

Designing a Recommender System to Recruit Older Adults for Research Studies

Md Atik Enam¹, Swapnil Srivastava¹ and Bart P. Knijnenburg¹

¹School of Computing, Clemson University, Clemson, USA

Abstract

Recruiting older adults for research studies is a challenging endeavor. We conducted an interview to understand older adults' preferences and expectations, with the goal of building a recommender system to support the selection of suitable research studies. Our findings suggest that sharing the results of the studies they participated in would motivate older adults to participate in more studies and give them a feeling of self-accomplishment and belonging. We list 15 design implications based on our user research and present a prototype system based on these design implications.

Keywords

Older adults, Design implications, Prototype design, Interviews, Recommender systems

1. Introduction

Older adults constitute a large part of the world population—a proportion projected to rise from 9% in 2019 to 16% in 2050 [40]. As this growing population requires special care [28], researchers study whether the lifestyles of these people can be improved by introducing technologies such as autonomous vehicles and smart homes [20, 6]. The goal of these technologies is to make older adults more independent [11] reduce their self-perception of burdening society [17] and help them contribute meaningfully to their community [8]. Most of these studies require older adults as participants—either to understand the specific needs and wants of this population, to evaluate systems that are built for them, or to study issues related to their use of existing systems that are generally designed for a younger population (cf. [24, 21, 19]). We therefore set out to study what researchers should keep in mind when recruiting older adult participants. Jacelon usefully outlined specific considerations regarding the recruitment process, interview length, instrument design, etc. [25]. However, what a research study looks like from the perspective of an older adult has not been thoroughly studied. To bridge this gap, we conducted in-depth interviews with older adult participants to answer the following research questions:

- **RQ1:** What characteristics of a study attract older adults, and how do they decide to get involved?
- **RQ2:** What are the gains and expectations of

older adults from the research studies they participate in?

Using the insights from our interviews, we designed a prototype of a recommender system that helps older adults evaluate, select, and provide feedback on available research studies, thereby answering one more research question:

- **RQ3:** What should designers keep in mind while designing intelligent user interfaces for older adults?

Using our findings to these RQs as a guideline, we discuss how HCI researchers can best design studies to attract older adult participants, how to create an adaptive decision support system that helps them evaluate those attributes, and, more in general, how to design intelligent user interfaces that are suitable for older adults.

2. Related Work

2.1. Designing for Older Adults

The main goal of our work is to design a recommender system that helps older adults in evaluating and selecting research studies to participate in. Designing an accessible recommender system for older adults is not a straightforward task. A number of general system design suggestions are provided in review papers by Morris [39] and by Fisk et al. [18]. Similarly, Mitzner et al., in a survey-based study, presented a few factors that may influence technology adoption in older adults. These predictors can help us understand how to design a system for older adults [35].

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✉ menam@clemson.edu (M. A. Enam); srivas7@clemson.edu

(S. Srivastava); bartk@clemson.edu (B. P. Knijnenburg)

🆔 0000-0002-0877-7063 (M. A. Enam); 0000-0003-1341-0669

(B. P. Knijnenburg)



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Table 1
Description of the Participants

Participant ID	Gender	Age	Computer Literacy	Occupation
P1	Male	92	Sometimes	Chemical Engineer
P2	Female	73	Sometimes	Arts Business
P3	Male	92	No longer Use	Engineer
P4	Female	84	Very Little Use	Volunteering Works
P5	Male	93	No longer Use	Business
P6	Female	89	Regular Use	Volunteering Works
P7	Male	93	No longer use	Navy Officer, Professor

2.2. Older Adults' Participation in Research Studies

However, to develop a recommender system for participating in research studies, it is important to know what factors influence older adults' preferences in participating in such studies. Beyond the work by Jacelon [25] outlined in the introduction, there are several other works related to how studies should recruit older adults to minimize barriers related to culture, health, or institutions [27, 46, 36]. Most of these works related to clinical research rather than technology-related studies [38, 3, 43]. We aim to focus on the latter, because technology can play a crucial role in helping older adults live their lives more comfortably [34, 10, 22].

Older adults are likely to participate in designing and developing smart technology systems if they find that it will improve their lifestyles [26]. Roger and Fisk provided an overview of how psychology can help to understand older adults' preferences and their importance in the participatory design process [44].

2.3. Computer Literacy among Older Adults

In designing a recommender system for older adults, it is important to keep in mind that many of them did not have computers in their early childhood, which impacts how they learn to use a new system [2]. This potential lack of digital literacy [42]—often coupled with anxiety and a lack of interest in learning computers [14, 1]—makes it difficult for designers to develop a system that older adults can learn and use independently [4].

