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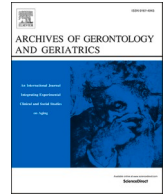
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# An “ultimate partnership”: Older persons’ perspectives on age-stereotypes and intergenerational interaction in co-designing digital technologies

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## ABSTRACT

**Aim:** There is often a gap between the ideal of involving older persons iteratively throughout the design process of digital technology, and actual practice. Until now, the lens of ageism has not been applied to address this gap. The goals of this study were: to voice the perspectives and experiences of older persons who participated in co-designing regarding the design process; their perceived role in co-designing and intergenerational interaction with the designers; and apparent manifestations of ageism that potentially influence the design of digital technology.

**Methods:** Twenty-one older persons participated in three focus groups. Five themes were identified using thematic analysis which combined a critical ageism ‘lens’ deductive approach and an inductive approach.

**Results:** Ageism was experienced by participants in their daily lives and interactions with the designers during the design process. Negative images of ageing were pointed out as a potential influencing factor on design decisions. Nevertheless, positive experiences of inclusive design pointed out the importance of “partnership” in the design process. Participants defined the “ultimate partnership” in co-designing as processes in which they were involved from the beginning, iteratively, in a participatory approach. Such processes were perceived as leading to successful design outcomes, which they would like to use, and reduced intergenerational tension.

**Conclusions:** This study highlights the potential role of ageism as a detrimental factor in how digital technologies are designed. Viewing older persons as partners in co-designing and aspiring to more inclusive design processes may promote designing technologies that are needed, wanted and used.

## 1. Introduction

Involving older persons in the design of digital technology is increasingly emphasized as a best practice that may result in designing technological products and services that are useful and actually used (Abelein & Paech, 2015; Bano & Zowghi, 2013; Fischer, Peine & Östlund, 2020). Nevertheless, various forms of exclusion of older persons from research and design of digital technology often occur due to ageism and age-stereotypes about older persons’ abilities to use technology and the perception that they cannot provide useful input in the design process (Mannheim et al., 2019). Inclusion in the design process is therefore a prerequisite, however does not guarantee that older persons are involved in a meaningful manner (Fischer et al., 2020), and that the design process is not negatively influenced by ageism or negative

images of ageing (Peine & Neven, 2021).

Ageism is defined as comprising of stereotypes, prejudice and discrimination (Officer & de la Fuente-Núñez, 2018). Older age is stereotypically associated with lower technological abilities, chronic illness, frailty, dependence and non-adoption of technology (Neven, 2010). Contrary to stereotypical assumptions of older persons as a homogenous group of ‘non-users’, (older) people hold more complex representations and approaches to using technology (Quan-Haase, Williams, Kicevski, Elueze & Wellman, 2018). Furthermore, older persons are increasingly adopting digital technologies (Nelson-Kakulla, 2020) and hold positive views of using them (Gélinas-Bronsard, Mortenson, Ahmed, Guay & Auger, 2019; Mitzner et al., 2010). Nevertheless, the discourse and image of old age in relation to digital technology is often perceived in research (Nelson-Kakulla, 2020) and design (Righi,

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Sayago & Blat, 2017) as 50+ or 60+. Unfortunately, this broad categorization of older persons entails a perception that all older persons are alike with similar (stereotypical) needs, regardless of the diversity of motivations, needs and desires that only increase in older age (Quan-Haase et al., 2018).

Whereas ageing is often discoursed as a “problem”, technology is often discoursed as an intervention to mitigate the problem and challenges of ageing (Vines, Pritchard, Wright, Olivier & Brittain, 2015). Such stereotypical assumptions about older persons might be incorporated into the design process of digital technology (Mannheim et al., 2022; McDonough, 2016). In a recent model on the Co-constitution of Ageing and Technology (CAT), Peine and Neven (2021) suggest a circular manner in which ‘images of ageing’, influence the ‘design worlds’ and how designers (mainly young) view the needs and abilities of older persons. Consequently, influencing the type of technologies designed and the underlining and implicit assumptions of how they ought to be used (‘scripts’). Older persons in turn interact with newly designed technologies (not always as intended), in accordance with their own motivations, needs, and attitudes, which further shapes how the ‘image’ of older persons is perceived in relation to digital technology.

Importantly, negative age stereotypes are learned and internalized throughout our lives and eventually may become self-directed (Levy, 2009). As such, older persons might perceive themselves as less technologically competent because of their age (Neves, 2012), and might avoid situations involving technologies to avoid the averseness of confirming negative stereotypes (Caspi, Daniel & Kavé, 2019; Köttl, Gallistl, Rohner & Ayalon, 2021). More so, as most technologies in the context of older persons are designed for care and healthcare purposes (Mannheim et al., 2022), many older persons might avoid using them as they do not meet their current needs (Neven, 2010; Righi et al., 2017) or might be perceived as stigmatizing (Köttl et al., 2021). Involving older persons in the design process is ever more important in order to capture the opinions and experiences of older persons, that are usually different than those of designers (van Boekel, Wouters, Grimberg, van der Meer & Luijckx, 2019), and include diverse needs and motivations such as leisure, fun and social communication (Astell, 2013; Greenhalgh et al., 2017; Quan-Haase et al., 2018).

Involving the (older) end-users throughout the design process is emphasized by most design approaches such as user-centred design and participatory design. A commonly used approach, derived from participatory design, is co-design, defined by Sanders and Stappers (2008) as “collective creativity as it is applied across the whole span of a design process” by “designers and people not trained in design working together in the design development process.” (Sanders & Stappers, 2008, p. 6). Such involvement throughout the design process is considered to be a continuous and iterative process (Razzouk & Shute, 2012). However, contrary to this ideal definition and reports of how collaborative participation may contribute to the success of designed technologies (Abelein & Paech, 2015; Bano & Zowghi, 2013), the reality of how older persons are involved is often different. In a recent literature review, Fischer et al. (2020) found that only 10 per cent of reviewed studies involved older persons throughout the whole design process, with most of the involvement being in initial phases of user requirements and final stages of user testing. More importantly, only 5 per cent could be defined as high involvement (users involved as partners with direct influence on design decisions), whereas the majority of studies were categorized as low involvement (users mainly involved as informants).

Low involvement of older persons may lead to misconceptions regarding their needs (Östlund, 2011). This, in combination with stereotypical assumptions and categorizations about older persons may eventually lead to designing inadequate products which are eventually not used and adopted (Greenhalgh et al., 2017). While many studies reporting the design of digital technology describe (to some extent) how older adults are involved, there is currently no study specifically examining how older persons experience their own participation in the design process. More importantly, potential manifestations of ageism in

the design process have not been assessed from the perspective of the older persons who participated in such design processes. Therefore, the goal and research questions of this study are to investigate: (1) what are the perspectives and experiences of older persons who participated in co-designing various digital technologies about the design process, ageing, and technology? (2) How do they perceive their role in the design process and the interaction with the designers? (3) And, do older adults perceive manifestations of ageism that may influence the design process?

