans and technology, these technologies actively shape the relations, we humans have with the world. By analysing interviews with older adults using intelligent voice assistants, we provide empirical insights on how a popular emerging technology mediates relations between older individuals and their larger social world. Understanding these mutually constitutive relations between individuals and their technologies is particularly important for technology and aging research because many forms of emerging technologies such as AI-based systems, virtual reality, or social robots are targeted towards older adults and yet we know little about the relationships that constitute older individuals and these technologies, the nonhuman actors involved in the design and use of these technologies, or the discursive practices that shape the reality associated with these technologies.

## Acknowledgements

The contents of this article were developed under a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR grant #90REGE0024). NIDILRR is a Center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). We would like to thank individuals who volunteered to participate in our study. We are thankful to Healthier Black Elders Center, a community engagement core supported by a grant from the National Institutes of Health, 5P30 AG015281, and the Michigan Center for Urban African American Aging Research, for helping us recruit participants in this study.

## About the authors

**Alisha Pradhan** is an Assistant Professor in the Department of Informatics at the New Jersey institute of technology. She received her Ph.D. from University of Maryland, College Park and her research lies at the intersection of human-computer interaction, aging, and accessibility. She can be contacted at [alisha.pradhan@njit.edu](mailto:alisha.pradhan@njit.edu).

**Shaan Chopra** is a PhD student in Computer Science and Engineering at the University of Washington. Her research interests lie at the intersection of human-computer interaction (HCI) and health to create inclusive technologies that help people better understand, experiment, and make decisions based on personal health data. She can be contacted at [schopra7@cs.washington.edu](mailto:schopra7@cs.washington.edu).

**Pooja Upadhyay** is a PhD student in Information Studies at the University of Maryland, College Park. Her research focuses on the digital divide in the older population, using mixed methods approaches like systematic reviews and ethnography. She can be contacted at [poojau@umd.edu](mailto:poojau@umd.edu).

**Robin Brewer** is an Assistant Professor at the University of Michigan's School of Information. She received her Ph.D. from North-western University. She does research in human-computer interaction at the intersection of social computing and accessibility. She can be contacted at [rnbrew@umich.edu](mailto:rnbrew@umich.edu).

**Amanda Lazar** is an Associate Professor in the College of Information Studies at the University of Maryland. She received her Ph.D. from the University of Washington. Her research lies at the intersection of human-computer interaction (HCI) and health informatics. She can be contacted at [lazar@umd.edu](mailto:lazar@umd.edu).