Note that while many studies on digital literacy focus barriers that hinder older adults in learning a new technology [32, 7, 37] Martínez-Alcalá showed that older adults can gain digital literacy if they are sufficiently motivated [33]. Note also that older adults vary substantially in their level of digital literacy, which makes it even more difficult to generalize designs for a particular age group [32]. We particularly take the importance of motivation and older adults' diversity of experiences into account

when designing our recommender system.

3. Methods

In October 2022 we conducted an IRB-approved study, interviewing 7 participants (see Table 1) to understand older adults' needs and expectations around participating in research studies. We recruited participants through the Director of Community Outreach (DCO) of a local assisted-living community. The DCO contacted the residents to schedule several interviews. After obtaining participants' consent to participate and to audio-record the conversation, we conducted semi-structured interviews using a number of predefined questions but asking in-depth follow-up questions whenever we desired more details or further explanation. The interviews lasted around 45-60 minutes. We analyzed the audio transcripts of the recordings using open coding, and compared codes to generate a list of design implications. These user research findings (see Section 4) then helped us design a prototype recommender system (see Section 5).

4. Findings from User Research

Upon discussing our open codes, we divided our findings into two broad categories: characteristics of research studies that attract older adults, and personal gains and expectations older adults have regarding research studies. The design implications related to our findings are displayed in Table 2. The quotes below are edited for clarity and brevity.

4.1. Characteristics of Research Studies that Attract Older Adults

4.1.1. Personal Interest and Challenge

[Basis for DI11 and DI14] Most participants expressed that if the topic of a research study is interesting, they will most likely participate. Of particular interest were research studies related to health and lifestyles improvements:

Table 2
Design Implications from User Research

ID	Design Implications
DI1	The system should consider the computer literacy level of the users
DI2	The system should consider the potential disabilities of older adults and provide assistance options
DI3	The system should recommend items based on the participant's past professions and skills
DI4	The system should not recommend things with which the participant had bad experiences
DI5	The system should ask whether the participant likes group activities or individual studies
DI6	The system should recommend items based on the participant's past volunteering experiences
DI7	The system should leverage word-of-mouth as a means to promote studies among older adults
DI8	The system should recommend studies that make older adults feel like they are contributing to society, especially related to health issues
DI9	The system should inform older adults about the results of the studies they participated in
DI10	The system should use a feedback system to help refine the recommendations
DI11	The system should provide recommendations that align with the participant's interests
DI12	The system should allow older adults to share their experiences with friends and family members
DI13	The system must consider the community building aspects of volunteering for older adults
DI14	The system should recommend interesting studies that challenge them within the limits of their abilities
DI15	The system should not recommend remote/virtual studies to participants who do not like such studies

“Once, they had a study where they put red buttons on the walls, and they tried to understand if we found that useful for emergencies or calling someone. We do not carry phones all the time. In a space like this [small patio] where most of the staff can not see us, a button is helpful to call someone quickly in case of an emergency.” —P7

Older adults also expressed a desire for challenging activities, such as pairing up with other people to create a prototype, or doing some other activity that is not beyond their limitations:

“I have participated with some of the things they got over there, which were very interesting. One was for five sessions, where I paired up with two students, and the object was for the students to design something those folks could really use in their life.”—P3

“When talk to some of the students here for some of their projects, I am impressed with them because they come up with some pretty interesting challenges.”—P3

4.1.2. Group Discussion

[DI5, DI13] All participants liked studies where they are asked to talk in a group rather than in a one-to-one discussion, because they want to socialize with the people around them:

“We have a meeting once a week... It is called Greet... It's held out in the entrance area of our my apartment. That group then gets together, and they hear each other... And so you get to see what other people, what they're having problems with.”—P3

Beyond these arranged events, they do not get many opportunities to discuss different topics with other people in the facility. Research studies provide residents with good opportunities to talk about things they usually do not feel comfortable about or do not know with whom to talk about. In that case, they want the groups to be as mixed as possible because they think such groups will consist of more diversified opinions:

“I get to hear all the opinions... sometimes they don't agree with me but that's more enjoyable to me. Uh, because I like to hear other people's opinions on this study as to where they think we're doing it right or wrong. Sometimes they have really good points.”—P3

4.1.3. Study Location

[DI2] Participants like to go outside for studies, but most have health issues that prohibit them from driving. They expressed that if studies provide them with transportation and accommodations, they are happy to go to a remote location:

“It depends on the circumstances, how you get there. Yeah, if you could go and

stay, and perhaps you know... Would they give you housing and food, or would you have to arrange it yourself?"—P6

4.1.4. Computer Literacy

[DI1, DI15] Our participants had moderate knowledge of how to use computers and mobile phones. Most of them use computers to communicate with others via email. Some also use social media applications to keep in contact with friends and family, and banking applications to manage finances:

"Say uh the email situation. I do all my banking on the computer and all that. And then, whenever I have a question about something, I go to Google. So yeah, I do (use computers)"—P3

None of the participants ever used a computer or mobile phone to find a research study to participate in, but all said they were willing to try out an application that can suggest studies based on their preferences. Furthermore, most of them had used a computer as an instrument of a study, or to participate in studies virtually:

"Sure, we've [used computers], but we were doing it as a six of us together on their computers..."—P4

4.1.5. Relation to Past Experiences, Professions, and Skills

[DI3, DI4, DI6] Past experiences with studies play an essential role in deciding whether to participate in future studies. If a study did not go well for them (e.g., the study was in an inconvenient location, or some study procedure made them feel sick), they are likely to avoid similar studies. One other participant recalled taking a chemistry class where students were experimenting with dogs:

"They used to do experiments, so they could get involved. These mad students, they were using dogs, and that's when I decided I didn't want to experiment on dogs."—P6

Participants like to use their past experiences and skills. One participant once had a near-death experience and overcame his fear by teaching others how to do CPR. He used the same attitude when deciding to participate in studies:

"I've had an up close and personal connection to the whole process. Either I can do this or be the test dummy, and I've already

been the test dummy. In this instance it has a tinge of overcoming fear. Okay this happened to me so I am going to prove I am over this by teaching someone else to do it... I generally end up volunteering for the same things: I want to use the skills I have acquired over a lifetime."—P2

4.1.6. Social Influence

[DI7, DI12] While not all participants initially enjoyed participating in studies, they often get motivated by friends living in the same facility who like to participate. Some noted that if they do not participate, others might think badly of them. One participant said that he participated in studies because it made others happy:

"I do not go out of my way to volunteer, especially for research studies. I do it because people around me are doing something like meals on wheels and it makes them happy."—P2

4.1.7. Invitation from Known Faces in the Facility

[DI7] In the facility where we conducted our interviews, the DCO usually contacts residents to determine whether they want to participate in the research studies:

"She comes over and tells us that we've got a group that's coming, and would we like to participate?"—P4

"The young lady came in earlier this week and told me students want to come over to interview you. Would you participate? And she knew I would say sure."—P2

Usually, residents instantly accept the DCO's invitation without knowing what the study is about. This can cause issues because participants may find out later that the study requires them to do something they dislike. While the DCO usually tells them *who* is conducting the study, this information is not sufficient. Instead, it would be a good practice to let participants know what the study is about, how long it takes, and whether it has any further requirements.

4.1.8. Preferences for virtual meeting platforms

[DI15] Most participants had health issues restricting them from participating in studies. When they started participate in studies virtually, they began to like online meeting platforms such as Zoom. Since then, they started using them for different purposes, such as "Sunday Church School."

“We zoom church and zoom ”Sunday School” now; zoom helps us to communicate without being there physically. Okay, so we do. You know, they still do that through [zoom].”—P1

4.1.9. Privacy protection

Most participants did not have any privacy issues regarding their participation in research studies. They do not want their names to be on the research articles, but beyond that, they cannot think of any other ways their privacy could be violated. While linkage attacks using the information provided in the research articles could be possible [15], most studies seem to ask only general questions about the issues they face as an older adult, which most older adults seemed completely fine with:

“You don’t have to use our names. Anyway, this is just a general question about senior citizens.”—P5

4.2. Gains, Expectations of Older Adults from the Research Studies

4.2.1. Self-Accomplishment

[DI8, DI14] Older adults know there are not many opportunities where they can contribute through physical work, so they seek out opportunities where they can help others through their experience:

“I feel inclined for example to help this kid... he wanted advice on something for his job. I like helping individuals who need help for specific things.”—P2

Similarly, our participants mentioned that they want to participate in studies that help others and contribute to society. This gives them a feeling of self-accomplishment:

“We look at projects that are probably good to have here, that will make the place better”—P3

4.2.2. Discussion with Family and Friends

[DI12] Participants said that on the weekends they spend a significant amount of time with family. They discuss what their week was like and share things that they find interesting. They mentioned that they often share their experience participating in research studies with their family members over dinner. To them, it is an accomplishment they can share with their family:

“I like to see they look healthy and that we are all together, but we’ll tell them tonight about our adventure with you folks today, so we discuss that.”—P4

4.2.3. Research follow-up

[DI9, DI10] Participants mentioned they would be happy to be contacted again if researchers had remaining questions; this would make them feel their experiences are an asset to the researchers. Furthermore, they would love to know more about the outcomes of the studies they participate in. This helps the residents see that they have made a small but valuable contribution to the research community and help them achieve something:

“I would like to see what some of those results mean for you. I never did hear a follow-up with results, and what I wanted to know how it all came out.”—P4

One participant asked researchers to bring in the published journal article so they could read the study’s outcomes:

“We would be happy to have that, since we were a part of this. Would be nice to put in the library here: Things from the participants of [facility name].”—P2

4.2.4. Decision Autonomy

One of the participants mentioned that he wanted more autonomy to choose what study to participate in. He mentioned that he would love to use a system that would recommend opportunities to volunteer for a study based on his experiences, skills, and preferences:

“Let me make up my own mind. What I like is when I have a diversity of options, like when I am on eBay. I can go and see the details of each option too.”—P2

5. Design of the Prototype

The design implications of our research are summarized in Table 2. Our user research findings show that older adults love to contribute to society by participating in research studies. Importantly, there are various individual factors that can be used to match participants with studies: some like to participate in group studies, others prefer challenging activities, and still others prefer studies related to health issues. Older adults also face a variety of limitations that prevent them from participating in certain studies. Ideally, older adults can use these factors to decide for themselves which studies they want to participate in. In the current process, researchers usually do not contact the participants personally, and participants have no opportunity to select studies that match their desires and limitations. Our primary focus is

Table 3

To avoid cold start problem, ROAFSS asks 6 questions to the participants, based on the design implications (DI1-DI7)

Id	Question
Q1	Do you have any disabilities? Please mark the disabilities that apply to you or leave them blank if they don't.
Q2	Please indicate if you need any accommodation or transportation for a remote study.
Q3	Do you have an experience from a past study that was uncomfortable for you?
Q4	Please list your skills to help us give you better recommendations.
Q5	Would you rather participate in a group study or an individual study?
Q6	How many hours of volunteering have you done?

Table 4

Feedback System to refine recommendation for the future based on the design implications.

Id	Feedback question	Related DIs
F1	Were you satisfied with the recommended volunteering opportunity?	DI4, DI6
F2	Does this volunteering experience help you develop skills of your interest?	DI1, DI6, DI11, DI14
F3	Was this study topic interesting to you?	DI4, DI6, DI11
F4	Are you satisfied with your learning outcomes from your participation in this study?	DI1
F5	Would you like to be updated on the progress of this research?	DI9
F6	Was the time commitment to this study comfortable for you?	DI6, DI10
F7	Would you like to participate in research studies of similar topics?	DI6, DI10, DI11
F8	Does the participation in this study increase a sense of community for you?	DI13
F9	Does participation in a study like this help you achieve your goals?	DI8
F10	Would you like to share this study with your peers?	DI7, DI12, DI13

thus on automating recruiting participants through a recommender system that can help the older adults evaluate and select research studies. We note that older adults sometimes need help to express their desires and limitations. We solved this issue by introducing a feedback option, which helps our system refine future recommendations.

Furthermore, our user research findings show that older adults love to learn more about the results of the studies they participated in. Currently, this generally does not happen. Our system helps “close the loop” from participating in research studies to learning about their findings and contributions by making the research outcomes available to users.

Our Recommender System for Older Adults to Find Suitable Studies (ROAFSS) consists of four main pages. The recommendation page (Fig. 1a) lists studies that the user may participate in, tailored to the answers they gave to six questions about their abilities and preferences (Table 3) and the feedback they gave to past studies. Each study is listed with a title, contribution (DI8), individual vs. group participation (DI5), remote vs. local requirements (DI15), and the names of friends who have already signed up to participate in the study (DI8). The study-specific page (Fig. 1b) shows additional details of the study, contact information, and the “Participate” and “Share” buttons (DI12). On the profile page (Fig. 1c) ROAFSS shows the past studies the user has participated in. From there, the user can visit the result page (Fig. 1d)

of a study if results are available (DI9), contact the researcher, or give feedback on the study (DI10). The feedback mechanism asks 10 questions (Table 4) about the study, avoids studies similar to the ones they disliked, and promotes studies similar to the ones they liked.