## 2. Methods

We chose to conduct focus groups, as the design process of digital technology is often conducted in groups, where the experience of individuals can differ. More so, digital technology is a domain in which older adults as a group are potentially stereotyped in society. In focus groups, participants’ beliefs and opinions, as well as “talk” and discussion between them, can be obtained (Wilkinson, 2004). Thus, allowing to identify agreement and disagreement or even controversial themes regarding the experience of the design process. Initially, we sought to conduct three focus groups, following the finding of Guest, Namey and McKenna (2017), indicating that 2–3 groups are sufficient to identify the most prevalent themes within a dataset. Eventually, a sense of saturation and repetition of themes was indeed reached after three groups.

### 2.1. Participants

We recruited participants who were part of a community of older persons co-designing various digital technologies. The community was established by a technological organization that hosted various age-tech start-ups and provided a platform to design, test and evaluate new technologies in a living lab setting in the south of Israel. As part of this community (named by the older adults as “the seniors”), older adults participated in various design processes and steering committees. More so, they formed digital literacy related activities for older adults together with a community relations officer appointed for this matter on behalf of the organization.

The community officer, together with leaders in the older adult “seniors” community, advertised the focus group study via a mailing list and other meetings and activities. The invitation provided basic information about the meeting. The goal of the study was described as a focus group aiming to learn about the way the community and end-users participate in the design process of new technologies. Contact details of the first author were also provided, and a more detailed information letter was attached. People interested in participating signed-up with a return email or call to the organizers. There were no restrictions regarding the age or physical condition of the participants. The only prerequisite for inclusion was that they participated in at least one design process within the framework of the organization and the “seniors” community, and that they could have a conversation in Hebrew. We aimed for a minimum of six participants to register per focus group.

### 2.2. Tools and procedure

Three focus groups were conducted during March – April 2019. Two days before the intended date of each focus group, the community officer sent a reminder to the participants. In the reminder, there was a request that the participants think about a picture, photo or object that they associate with technology. Participants were asked to bring this object with them to the meeting, and this was used as an opening activity of the focus group as a probe to elicit responses and initiate the discussion.

The time of the meeting was before lunchtime, lasted for around 1.5 h and took place in a closed meeting room. The room was in an isolated and quiet part of the building, brightly illuminated, air conditioned and provided a comfortable environment. A table with refreshments was

situated outside the meeting room. Participants sat around a big meeting table which allowed all participants to see each other. In front of every seat, on the table, were the information letter, consent forms, a short demographic form and blocks of paper and pens which participants could write thoughts and notes upon. Participants read the information letter again and signed the consent and demographic forms. After signing the forms, name tags were provided by the researchers and the audio recording was initiated.

Two researchers (IM and DW) facilitated the focus group. At each moment one researcher facilitated the discussion and the other researcher took notes to compare later with the transcriptions in order to easily identify which group-member said what. Participants introduced themselves and their thoughts about technology through the objects that they had brought with them. Following the opening activity round, participants were asked about: (a) the types of technologies they use in their daily life; (b) how they perceive their own technological abilities; (c) how they think people in this organization and others perceive their abilities to use technology; and (d) if they could give an example of an experience they had in which they felt they do not understand something about technology; and (e) what they did when that happened. Afterwards, participants were presented with questions focusing more on the design process and their experiences in co-designing. Specifically, they were asked to elaborate about: (a) their experiences at the organization; (b) what they were asked to do in the meetings; (c) what they were told about the goals or purpose of the meetings; (d) how the technologies were explained to them; and (e) their interaction with the designers; and how they felt that their feedback was taken into account. Finally, they were asked what they thought is the best way to involve older persons in the design process and what the organization (or other organizations) can improve to better involve older persons in the process.

The study received ethical approval from the Fontys University of Applied Science ethics research committee (approval file no. Mannheim22022019).

### 2.3. Coding and analysis

As the potential effects of ageism on the design of digital technology is not yet well theorized, we drew inspiration from the constructivist grounded theory (Charmaz, 2006) in combination with a thematic analysis approach according to the steps by Braun and Clarke (2012). Due to the flexibility these approaches offer in viewing the data through a more social, structural and theoretical deductive approach (of ageism in our case) as well as through an inductive approach capturing the experiences of the participants. Audio recordings were transcribed verbatim by a research assistant and were verified by the first author. Initially, all transcriptions were read and re-read independently by two researchers who also led the focus groups (IM and DW). After this phase of familiarization, the two researchers met for an initial discussion of identified codes, applying a combination of a critical deductive approach using an ageism ‘lens’, and inductive approach to identify initial patterns in the data corpus. To enhance validation, both researchers coded all the data independently using ATLAS-ti8. Coding of text segments was done via open and in-vivo coding. Thereafter, comparison was made between the two independent lists of codes. Similar codes were merged and codes linking with similarities of meaning were grouped under categories (or sub-themes). This process continued iteratively through several meetings until agreement was reached for a final list of categories and the codes they consisted of, and an initial grouping of overarching themes was developed. As the final stage of the thematic analysis, all authors (IM, DW, YvZ and EW) met together to discuss the overarching theory and patterns that were derived from the categories in order to create a distinctive group of themes.

### 2.4. Member check

After finalizing the analysis, the results were presented to participants of the focus groups, as a form of member check, and their opinions regarding the accuracy and interpretation of the themes and categories were collected. The meeting was held online on Zoom in January 2021 due to Covid-19 restrictions. During the meeting, the broader goal of this study, namely identifying the role of ageism in the use and design of digital technology was revealed. After that, the results of the study were presented and a discussion was facilitated to obtain participants opinions.

## 3. Results

Twenty-one older adults participated in three focus groups (5–9 per group). Table 1 presents the characteristics of participants by groups. All participants were physically independent, community dwelling older adults, who had participated in at least one design activity within the technological organization. 57 per cent of the participants were female and the age of participants ranged from 59 to 79 ( $M_{age} = 68.75$ ,  $SD = 5.29$ ). Accordingly, participants had retired from work between a few months to 13 years before the study. Even so, some participants described themselves as still performing various kinds of occupations, such as teaching, guiding and volunteering work. Most participants had a higher education level (57%) or professional education (24%). During the focus groups, many participants described their occupational experience, and related it to their experience with digital technology. Groups included people who worked as photographers, engineers, IT professionals, lecturers in the academia and in the educational system (including a person responsible for developing remote learning in the south of Israel). Participants described involvement in design processes of various digital technologies s, such as fall prevention apps, social volunteering apps, assistive robots, a physical activity platform, smart city technologies and a ‘hackathon’ event.