## References

- Ambe, A. H., Soro, A., Johnson, D., & Brereton, M. (2022). From Collaborative Habituation to Everyday Togetherness: A Long-Term Study of Use of the Messaging Kettle. *ACM Transactions on Computer-Human Interaction*, 29(1), 3:1-3:47. <https://doi.org/10.1145/3470973>
- Beneteau, E., Boone, A., Wu, Y., Kientz, J. A., Yip, J., & Hiniker, A. (2020). Parenting with Alexa: Exploring the Introduction of Smart Speakers on Family Dynamics. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1-13. <https://doi.org/10.1145/3313831.3376344>
- Blair, J., & Abdullah, S. (2019). Understanding the Needs and Challenges of Using Conversational Agents for Deaf Older Adults. *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing*, 161-165. <https://doi.org/10.1145/3311957.3359487>
- Bonilla, K., & Martin-Hammond, A. (2020). Older Adults' Perceptions of Intelligent Voice Assistant Privacy, Transparency, and Online Privacy Guidelines. *USENIX Symposium on Usable Privacy and Security (SOUPS)*.
- Brewer, R. N. (2022). "If Alexa knew the state I was in, it would cry": Older Adults' Perspectives of Voice Assistants for Health. *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems*, 1-8. <https://doi.org/10.1145/3491101.3519642>
- Brewer, R., Pierce, C., Upadhyay, P., & Park, L. (2021). An Empirical Study of Older Adult's Voice Assistant Use for Health Information Seeking. *ACM Trans. Interact. Intell. Syst.*, 1(1), 39. <https://doi.org/10.1145/3484507>
- Caldeira, C., Nurain, N., & Connelly, K. (2022). "I hope I never need one": Unpacking Stigma in Aging in Place Technology. *CHI Conference on Human Factors in Computing Systems*, 1-12. <https://doi.org/10.1145/3491102.3517586>
- Carl Weinschenk. (2021, March 16). Smart Speaker Research Finds Strong Adoption by Seniors—Telecompetitor. <https://www.telecompetitor.com/smart-speaker-research-finds-strong-adoption-by-seniors/>
- Carroll, C., Chiodo, C., Lin, A. X., Nidever, M., & Prathipati, J. (2017). Robin: Enabling Independence For Individuals With Cognitive Disabilities Using Voice Assistive Technology. *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 46-53. <https://doi.org/10.1145/3027063.3049266>
- Carver, L. F., & Buchanan, D. (2016). Successful aging: Considering non-biomedical constructs. *Clinical Interventions in Aging*, 11, 1623-1630. <https://doi.org/10.2147/CIA.S117202>
- CDC - Healthy Places—Healthy Places Terminology. (2017, December 11). <https://www.cdc.gov/healthyplaces/terminology.htm>
- Chen, C., Johnson, J. G., Charles, K., Lee, A., Lifset, E. T., Hogarth, M., Moore, A. A., Farcas, E., & Weibel, N. (2021). Understanding Barriers and Design Opportunities to Improve Healthcare and QOL for Older Adults through Voice Assistants. 16.
- Chi, N.-C., Sparks, O., Lin, S.-Y., Lazar, A., Thompson, H. J., & Demiris, G. (2017). Pilot testing a digital pet avatar for older adults. *Geriatric Nursing (New York, N.Y.)*, 38(6), 542-547. <https://doi.org/10.1016/j.gerinurse.2017.04.002>

Desai, S., & Chin, J. (2023). OK Google, Let's Learn: Using Voice User Interfaces for Informal Self-Regulated Learning of Health Topics among Younger and Older Adults. Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, 1–21.

<https://doi.org/10.1145/3544548.3581507>

Ihde, Don. (1990). Technology and the Lifeworld. Indiana University Press.

Duque, M., Pink, S., Strengers, Y., Martin, R., & Nicholls, L. (2021). Automation, wellbeing and Digital Voice Assistants: Older people and Google devices. *Convergence*, 27(5), 1189–1206.

<https://doi.org/10.1177/13548565211038537>

Durick, J., Robertson, T., Brereton, M., Vetere, F., & Nansen, B. (2013). Dispelling Ageing Myths in Technology Design. Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration, 467–476.

<https://doi.org/10.1145/2541016.2541040>

Emily Olsen. (2021, October 25). Amazon to launch Alexa at senior living facilities, health systems. *MobiHealthNews*. <https://www.mobihealthnews.com/news/amazon-launch-alexa-senior-living-facilities-health-systems>

Estes, C. L., & Binney, E. A. (1989). The Biomedicalization of Aging: Dangers and Dilemmas<sup>1</sup>. *The Gerontologist*, 29(5), 587–596. <https://doi.org/10.1093/geront/29.5.587>

Federica Laricchia. (2022). Number of smart speaker users: U.S. seniors 2018. Statista. <https://www.statista.com/statistics/941091/united-states-smart-speaker-senior-citizen-usage/>

Frauenberger, C. (2019). Entanglement HCI The Next Wave? *ACM Transactions on Computer-Human Interaction*, 27(1), 2:1–2:27. <https://doi.org/10.1145/3364998>

Giusti, L., Mencarini, E., & Zancanaro, M. (2010). “Luckily, I Don’T Need It”: Elderly and the Use of Artifacts for Time Management. Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries, 198–206. <https://doi.org/10.1145/1868914.1868940>

Harrington, C. N., Garg, R., Woodward, A., & Williams, D. (2022). “It’s Kind of Like Code-Switching”: Black Older Adults’ Experiences with a Voice Assistant for Health Information Seeking. CHI Conference on Human Factors in Computing Systems, 1–15.