ROAFSS collects and stores personal information about study participants, which may cause privacy concerns. Note, though, that participants in our studies did not seem overly concerned about this. Moreover, ROAFSS can potentially serve as a portal for research study participation, so that individual studies themselves do not have to collect any personally identifiable information. This would increase the overall privacy of the study participants, since they only have to disclose their identifiable information once, and this information is never stored alongside their research participation data.

6. Discussion

Older adults’ perspectives matter and they love to contribute to the society While existing works [39, 18, 25, 27, 36, 44] are essential to help reduce the challenges older adults face in research studies, they do not explicitly consider older adults’ motivations and desires to participate. Our study found that older adults are eager to participate in research studies that are a) challenging and interesting, b) social, and c) relevant to their past professions and skills. Participation is heavily in-

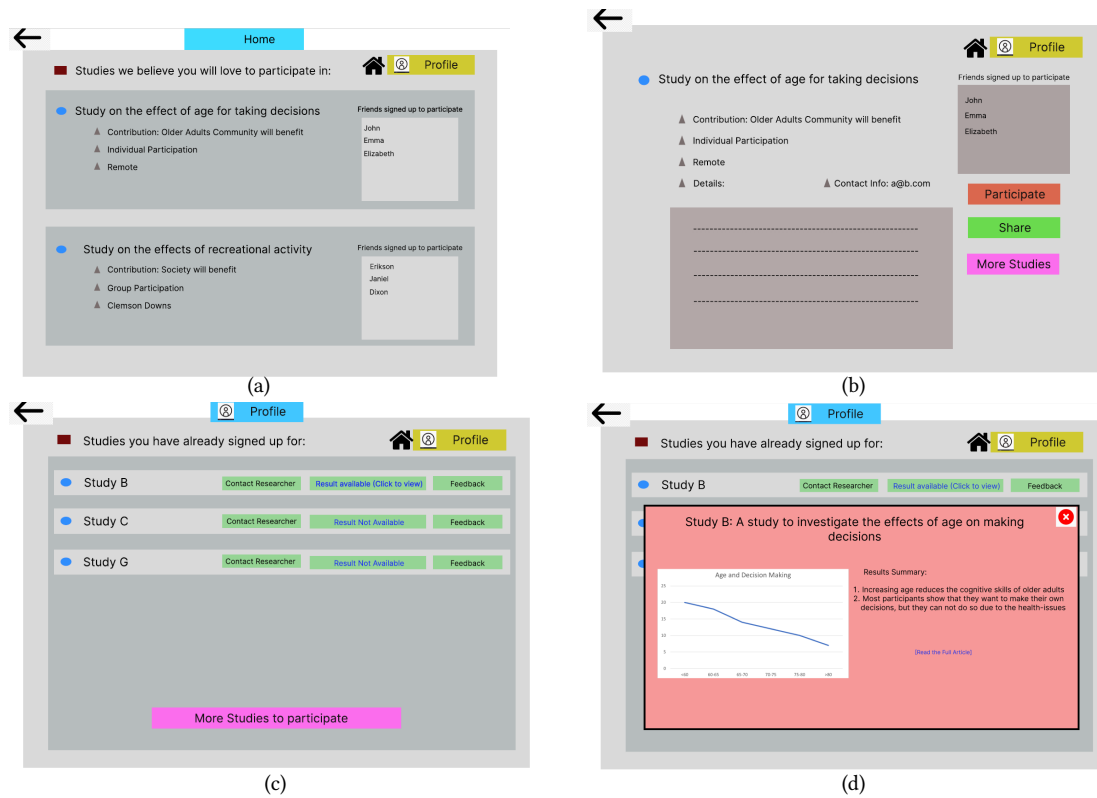


Figure 1: The (a) study recommendation page, (b) specific study page, (c) profile page, and (d) result page of a study.

fluenced by peers' participation in the same studies, and older adults love to share their participation experiences with friends and family. Finally, older adults would love to hear about the results of the studies they participate in—this gives them a feeling of self-accomplishment and belonging.

Designers must carefully consider what older adults look for Practitioners and researchers have compiled useful guidelines for developing systems for older adults [41, 12, 9, 5, 16, 31], but little work exists that takes an explicit user-centric approach to the design of recommender systems for older adults. Our results include several design implications based on in-depth interviews with older adult participants that practitioners and researchers can use as a guide to develop recommender systems for this user community. Furthermore, we encourage designers and researchers to use our methodology to find system-specific design implications.

Limitations and Future Work We ran our study with a small number of older adults from a single residential community. Different communities and people from di-

verse backgrounds will have different experiences, so future work should expand the participant pool to see if our findings generalize. Moreover, future research may implement our proposed system and conduct a user experiment [29] to see if the system indeed increases older adult participants' satisfaction, how it supports their self-actualization [30], and how the feedback systems help refine the recommendations.