### 3.1. Main themes

Eighty-seven codes were identified in the data and agreed upon through iterative discussions. Further discussion led to aggregating codes with similar contextual meaning into 24 categories. After further discussion within the whole research group, five themes were identified:

- 1) Intergenerational gap in perceptions of digital technology and ageing
- 2) Digital divide, accessibility and ongoing willingness to learn

**Table 1**  
Characteristics of participants by groups.

	Total (N = 21)	FG 1 (n = 9)	FG 2 (n = 5)	FG 3 (n = 7)
Gender (female)	57%	44%	60%	71%
<u>Age<sup>*</sup>:</u>				
Mean (SD)	68.75 (5.29)	68.88 (5.17)	69.6 (6.8)	68.0 (5.03)
Range (min-max)	59 - 79	59 - 74	63 - 79	60 - 74
<u>Education:</u>				
Less than 12 years	5%	–	20%	–
12 years	14%	33%	–	–
Professional studies	24%	22%	20%	–
Academic	57%	45%	60%	100%
<u>Marital status:</u>				
Married or living with a partner	76%	89%	80%	58%
Divorced	9.5%	–	20%	14%
Widowed	9.5%	11%	–	14%
Single	5%	–	–	14%
Children - yes	100%	100%	100%	100%

FG – Focus groups.

\* 1 participant did not report their age.

- 3) Ambivalent affect
- 4) Experiences of co-design
- 5) “The ultimate partnership” – The perceived role of older adults in co-design

Table 2 presents the list of themes and categories (for the full list including codes, categories and themes see Appendix A). The first three themes, relate to participants’ perceptions and experiences of ageing and technology. These themes detail participants’ everyday experiences, as well as interactions about technology with family members, friends, other older persons, and with designers from the technological organizations during the design process. The fourth and fifth theme relate directly to participants’ experiences of the design process of digital technologies, the interaction with the designers, and the role older adults believe they can have in the design process compared to the role they actually fulfil.

Twelve participants agreed to participate in the member check session, which took place during January 2021. There was a general agreement with the results and none of the participants rejected them. The themes are elaborated hereby.

**Table 2**  
Themes and categories identified in the thematic analysis.

Theme	Categories
<b>1) Intergenerational gap in perceptions of digital technology and ageing</b>	<ul style="list-style-type: none"> <li>- Positive attitudes of older adults towards technology</li> <li>- Positive aspects that technology enables</li> <li>- Negative aspects embedded and generated by technology</li> <li>- Technology leads to changes in every aspect of life</li> <li>- Perception of age and intergenerational differences in technology use</li> <li>- Stereotypes and perceptions about the “third age”</li> </ul>
<b>2) Digital divide, accessibility and ongoing willingness to learn</b>	<ul style="list-style-type: none"> <li>- General digital divide</li> <li>- Us compared to digital illiterate older adults - perceived digital divide between the participants and the general older population</li> <li>- Experience of learning to use technologies</li> <li>- Accessibility of technology for older persons</li> <li>- The importance of advancing digital literacy</li> </ul>
<b>3) Ambivalent affect</b>	<ul style="list-style-type: none"> <li>- Positive emotions and feelings that arise in relation to technology</li> <li>- Negative emotions and feelings that arise in relation to technology</li> <li>- Motivation</li> </ul>
<b>4) Experiences of co-design</b>	<ul style="list-style-type: none"> <li>- Positive aspects and experience of the development process</li> <li>- Negative aspects and experience of the development process</li> <li>- Influence of acquaintance and intergenerational interaction on the design process</li> <li>- Positive feeling of assimilating feedback and iterative process</li> <li>- Manner of accepting feedback by the developers</li> </ul>
<b>5) “The Ultimate Partnership” – The perceived role of older adults in co-design</b>	<ul style="list-style-type: none"> <li>- Participants as partners of the developers</li> <li>- “Ultimate partnership” - Involvement from the beginning to say if it’s relevant and avoid waste of work and resources</li> <li>- The basis of the design process starts with understanding the heterogeneous needs of older adults</li> <li>- Older adults’ perception of their role as active advisors in the design process</li> <li>- Reaching the relevant target group in the design process</li> </ul>

### 3.1.1. Intergenerational gap in perceptions of digital technology and ageing

Throughout the focus groups, participants projected their perceptions on how older adults are perceived in relation to technology. While we aimed to discuss digital technology, which was also the context and line of work within the technological organization, we asked our questions in relation to “technology” which is a broader concept. Participants related mostly to digital technology, but also described technology as “everything that can improve our quality of life”. Technology was described as touching every aspect of their lives, from printing to digitalization of services and extensive use in communication (mainly referring to smartphones). Technology was also described as constantly changing, evolving and infiltrating every aspect of life. Participants mainly presented positive aspects that technology can enable and discussed positive attitudes towards using technology.

*P. (female), FG3: “Technology in my eyes, I am joyful that I live in the 21st century. And technology can really improve, and indeed greatly improves the quality of life of the adult person.”*

Nevertheless, participants also pointed out negative aspects of technology. Stating that technological development is constantly changing, and while they might have always been up to date when they were still working, it is now more difficult to catch up. There was also discussion about general negative aspects of some digital technologies, for example, being unreliable, alienating, not intuitive, or even harmful. This was often put into context of intergenerational differences.

Participants described a perceived intergenerational gap between younger and older people, describing on the one hand their own curiosity and attempts to close this gap and stay “up to date”, but on the other hand how older persons are to begin with negatively perceived by younger people as “less capable” in interactions regarding technology.

*B. (female) FG1: “I think maybe we feel that we are trying to close the gaps. I think people who look at us, a society of a generation below us, I think there is a bigger gap there. Because their objective or subjective perception is that we are still in the age of the waggon.”*

Low tolerance and patience of younger people towards older adults in interactions about digital technology was often emphasized, but also the difference in the intuitive ability (or concerns) of using digital technology, which was sometimes portrayed as negative (dependency) or positive (ability to learn from younger people). Some participants also identified themselves as “digital immigrants” who need to constantly learn in order not to be left behind.