<https://doi.org/10.1145/3491102.3501995>

Hudson, J., Ungar, R., Albright, L., Tkatch, R., Schaeffer, J., & Wicker, E. R. (2020). Robotic Pet Use Among Community-Dwelling Older Adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 75(9), 2018–2028. <https://doi.org/10.1093/geronb/gbaa119>

Jönsson, K.-E., Ornstein, K., Christensen, J., & Eriksson, J. (2019). A reminder system for independence in dementia care: A case study in an assisted living facility. Proceedings of the 12th ACM International Conference on Pervasive Technologies Related to Assistive Environments, 176–185. <https://doi.org/10.1145/3316782.3321530>

Kim, S. (2021). Exploring How Older Adults Use a Smart Speaker-Based Voice Assistant in Their First Interactions: Qualitative Study. *JMIR mHealth and uHealth*, 9(1), e20427. <https://doi.org/10.2196/20427>

Kim, S., & Choudhury, A. (2021). Exploring older adults’ perception and use of smart speaker-based voice assistants: A longitudinal study. *Computers in Human Behavior*, 124, 106914. <https://doi.org/10.1016/j.chb.2021.106914>



- Kowalski, J., Jaskulska, A., Skorupska, K., Abramczuk, K., Biele, C., Kopeć, W., & Marasek, K. (2019). Older Adults and Voice Interaction: A Pilot Study with Google Home. Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, LBW0187:1-LBW0187:6. <https://doi.org/10.1145/3290607.3312973>
- Lazar, A., Thompson, H. J., Piper, A. M., & Demiris, G. (2016). Rethinking the Design of Robotic Pets for Older Adults. Proceedings of the 2016 ACM Conference on Designing Interactive Systems, 1034-1046. <https://doi.org/10.1145/2901790.2901811>
- Lopatovska, I., & Williams, H. (2018). Personification of the Amazon Alexa: BFF or a Mindless Companion. Proceedings of the 2018 Conference on Human Information Interaction & Retrieval - CHIIR '18, 265-268. <https://doi.org/10.1145/3176349.3176868>
- McGlynn, S., Snook, B., Kemple, S., Mitzner, T. L., & Rogers, W. A. (2014). Therapeutic Robots for Older Adults: Investigating the Potential of Paro. Proceedings of the 2014 ACM/IEEE International Conference on Human-Robot Interaction, 246-247. <https://doi.org/10.1145/2559636.2559846>
- Mettouris, C., Yeratziotis, A., Fixl, L., Parker, S., Starosta-Sztuczka, J., Clarke, V., Rosenauer, G., Daxberger, W., Koumou, S., Panayides, M., Zampa, G., Theodorou, C., & Papadopoulos, G. A. (2023). eSticky: An Advanced Remote Reminder System for People with Early Dementia. SN Computer Science, 4(4), 334. <https://doi.org/10.1007/s42979-023-01768-3>
- Milka Trajkova, & Martin-Hammond, A. (2020). "Alexa is a Toy": Exploring Older Adults' Reasons for Using, Limiting, and Abandoning Echo. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1-13. <https://doi.org/10.1145/3313831.3376760>
- Nurain, N., Chung, C.-F., Caldeira, C., & Connelly, K. (2021). Hugging with a Shower Curtain: Older Adults' Social Support Realities During the COVID-19 Pandemic. Proceedings of the ACM on Human-Computer Interaction, 5(CSCW2), 463:1-463:31. <https://doi.org/10.1145/3479607>
- Oewel, B., Ammari, T., & Brewer, R. N. (2023). Voice Assistant Use in Long-Term Care. Proceedings of the 5th International Conference on Conversational User Interfaces, 1-10. <https://doi.org/10.1145/3571884.3597135>
- Porcheron, M., Fischer, J. E., Reeves, S., & Sharples, S. (2018). Voice Interfaces in Everyday Life. Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18, 1-12. <https://doi.org/10.1145/3173574.3174214>
- Pradhan, A., Findlater, L., & Lazar, A. (2019). Phantom Friend or Just a Box with Information: Personification and Ontological Categorization of Smart Speaker-based Voice Assistants by Older Adults. Proceedings of the ACM on Human-Computer Interaction, 3(CSCW), 214. <https://doi.org/10.1145/3359316>
- Pradhan, A., Gallier, J., Domjan, R., Dixon, E., Bao, R., Maddali, H. T., & Lazar, A. (2023). Towards a System Architecture for Connected Physical and Digital Reminders Using Embodied Objects for People with Dementia. The 25th International ACM SIGACCESS Conference on Computers and Accessibility. <https://doi.org/10.1145/3597638.3614506>
- Pradhan, A., Lazar, A., & Findlater, L. (2020). Use of Intelligent Voice Assistants by Older Adults with Low Technology Use. ACM Transactions on Computer-Human Interaction, 27(4), 31:1-31:27. <https://doi.org/10.1145/3373759>
- Pradhan, A., Mehta, K., & Findlater, L. (2018). "Accessibility Came by Accident": Use of Voice-Controlled Intelligent Personal Assistants by People with Disabilities. Proceedings of the 2018