This article does not consider the age-related accessibility issues older adults face [13, 45, 23]. Our focus is more on the general opinions of older adults about participating in research studies. Thus, future works may examine how older adults with accessibility issues perceive participation in research studies.

7. Conclusion

We conducted in-depth interviews with older adults to understand their motivations, restrictions and expectations around participating in research studies. We found that older adults participate in research studies because like to contribute to society with their work and opinions. We also built a prototype that will recommend the users

of the system research studies that they can choose from. Such a recommender system can provide the older adult community useful support in selecting research studies that fit their preferences and limitations.

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References

- [1] Lisa A. Hollis-Sawyer, Harvey L. Sterns. 1999. A novel goal-oriented approach for training older adult computer novices: Beyond the effects of individual-difference factors. *Educational Gerontology* 25, 7 (1999), 661–684.
- [2] Robert H Anderson, Tora K Bikson, Sally Ann Law, and Bridger M Mitchell. 2001. Universal access to email: feasibility and societal implications. In *The digital divide: facing a crisis or creating a myth?* 243–262.
- [3] Patricia A Areal and Dolores Gallagher-Thompson. 1996. Issues and recommendations for the recruitment and retention of older ethnic minority adults into clinical research. *Journal of consulting and clinical psychology* 64, 5 (1996), 875.
- [4] Sajay Arthanat, Kerryellen G Vroman, Catherine Lysack, and Joseph Grizzetti. 2019. Multi-stakeholder perspectives on information communication technology training for older adults: implications for teaching and learning. *Disability and Rehabilitation: Assistive Technology* 14, 5 (2019), 453–461.
- [5] Laura-Mihaela Bogza, Cassandra Patry-Lebeau, Elina Farmanova, Holly O Witteman, Jacobi Elliott, Paul Stolee, Carol Hudon, Anik MC Giguere, et al. 2020. User-centered design and evaluation of a web-based decision aid for older adults living with mild cognitive impairment and their health care providers: mixed methods study. *Journal of medical Internet research* 22, 8 (2020), e17406.
- [6] Julian Brinkley, Earl W Huff, and Md Atik Enam. 2022. Transforming Transportation in the Pursuit of Barrier Free Mobility: The State-of-the-Art in Autonomous Vehicle Interaction Technologies for People with Disabilities. In *Conference: The 2022 ICT Accessibility Testing Symposium: Driving Accessibility Together*. ACM, 11–26.
- [7] Ke Chen and Alan Hoi Shou Chan. 2014. Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM). *Ergonomics* 57, 5 (2014), 635–652.
- [8] Lona H Choi. 2003. Factors affecting volunteerism among older adults. *Journal of Applied Gerontology* 22, 2 (2003), 179–196.
- [9] Victor Philip Cornet, Tammy Toscos, Davide Bolchini, Romisa Rohani Ghahari, Ryan Ahmed, Carly Daley, Michael J Mirro, and Richard J Holden. 2020. Untold stories in user-centered design of mobile health: Practical challenges and strategies learned from the design and evaluation of an app for older adults with heart failure. *JMIR mHealth and uHealth* 8, 7 (2020), e17703.
- [10] Sara J Czaja, Walter R Boot, Neil Charness, Wendy A Rogers, and Joseph Sharit. 2018. Improving social support for older adults through technology: Findings from the PRISM randomized controlled trial. *The Gerontologist* 58, 3 (2018), 467–477.
- [11] Sara J Czaja, José H Guerrier, Sankaran N Nair, and Thomas K Landauer. 1993. Computer communication as an aid to independence for older adults. *Behaviour & Information Technology* 12, 4 (1993), 197–207.
- [12] Ana Correia De Barros, Roxanne Leitão, and Jorge Ribeiro. 2014. Design and evaluation of a mobile user interface for older adults: navigation, interaction and visual design recommendations. *Procedia Computer Science* 27 (2014), 369–378.
- [13] José-Manuel Díaz-Bossini and Lourdes Moreno. 2014. Accessibility to mobile interfaces for older people. *Procedia Computer Science* 27 (2014), 57–66.
- [14] R Darin Ellis and Jason C Allaire. 1999. Modeling computer interest in older adults: The role of age, education, computer knowledge, and computer anxiety. *Human Factors* 41, 3 (1999), 345–355.
- [15] Md Atik Enam, Sadman Sakib, and Md Saidur Rahman. 2019. An algorithm for l-diversity clustering of a point-set. In *2019 International Conference on Electrical, Computer and Communication Engineering (ECCE)*. IEEE, 1–6.
- [16] Miranda A Farage, Kenneth W Miller, Funmi Ajayi, and Deborah Hutchins. 2012. Design principles to accommodate older adults. *Global journal of health science* 4, 2 (2012), 2.
- [17] Miranda A Farage, Kenneth W Miller, Enzo Berardesca, and Howard I Maibach. 2008. Psychosocial and societal burden of incontinence in the aged population: a review. *Archives of gynecology and obstetrics* 277, 4 (2008), 285–290.
- [18] Dan Fisk, Neil Charness, Sara J Czaja, Wendy A Rogers, and Joseph Sharit. 2004. *Designing for older adults*. CRC press.
- [19] Norina Gasteiger, Ho Seok Ahn, Christopher Lee,