*A. (male) FG2: “One of the examples, I have a fear of pressing a button that I do not know what it will give me. So I call him (my son) ‘I have a screen here’ ... (and the son replies) ‘What, don’t you have a head on your shoulders that you cannot press it!’ That’s the story. Also in solutions, also maybe in mentality, I came from a completely different society.”*

While acknowledging that there are actual digital gaps (further detailed in the second theme), participants explicitly related to old age-stereotypes as a burning issue that influences how others (e.g., family members, designers) perceive them. Participants apposed homogeneous images of a so called “third-age” person, that portrays all older adults as “elderly” and is embedded in design assumptions, rather than acknowledging the diversity of older adults in relation to physical and cognitive abilities, wants and needs. As illustrated in the following group discussion:

*P. (female) FG3: “The concept of the third age is problematic. Because it’s very heterogeneous, what’s a third age? I am a third age and also a 90 year old person is a third age.”*

*Bn. (male): “It is not possible to segment by age alone. There is a 70-year-old who is demented and there is a 90-year-old who is clear.”*

**P.:** “Exactly. So now, also about the use of apps. The developers have developed an app to prevent falls, so apparently there was some kind of elderly figure in front of their eyes. Now it’s funny to me that I’m an elder (laughs). 63 year old. Okay, I’m old, that’s nice, I didn’t know. Because in my eyes this elderly person is poor and frail... In the falls prevention meeting they asked “move your hand and do this exercise”. I go to Holmes Place (gym)... What does this have to do with me? So it made me laugh... what is this nonsense? I go to the gym, I do Pilates, I do body shaping, I swim... so this general definition of third age is problematic. Because it’s very very very (emphasis) heterogeneous.”

### 3.1.2. Digital divide, accessibility and ongoing willingness to learn

While the first theme related to perceptions of age and intergenerational differences that influence older adults in their technological-related interactions, the second theme relates to how participants observe the actual “objective” situation of older adults and digital technology. Participants strongly distinguished themselves (“us”) comparing to the general older adult population (“them”), as highly capable, whereas most older adults are left behind and do not realize the potential of digital technology even if they use it.

**R. (female), FG3:** “The team sitting here, we are all from the development team. Elsewhere, I am sure there are people our age even, who are less knowledgeable, who have no idea.”

**L. (female), FG1:** “We are at a much higher level than the general public who are lacking a lot. There are even certain groups that are even in a critical state. And those are usually people over a certain age who totally came before the computer age.”

**B. (female), FG1:** “On the other hand, it’s (we are) a thousandth out of a thousandth of the people who are very interested and want to close gaps. But what happens beyond the corner here, and I meet them every day, the gaps are insane. And growing. And a kind of anxiety not to touch. It’s great what’s going on here. But outside the situation is worrying.”

While in the previous example, participants related to some older adults lagging behind for intrinsic reasons, there was also a strong emphasis on the need to improve immensely the accessibility of digital technologies for older adults in general in order to fulfil the potential of digital technology. Thus, acknowledging that with older age there is a sensory deterioration in some abilities which require design adjustments. Yet, participants highly stressed that younger developers know very little about how to address this.

**C. (female), FG1:** “Accessibility, this is one of the things that young people understand less about the problems of older people. And I think that slowly it infuses here as well, that we actually need to work on accessibility as well. And accessibility also means that the fingers become less flexible and a little thicker, and it’s hard to press one key, and not make a mistake in the message being written. And then you read and you are ashamed that you wrote N instead of V etc.... And a very simple thing, a font cannot be number 11 at our age, because then you have to take off the glasses...”

**P. (male):** “Or put on the glasses... (laughs)”

Importantly, participants expressed that the responsibility to close the digital divide does not depend only on the motivation of older adults, or making the design more accessible, but also on the responsibility of policy makers and local authorities to provide solutions for advancing digital literacy.

### 3.1.3. Ambivalent affect – internalized age stereotypes embedded in emotional and motivational barriers

Different emotions and motivations in relation to digital technology were described by participants during the discussions, embedded in examples they provided about their experiences of using digital technology (either by themselves or others) and the design process.

Discussion of emotions and motivations revealed different internalized age-stereotypes, expectations and barriers to the use of digital technology. Positive affect was connected to expectations of older adults from digital technology. Namely, they discussed how using digital technology improves their lives in various aspects. More importantly, they expressed their higher interest and strong motivation to use digital technologies that are enjoyable and promote positive social experiences (rather than healthcare related technologies). An example that repeated between the groups was a contrast in how the participants described their experiences in participating in the design of care-related technologies such as a fall prevention app or an assistive robot, compared to a social community-based volunteering app. Ambivalence and differences in affect were found in relation to designing digital technologies with different purposes (elaborated in the fourth theme), as well as using them.

Nevertheless, negative affect and emotions were strongly embedded in the discussions. Fear, anxiety and shame were the most accounted for. Fear and anxiety of using digital technology were strongly related to as a barrier for many older adults. This fear was often described in an intergenerational context, in which older adults fear to use digital technology because they might do irreversible harm (to the digital technology or to themselves as a consequence of misuse), compared to younger adults who have no fear and intuitively learn how to use it. Ambivalence towards digital technology was therefore also seen. As one participant related to her smartphone as “this monster, that I hate the most, but need the most” (L, (female), FG1). Subsequently, shame of making mistakes with digital technology, and mainly being perceived as weak or incompetent by other (younger) people, was described as a barrier to the use of digital technology. Motivation in this manner connected strongly to the need to stay relevant, and not being left behind. Participants described their motivation to learn how to use digital technology although there are difficulties. Nevertheless, they also related to lack of motivation (by others) as a potential barrier to using digital technology.

**I. (female), FG3:** “I had much better control of the computer, and all these skills. But since I retired five years ago, I feel like I’ve backed down. I want to know more, but I don’t have the child or the husband at home to help me when I get stuck. And I very quickly give up. I still have some reluctance and fear of these things, and I want to get over it.”

**A. (male), FG2:** “One of the main problems is our reservations. I mean, that we’re afraid. This is the gap. It is more in attitude than in knowledge. The youth are not afraid. They go to the computer, and phone, they will try a thousand things while you will not touch until they tell you exactly how to. Do you know how a grandson does it? He doesn’t look at anything, starts just like you, pressing all the buttons. He always makes it. I... what’s the difference between us? Because...”

**I (female):** “(interrupts) Because they dare to and we don’t.”

**A.:** “Because there is a button, if I press, it could be that I can ruin something.”

### 3.1.4. Experiences of co-design

Generally, participants had a positive feeling towards the way they were treated within the technological organization and most design sessions. They felt personal and respectful attention from the designers, that their feedback was mostly taken into consideration and implemented in iterations of the design process. This led to the feeling that their feedback and experience was valuable and led to a sense of contribution to the design process and accomplishment. Nevertheless, participants also contrasted positive experiences with negative examples. Mainly, a feeling in some design sessions of disrespect for the abilities of older adults to contribute to the development process. A specific example that stood out within all groups related to an “experiment” with an assistive robot, in which participants received poor instructions and explanations regarding the purpose of the meeting. It was

a single meeting with no iteration or continuation in which participants did not feel that their feedback was taken seriously. More so, the technology tested was perceived as not appropriate and not relevant to their physical and cognitive situation.