CHI Conference on Human Factors in Computing Systems, 459:1-459:13.

<https://doi.org/10.1145/3173574.3174033>

Rogers, Y., Paay, J., Brereton, M., Vaisutis, K. L., Marsden, G., & Vetere, F. (2014). Never too old: Engaging retired people inventing the future with MaKey MaKey. Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI '14, 3913-3922.

<https://doi.org/10.1145/2556288.2557184>

Rosenberger, R., & Verbeek, P. P. C. C. (2015). Postphenomenological Investigations: Essays on Human-Technology Relations. Lexington Books.

<https://research.utwente.nl/en/publications/postphenomenological-investigations-essays-on-human-technology-re>

Shantanu Kurhekar. (2021, October). Alexa is Coming to Hospitals and Senior Living Communities to Improve Care Experience and Help Fight Loneliness. Alexa-Blog.

<https://developer.amazon.com/en-US/blogs/alexa/device-makers/2021/10/alexa-is-coming-to-hospitals-and-senior-living-communities.html>

St. Pierre, E. A. (2018). Writing Post Qualitative Inquiry. Qualitative Inquiry, 24(9), 603-608.

<https://doi.org/10.1177/1077800417734567>

Stigall, B., Waycott, J., Baker, S., & Caine, K. (2019). Older Adults' Perception and Use of Voice User Interfaces: A Preliminary Review of the Computing Literature. Proceedings of the 31st Australian Conference on Human-Computer-Interaction, 423-427.

<https://doi.org/10.1145/3369457.3369506>

Strauss, A. L. (1987). Qualitative Analysis for Social Scientists. Cambridge University Press.

Upadhyay, P., Heung, S., Azenkot, S., & Brewer, R. N. (2023). Studying Exploration & Long-Term Use of Voice Assistants by Older Adults. Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, 1-11. <https://doi.org/10.1145/3544548.3580925>

Verbeek, P.-P. (2015, April 27). Beyond interaction: A short introduction to mediation theory. Interactions, 22(3), 26-31.

Vines, J., Pritchard, G., Wright, P., Olivier, P., & Brittain, K. (2015). An Age-Old Problem: Examining the Discourses of Ageing in HCI and Strategies for Future Research. ACM Transactions on Computer-Human Interaction, 22(1), 1-27. <https://doi.org/10.1145/2696867>

Zubatiy, T., Vickers, K. L., Mathur, N., & Mynatt, E. D. (2021). Empowering Dyads of Older Adults With Mild Cognitive Impairment And Their Care Partners Using Conversational Agents. Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems, 1-15.

<https://doi.org/10.1145/3411764.3445124>

© [CC-BY-NC 4.0](#) The Author(s). For more information, see our [Open Access Policy](#).