- Jongyoon Lim, Bruce A Macdonald, Geon Ha Kim, and Elizabeth Broadbent. 2022. Participatory Design, Development, and Testing of Assistive Health Robots with Older Adults: An International Four-year Project. *ACM Transactions on Human-Robot Interaction* (2022).
- [20] Abir Ghorayeb, Rob Comber, and Rachael Goberman-Hill. 2021. Older adults' perspectives of smart home technology: Are we developing the technology that older people want? *International journal of human-computer studies* 147 (2021), 102571.
- [21] Aaron Gluck, Kwajo Boateng, Earl W Huff Jr, and Julian Brinkley. 2020. Putting Older Adults in the Driver Seat: Using User Enactment to Explore the Design of a Shared Autonomous Vehicle. In *12th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. 291–300.
- [22] Maurita T Harris, Kenneth A Blocker, and Wendy A Rogers. 2022. Older adults and smart technology: facilitators and barriers to use. *Frontiers in Computer Science* (2022), 41.
- [23] Earl W. Huff, Natalie DellaMaria, Brianna Posadas, and Julian Brinkley. 2019. Am I Too Old to Drive? Opinions of Older Adults on Self-Driving Vehicles. In *Proceedings of the 21st International ACM SIGACCESS Conference on Computers and Accessibility* (Pittsburgh, PA, USA) (*ASSETS '19*). Association for Computing Machinery, New York, NY, USA, 500–509. <https://doi.org/10.1145/3308561.3353801>
- [24] Earl W Huff Jr, Natalie DellaMaria, Brianna Posadas, and Julian Brinkley. 2019. Am I too old to drive? opinions of older adults on self-driving vehicles. In *The 21st International ACM SIGACCESS Conference on Computers and Accessibility*. 500–509.
- [25] Cynthia S Jacelon. 2007. Older adults' participation in research. *Nurse Researcher* 14, 4 (2007).
- [26] Cynthia S Jacelon and Allen Hanson. 2013. Older adults' participation in the development of smart environments: An integrated review of the literature. *Geriatric Nursing* 34, 2 (2013), 116–121.
- [27] Betül Kanık, Özden Melis Uluğ, Nevin Solak, and Maria Chayinska. 2022. “Let the strongest survive”: Ageism and social Darwinism as barriers to supporting policies to benefit older individuals. *Journal of Social Issues* (2022).
- [28] Jürgen Kiessling, Margaret Kathleen Pichora-Fuller, Stuart Gatehouse, D Stephens, Stig Arlinger, T Chisolm, AC Davis, NP Erber, L Hickson, A Holmes, et al. 2003. Candidature for and delivery of audiological services: special needs of older people. *International journal of audiology* 42, sup2 (2003), 92–101.
- [29] B.P. Knijnenburg and M.C. Willemsen. 2015. Evaluating recommender systems with user exper-
iments. In *Recommender systems handbook*. Springer, Boston, MA, 309–352.
- [30] Bart P. Knijnenburg, Saadhika Sivakumar, and Darcia Wilkinson. 2016. Recommender Systems for Self-Actualization. In *Proceedings of the 10th ACM Conference on Recommender Systems* (Boston, Massachusetts, USA) (*RecSys '16*). Association for Computing Machinery, New York, NY, USA, 11–14. <https://doi.org/10.1145/2959100.2959189>
- [31] Chuan Ma, Olivia Guerra-Santin, and Masi Mohammedi. 2021. Smart home modification design strategies for ageing in place: a systematic review. *Journal of Housing and the Built Environment* (2021), 1–27.
- [32] Ittay Mannheim, Ella Schwartz, Wanyu Xi, Sandra C Buttigieg, Mary McDonnell-Naughton, Eveline JM Wouters, and Yvonne Van Zaaen. 2019. Inclusion of older adults in the research and design of digital technology. *International Journal of Environmental Research and Public Health* 16, 19 (2019), 3718.
- [33] Claudia I Martínez-Alcalá, Alejandra Rosales-Lagarde, María de los Ángeles Alonso-Lavernia, José Á Ramírez-Salvador, Brenda Jiménez-Rodríguez, Rosario M Cepeda-Rebollar, José Sócrates López-Noguerola, María Leticia Bautista-Díaz, and Raúl Azael Agis-Juárez. 2018. Digital inclusion in older adults: A comparison between face-to-face and blended digital literacy workshops. *Frontiers in ICT* 5 (2018), 21.
- [34] Rachel McCloud, Carly Perez, Mesfin Awoke Bekalu, K Viswanath, et al. 2022. Using Smart Speaker Technology for Health and Well-being in an Older Adult Population: Pre-Post Feasibility Study. *JMIR aging* 5, 2 (2022), e33498.
- [35] Tracy L Mitzner, Wendy A Rogers, Arthur D Fisk, Walter R Boot, Neil Charness, Sara J Czaja, and Joseph Sharit. 2016. Predicting older adults' perceptions about a computer system designed for seniors. *Universal Access in the Information Society* 15, 2 (2016), 271–280.
- [36] Lona Mody, Douglas K Miller, Joanne M McGloin, Marcie Freeman, Edward R Marcantonio, Jay Magaziner, and Stephanie Studenski. 2008. Recruitment and Retention of Older Adults in Aging Research: (See editorial comments by Dr. Stephanie Studenski, pp 2351–2352). *Journal of the American Geriatrics Society* 56, 12 (2008), 2340–2348.
- [37] Ashley N Moore, Ann M Rothpletz, and Jill E Pre-minger. 2015. The effect of chronological age on the acceptance of Internet-based hearing health care. *American Journal of Audiology* 24, 3 (2015), 280–283.
- [38] Gina Moreno-John, Anthony Gachie, Candace M Fleming, Anna Napoles-Springer, Elizabeth Mutran,