**L. (female) FG1:** “Once they asked to go with the robot behind me... (participants interrupt her)”

**B. (female):** “No one explained anything, I had something to say and nobody noticed me. I walked like a ‘dummy’ with the robot back and forth (participants interrupt her again)”

**S. (male):** “Well, that was an extreme example.”

**B. (female):** “And the questionnaire they used was not relevant at all, and they didn’t even speak a word with me. They were occupied with themselves and I went with the robot back and forth. And I felt... I questioned if I would come next time. If that’s the way.”

Contrary to this negative experience of a single meeting, participants illustrated how continuous acquaintance and intergenerational interaction during the design process, actually reduced boundaries and stereotypes. Eventually “surprising” the developers regarding the potential of older adults’ contributions.

**R. (female) FG3:** “I want to give an example of (name of app). When they invited us for the first time to show us their development environment. They were shocked by the feedback they received. Only then they realized how important it was to include us in the design process. They, I don’t think expected it. Each of us wrote at least 10 things as feedback on what we experienced. They constantly include us and contact us since.”

### 3.1.5. “The ultimate partnership” – the perceived role of older adults in co-design

The (ideal) role of older persons in co-design as “partners” of the designers and not only “participants in an experiment” was substantially discussed across the different groups. From their point of view, this partnership does not include sharing the revenue, but does encompass a “win-win” situation, in which older adults can contribute their time and their vast (professional and life) experience. In return, they contribute to designing technologies that are needed, understandable, well-designed and seem desirable to use. The ideal or “ultimate partnership” was viewed as involving older adults from the very first moment of the design process, and throughout the design process. Participants provided positive examples of design processes where this “ultimate partnership” existed, and further emphasized that the outcome of the design was desired and appealing for future use.

**A. (male), FG1:** “What we wanted was for us to be **partners** in the development of a product from the beginning.”

**C. (female) FG1:** “...in the early stages of development. And this is a very, very important thing. And I say we really dealt with small details. Some visual and textual stuff. Font size, some information on the first page, how to do the enrolment questionnaire, how to do the assessment questionnaire...”

**Moderator:** “Each time they showed you something small?”

**C.:** “We worked here for three hours. It was the first stage they thought of something, a developer came in and was in charge of the project and we were three people and said our opinions in the process. **And it was kind of an ultimate partnership.**”

On the other hand, participants highlighted that this is not always the actual practice, and several times they were involved in evaluating a prototype or idea in an advanced phase, which they thought was not relevant and they felt they could have saved the designers time and money had they been involved earlier. Early involvement was described as important because of the gap in knowledge young designers have in understanding the world of older adults and their needs.

**D. (female) FG3:** “The basics when you bring a product to the market, you do a market survey. But when you develop an app, sometimes it seems that they skip this step because of the enthusiasm about the app. And they don’t actually examine who the target population is, that can benefit from this app.”

**R. (female) FG3:** “I think there is some misconception here that perhaps the third age has nothing to give in these (early) stages of development, but rather only in the stage of experiencing with the final product. And I think it’s really fundamentally wrong, because there are a lot of people here who have tremendous experience in practical things that can contribute from the first moment (of the design process).”

More so, participants stressed that involving the most suitable older end-user is needed according to the type of digital technology developed, further indicating that they did not always feel that they were the most accurate target group (e.g., using very healthy and active people for a fall prevention app). Participants indicated that for such technologies, a stronger partnership could also facilitate a bridge between developers and end-users, as older persons could be used as advisors and mediators who would reach the “right” population for each design.

## 4. Discussion

### 4.1. Experiences of inclusion in the design process

Using a critical approach and lens of ageism, this study investigated the design of digital technology from the perspective and experiences of the older persons who participated in the design processes. As a principal, we did not ask directly about experiences of ageism. Nevertheless, participants described examples of stereotypes, prejudice and discrimination in relation to using and designing digital technology. Manifestations of ageism were strongly identified in an intergenerational context of younger persons (mainly family members and the designers) versus older persons. Also, ageism was identified in how the specific older persons in the focus groups related to other older persons, as well as expressions of self-directed age-tech stereotypes.

Experiences of the older persons in the design process were diverse as were the types of digital technologies they were involved in designing. Interestingly, participants linked the examples of digital technologies they were involved in designing to good and bad practices of design. “Good” or successful design involvement examples were described as involving the “most relevant” older persons from the beginning of the design process, in a continuous and iterative manner throughout the whole process, while being attentive to their needs as they see them and incorporating their feedback. Notably, participants expressed overall satisfaction in how they were involved within the technological organization. “Good” design practices were associated with creating a sense of partnership in which participants felt respected, acknowledged for their experience and seen as a diverse group of individuals able to contribute with rich and valuable experiences. Importantly, successful involvement was associated by participants with higher probability of designing a product that they would like to use. Contrary, unsuccessful involvement was described as involving older adults who do not fit the need or goal the technology intends to fulfil, or being involved only in the evaluation or advanced testing stage of the design process in which changes in the design (even if participants identified flaws) are less likely to occur. Low involvement was characterized as a single iteration, with no continuation, insufficient explanation or instructions about the purpose of the meeting. Participants described such examples as eliciting negative emotion, and perceived that their feedback was not accounted for in a meaningful way.

Participants expressed interest, positive emotions and strong motivation to use digital technologies that are enjoyable and promote positive social experiences. The less successful examples were mainly healthcare related technologies (e.g., fall prevention, assistive robot). Participants acknowledged the importance of healthcare related

technologies, however linked the design of such digital technology to a more stereotypical “elderly” imagery on behalf of the designers. This finding is consistent with findings from several studies showing that there is often a bias in involving healthy, younger, tech savvy older persons who do not identify themselves as the right target group to develop such technologies. While acknowledging that such technologies might be useful, older persons often do not imagine themselves using them in the present (Greenhalgh et al., 2017; Neven, 2010; Righi et al., 2017). Digital technology designed for care and healthcare seem to comprise most of the age-tech innovation (Mannheim et al., 2022; Schulz et al., 2015). It seems that more attention to how the design cycle is influenced by ageism, diversity, and how we view “old age” (Righi et al., 2017) is needed, especially in the design of healthcare technologies. Nonetheless, it seems that while imagining the needs of older persons, designers should also consider additional diverse and positive needs and wants of older persons such as social, leisure and communication needs (Astell, 2013).

The “ultimate partnership” is therefore more than just involving older persons in an iterative way, but rather an exchange or a “win-win”, in which a sense of community and shared goal is developed (Righi et al., 2017; Span et al., 2018; Wu, Damné, Kerhervé, Ware & Rigaud, 2015). While the technological organization gained insight from the participants, they in turn felt a sense of achievement and an opportunity to use their unique experiences and strengths to generate meaningful insights for the developers. More so, a place in which they could promote their own ideas and activities to increase self-literacy and contribute to designing digital technologies that can improve the lives and well-being of older persons.

Partnership was also described as a way to reduce ageism. Participants described a sense of surprise, contra to stereotype, amongst the designers, who realized the value of older persons’ feedback, and described how acquaintance and ongoing communication led to the perception of reducing ageism in the design process. Partnership also related to involving the most relevant older persons. Participants saw themselves as a potential bridge to reach the “right” persons for co-designing a specific technology. Indeed, this strong emphasis of involving older persons in the design process is associated from the designers’ perspective with learning about the needs and wants of older persons, adjusting the design and increasing sense of participation and ownership by the participants (Fischer et al., 2020). More importantly, higher (diverse) involvement may assist in mitigating barriers of usability and accessibility that may arise from not addressing certain age-related limitations (Czaja, Boot, Charness & Rogers, 2019).

#### 4.2. Ageism, internalized age-tech stereotypes and intergenerational interaction

Age stereotypes were identified in the specific context of digital technology. Whereas participants seemed to mainly discuss the positivity of digital technology (contra to common stereotypes), an intergenerational gap was identified in how older people experience the way younger people, including the designers, view their technological capabilities and interests. Mainly, the groups emphasized the bias in perception of a so called homogeneous “third age”, whereas they believe older persons (as are younger persons) are a highly diverse group of people. Nevertheless, participants acknowledged that not all older persons are proficient in using digital technology and a digital divide indeed persists. More so, participants acknowledged “objective” age declines that requires accessibility, which the designers understand little about according to their perceptions. Notably, participants in this study strongly distinguished themselves from the general older population (“them”), as being uniquely more technologically proficient in a form of “othering” that could be considered ageist (Higgs & Gilleard, 2020). In this sense, participants called out the sampling bias of not reaching a more diverse group of older persons in the design process. Notably, this may also be a pitfall in general in the design world, whereas

considerations of ethnic diversity (Chauhan, Leefe, Shé & Harrison, 2021), underserved populations and contexts such as mental health (Black et al., 2023), or dementia (Lazar, Edasis & Piper, 2017; Span et al., 2018), are limited.

Findings of this study point out that similar to the Risk of Ageism model (Swift, Abrams, Lamont & Drury, 2017) and other studies, ageism operates on three levels. First, ageism is experienced by others (behavioural aspect). This was found to happen mainly in an intergenerational context in which participants experienced being treated impatiently by younger persons, or treated as weaker or fragile because they are old. Indeed, intergenerational interaction can facilitate (Luijckx, Peek & Wouters, 2015) or hamper the use of digital technology (Xi, Zhang & Ayalon, 2021, 2022). However, participants in our study also related intergenerational tension to the second component in the risk of ageism model – stereotypes threat. According to Caspi et al. (2019), merely presenting technology may impose a threat to confirm age-stereotypes. Stereotype threat was related by the participants to emotions of fear and shame of making mistakes and adhering to the image of an older person who fails to use technology the same way younger persons do. Thus, leading to avoidance of using digital technology completely or in certain situations. Finally, participants expressed self-ageist remarks about the ability of older persons as a group to use technology. A recent review by Köttl, Allen, Mannheim and Ayalon (2022) indeed points out that self-ageism and stereotype embodiment may be associated with lower technology usage. Additionally, participants directly linked several aspects of design and policy to actual use of digital technology, such as accessibility, stigmatizing assumptions in the design process and the role of policy on increasing digital literacy. Thus, as claimed by Swift et al. (2017), ageism in relation to using and designing digital technology is identified as a barrier to active and successful ageing.

Importantly, as also emphasized by the participants, perceptions of implicit ageism in the design as well as other negative impressions about their involvement may affect their motivation to participate in the design process and therefore impact the outcome product (Tremblay et al., 2019). Participants are thus reluctant to contribute in a meaningful way when they perceive their role as being used as experiment subjects rather than experts (Hakobyan, Lumsden & O’Sullivan, 2015).

#### 4.3. Strengths and limitations

Several measures were taken to increase the trustworthiness and validity of our analysis. To begin with, two researchers with experience in research on ageing conducted the focus groups. The same researchers analysed the data first independently and later on together in an iterative process in order to reach a rich and coherent representation of the units of meaning identified in the data. Finally, the whole process was triangulated and reviewed in several meetings, including a member check with the participants and revisions of the full manuscript by the whole research team. Nevertheless, we acknowledge our own potential bias, as researchers enthusiastic in critically evaluating design of technology under an ageism lens. Although we identified convergence between the findings of this focus group study and a former scoping review (Mannheim et al., 2022) on involving older persons in design, further studies are needed in order to generalize these results and examine the potential role of ageism in the design process with additional populations and technological and cultural contexts.

An additional limitation of this study is a sample bias of very independent and highly technologically proficient older persons. A bias that was emphasized by the participants themselves. Nevertheless, this is actually a mirror image of the older adults who participated in the design processes in the technological organization. Thus, emphasizing perhaps a broader limitation in the design worlds of technology which is often mentioned in the literature. Furthermore, this study did not capture the perspectives of the designers involved in the design process with the older persons. Nor did it investigate in particular specific technologies intended for specific uses or populations. Future studies could



indeed enquire in more depth into the intergenerational interactions by involving not only the older persons but also the designers, as well as focusing on specific contexts and comparison between diverse populations in terms of health conditions, socioeconomic status, ethnicity and lower technological capabilities.

4.4. Conclusion

From the perspective of the participants in this study, an ideal design process of technology for (older) persons starts with a partnership. The “ultimate partnership” described above adheres to involving the most suitable end-users, from the beginning and throughout the design process, in an iterative manner and by sharing control over design decisions. Not as informants, but increasingly as equals who have valuable contributions. While this vision is also shared by many designers, in actual practice this is not always the case. As illuminated by the examples of participants in this study, a recent review by Mannheim et al. (2022) identified a discrepancy between this ideal vision shared by designers and their actual practice. Similar to the perspectives of older persons in this study, the latter also identified how ageism manifests in implicit and explicit discourse about ageing and how negative and ageist images of ageing may influence decisions in the design process.