- Spero M Manson, and Eliseo J Pérez-Stable. 2004. Ethnic minority older adults participating in clinical research. *Journal of Aging and Health* 16, 5_suppl (2004), 93S-123S.
- [39] J Morgan Morris. 1994. User interface design for older adults. *Interacting with computers* 6, 4 (1994), 373-393.
- [40] United Nations. 2020. World Population Ageing 2020 Highlights - the United Nations. https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Sep/un_pop_2020_pf_ageing_10_key_messages.pdf
- [41] Ferda Oflı, Gregorij Kurillo, Štěpán Obdržálek, Ruzena Bajcsy, Holly Brugge Jimison, and Misha Pavel. 2015. Design and evaluation of an interactive exercise coaching system for older adults: lessons learned. *IEEE journal of biomedical and health informatics* 20, 1 (2015), 201-212.
- [42] Sarah Soyeon Oh, Kyoung-A Kim, Minsu Kim, Jaeuk Oh, Sang Hui Chu, and JiYeon Choi. 2021. Measurement of digital literacy among older adults: systematic review. *Journal of medical Internet research* 23, 2 (2021), e26145.
- [43] Darina V Petrovsky, Lan N Doàn, Maria Loizos, Rachel O’Conor, Micah Prochaska, Mazie Tsang, Rachel Hopman-Droste, Tara C Klinedinst, Aarti Mathur, Karen Bandeen-Roche, et al. 2022. Key recommendations from the 2021 “inclusion of older adults in clinical research” workshop. *Journal of Clinical and Translational Science* 6, 1 (2022).
- [44] Wendy A Rogers and Arthur D Fisk. 2010. Toward a psychological science of advanced technology design for older adults. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 65, 6 (2010), 645-653.
- [45] Sergio Sayago and Josep Blat. 2009. About the relevance of accessibility barriers in the everyday interactions of older people with the web. In *Proceedings of the 2009 International Cross-Disciplinary Conference on Web Accessibility (W4A)*. 104-113.
- [46] Mina S Sedrak, Supriya G Mohile, Virginia Sun, Can-Lan Sun, Bihong T Chen, Daneng Li, Andrew R Wong, Kevin George, Simran Padam, Jennifer Liu, et al. 2020. Barriers to clinical trial enrollment of older adults with cancer: A qualitative study of the perceptions of community and academic oncologists. *Journal of geriatric oncology* 11, 2 (2020), 327-334.