We therefore call upon highlighting the role of ageism as a detrimental factor in how digital technology is designed. Involving older adults in the design process is important, but how and when it is done is what matters. Designers should make more effort to adhere to this ideal shared vision of how-to co-design. More attention should be directed at envisioning the diversity of older persons and their needs, thus increasing the attention to designing digital technologies for a variety of social, leisure and communication needs. Understanding co-design with older adults as a “partnership” might lead to avoiding insufficient prototyping, biases and errors in the design process. Eventually leading to designing technologies that are needed, desired and used, and as a “side effect” might increase the use of less desired, but very much needed digital technologies.

Appendix A. Full list of themes, categories and codes identified in the thematic analysis

Theme	Category	Codes
1) Intergenerational gap in perceptions of digital technology and ageing	Positive attitudes of older adults towards technology Positive aspects that technology enables	<ul style="list-style-type: none"> <li>Positive attitudes of older adults towards technology</li> <li>Positive aspects of technology and what it enables</li> <li>Technology improves quality of life, independence and enjoyment</li> <li>Technology can assist different life aspects of the “third age”</li> <li>Technology enables communication and to express yourself</li> </ul>
	Negative aspects embedded and generated by technology	<ul style="list-style-type: none"> <li>Negative aspects of technology - harmful, alienating, unreliable</li> <li>At the end you need to ask the children/ grandchildren</li> <li>Troubles with technology - often hard to understand, complicated, problems, limited abilities</li> </ul>
	Technology leads to changes in every aspect of life	<ul style="list-style-type: none"> <li>Technology infiltrates every aspect of life</li> <li>New technologies are introduced quickly and suddenly, pushing aside old technologies</li> <li>Digitalization</li> <li>Technology leads to changes (in occupation, daily life, etc.)</li> <li>Technology = is basic like food</li> </ul>
	Perception of age and inter-generational differences in technology use	<ul style="list-style-type: none"> <li>Inter-generational differences in attitude towards technology</li> <li>How older adults perceive younger adults and technology</li> <li>How younger adults perceive ageing and technology</li> <li>How older adults perceive ageing and technology</li> </ul>
	Stereotypes and perceptions about the "third age"	<ul style="list-style-type: none"> <li>Ageism as a barrier to adopt tech for older adults / healthcare technology not relevant for healthy older adults</li> <li>Ageism</li> <li>Stereotypes and exclusion</li> <li>What is an older adult, what is the "third age"</li> </ul>
2) Digital divide, accessibility and ongoing willingness to learn	General digital divide	<ul style="list-style-type: none"> <li>Communication technologies are basic</li> <li>Feeling the older adults do not realize (fulfil) the full potential of (smart) technologies</li> </ul>

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Author contribution

IM and DW conducted the focus groups, coded and made the initial analysis of the data. IM wrote the first draft of the manuscript. All authors (IM, DW, YvZ and EW) contributed to developing the research protocol, discussing and making the advanced analysis and revising the manuscript.

The first author may be contacted for additional information about the data used in this study.

Ethical statement

The study received ethical approval from the Fontys University of Applied Science ethics research committee (approval file no. Mannheim22022019).

Declaration of Competing Interest

None.

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Theme	Category	Codes
	Us compared to others - perceived digital divide between the participants and the general older population	<ul style="list-style-type: none"> <li>• Technology advances rapidly and creates gaps</li> <li>• There is a digital divide amongst a lot of (other) older adults</li> <li>• We're stronger with technology compared to other older adults</li> </ul>
	Experience of learning to use technologies	<ul style="list-style-type: none"> <li>• Way of learning technology</li> <li>• Feeling there is no place to learn to use technology</li> <li>• Lack of time hampers learning to use new technologies</li> <li>• The social aspect has an important role in reaching learning sessions</li> </ul>
	Accessibility of technology for older persons	<ul style="list-style-type: none"> <li>• Technology that is not adaptable or accessible</li> <li>• Training and accessibility</li> <li>• Obligation of accessibility and establishing accessibility in legislation</li> <li>• Advanced technology is technology that the interface is intuitive for the user</li> </ul>
	The importance of advancing digital literacy	<ul style="list-style-type: none"> <li>• Importance of learning digital literacy</li> <li>• Responsibility of local authorities for digital literacy</li> <li>• Goal of the group - advancing accessibility and literacy</li> </ul>
<b>3) Ambivalent affect</b>	Positive emotions and feelings that arise in relation to technology	<ul style="list-style-type: none"> <li>• Older people are interested in something that will be enjoyable</li> <li>• People can find interest in technology</li> <li>• Pride</li> </ul>
	Negative emotions and feelings that arise in relation to technology	<ul style="list-style-type: none"> <li>• Fear, anxiety and reluctance to touch and use</li> <li>• Shame of malfunctions as a barrier</li> <li>• Ambivalent attitude towards technology</li> <li>• Not afraid of technology</li> <li>• The fear of technology decreases with increasing exposure to it</li> </ul>
	Motivation	<ul style="list-style-type: none"> <li>• Guilt - of not learning and not being open to learn</li> <li>• Motivation to learn (even if difficult) in order to stay relevant and be able to use</li> <li>• Motivation to learn and also to give back</li> <li>• Motivation to use technology</li> <li>• No motivation as a barrier to using technology</li> </ul>
<b>4) Experiences of co-design</b>	Positive aspects and experience of the development process	<ul style="list-style-type: none"> <li>• Sense of contribution to the development process</li> <li>• Personal attention from the developers</li> <li>• Interesting experience, respectful attitude</li> <li>• Good feeling in participating in the activities in the technology organization</li> <li>• The developers appreciate the technological capabilities of the older adults</li> </ul>
	Negative aspects and experience of the development process	<ul style="list-style-type: none"> <li>• A sense of disrespect for the older adults' abilities to contribute to the development process</li> <li>• A feeling that the technology and the purpose of the encounter and experience was not explained</li> <li>• The experiment was not ready for the stage of involving participants in their opinion</li> <li>• No contact with the participant after the first meeting</li> <li>• Anxiety that an accompanying robot goes behind and not aside or in front</li> <li>• Negative feelings regarding the experiment with the robot</li> </ul>
	Influence of acquaintance and inter-generational interaction on the design process	<ul style="list-style-type: none"> <li>• Goal of the experiment with the robot was not indicated</li> <li>• What drives the developers to develop technologies for older adults</li> <li>• Lack of familiarity with the older adults and their ability to contribute leads to less sharing, familiarity leads to more</li> <li>• The developers were pleasantly surprised by the older adults</li> <li>• Inter-generational cooperation in the design process</li> </ul>
	Positive feeling of assimilating feedback and iterative process	<ul style="list-style-type: none"> <li>• Giving valuable feedback</li> <li>• Assimilating feedback and iterative approach</li> </ul>
	Manner of accepting feedback by the developers	<ul style="list-style-type: none"> <li>• Good acceptance of negative feedback</li> <li>• Laconic acceptance of negative feedback</li> </ul>
<b>5) "The Ultimate Partnership" – The perceived role of older adults in co-design</b>	Participants as partners of the developers	<ul style="list-style-type: none"> <li>• Older adults have both professional and life experience that can help startups</li> <li>• Incorporating older adults in the design process in the initial design phases</li> <li>• Perception of the meaning of partnership for all parties – 'win-win'</li> <li>• Contribution - making things more understandable</li> </ul>
	"Ultimate partnership" - Involvement from the beginning to say if it's relevant and avoid waste of work and resources	<ul style="list-style-type: none"> <li>• The partnership is not yet sufficiently assimilated</li> <li>• Involvement from the beginning to say if it's relevant and avoid waste of work and resources</li> <li>• Partnership from the beginning is the ultimate partnership</li> <li>• There is also duplication and development of technologies for things that already exist</li> </ul>

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Theme	Category	Codes
	The basis of the design process starts with understanding the heterogeneous needs of older adults	<ul style="list-style-type: none"> <li>• Difficulty in defining the needs of older adults</li> <li>• The basis of every development should be the needs of older adults</li> <li>• Gap of young developers in understanding the difficulties of older adults</li> <li>• Some technologies currently developed for older adults are ridiculous</li> </ul>
	Older adults' perception of their role as active advisors in the design process	<ul style="list-style-type: none"> <li>• The role of the older adults in the group - mediating and reaching other older adults</li> <li>• Participation as participants in experiments</li> <li>• The role of the older adults in the group - to be advisors/consultants, not only participants in experiments</li> </ul>
	Reaching the relevant target group in the design process	<ul style="list-style-type: none"> <li>• Difficulty in reaching the relevant target group</li> <li>• Entrepreneurs' reasoning for using an inappropriate target group (in the opinion of the older adults)</li> </ul>

## References

- Abelein, U., & Paech, B. (2015). Understanding the influence of user participation and involvement on system success—a systematic mapping study. *Empirical Software Engineering*, 20(1), 28–81. <https://doi.org/10.1007/s10664-013-9278-4>
- Astell, A. (2013). Technology and fun for a happy old age. In S. A. & G. Gutman (Eds.), *Technologies for active aging* (pp. 169–187). Springer. [https://doi.org/10.1007/978-1-4419-8348-0\\_10](https://doi.org/10.1007/978-1-4419-8348-0_10)
- Bano, M., & Zowghi, D. (2013). User involvement in software development and system success: A systematic literature review. In *Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering*. <https://doi.org/10.1145/2460999.2461017>
- Black, C. J., Berent, J. M., Joshi, U., Khan, A., Chamlagai, L., Shrivastava, R., et al. (2023). Applying human-centered design in global mental health to improve reach among underserved populations in the United States and India. *Global Health: Science and Practice*, 11(1). <https://doi.org/10.9745/ghsp-D-22-00312>
- Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, vol. 2. research designs: Quantitative, qualitative, neuropsychological, and biological* (Vol. 2, pp. 57–71). American Psychological Association. <https://doi.org/10.1037/13620-004>
- Caspi, A., Daniel, M., & Kavé, G. (2019). Technology makes older adults feel older. *Aging & mental health*, 23(8), 1025–1030. <https://doi.org/10.1080/13607863.2018.1479834>
- Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Sage. <https://doi.org/10.7748/nr.13.4.84.4>
- Chauhan, A., Leefe, J., Shé, É. N., & Harrison, R. (2021). Optimising co-design with ethnic minority consumers. *International Journal for Equity in Health*, 20, 1–6. <https://doi.org/10.1186/s12939-021-01579-z>
- Czaja, S. J., Boot, W. R., Charness, N., & Rogers, W. A. (2019). *Designing for older adults: Principles and creative human factors approaches* (3rd ed.). CRC press. <https://doi.org/10.1201/b22189>
- Fischer, B., Peine, A., & Östlund, B. (2020). The importance of user involvement: A systematic review of involving older users in technology design. *The Gerontologist*, 60(7), e513–e523. <https://doi.org/10.1177/1525822x16639015>
- Gélinas-Bronsard, D., Mortenson, W. B., Ahmed, S., Guay, C., & Auger, C. (2019). Co-construction of an Internet-based intervention for older assistive technology users and their family caregivers: Stakeholders' perceptions. *Disability and Rehabilitation: Assistive Technology*, 14(6), 602–611. <https://doi.org/10.1080/17483107.2018.1499138>
- Greenhalgh, T., Wherton, J., Papoutsis, C., Lynch, J., Hughes, G., Hinder, S., et al. (2017). Beyond adoption: A new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. *Journal of medical Internet research*, 19(11), e367. <https://doi.org/10.2196/jmir.8775>
- Guest, G., Namey, E., & McKenna, K. (2017). How many focus groups are enough? Building an evidence base for nonprobability sample sizes. *Field methods*, 29(1), 3–22. <https://doi.org/10.1177/1525822x16639015>
- Hakobyan, L., Lumsden, J., & O'Sullivan, D. (2015). Participatory design: How to engage older adults in participatory design activities. *International Journal of Mobile Human Computer Interaction (IJMHCI)*, 7(3), 78–92. <https://doi.org/10.4018/ijmhci.2015070106>
- Higgs, P., & Gilleard, C. (2020). The ideology of ageism versus the social imaginary of the fourth age: Two differing approaches to the negative contexts of old age. *Ageing & Society*, 40(8), 1617–1630. <https://doi.org/10.1017/s0144686x19000096>
- Köttl, H., Allen, L. D., Mannheim, I., & Ayalon, L. (2022). Associations between everyday ICT usage and (self-) ageism: A systematic literature review. *The Gerontologist*. <https://doi.org/10.1093/geront/gnac075>
- Köttl, H., Gallistl, V., Rohner, R., & Ayalon, L. (2021). But at the age of 85? Forget it!": Internalized ageism, a barrier to technology use. *Journal of Aging Studies*, 59, Article 100971. <https://doi.org/10.1016/j.jaging.2021.100971>
- Lazar, A., Edasis, C., & Piper, A. M. (2017). *A critical lens on dementia and design in hci*. May 6–11. Denver, CO, USA: Chi. <https://doi.org/10.1145/3025453.3025522>
- Levy, B. R. (2009). Stereotype embodiment: A psychosocial approach to aging. *Current directions in psychological science*, 18(6), 332–336. <https://doi.org/10.1111/j.1467-8721.2009.01662.x>
- Luijckx, K., Peek, S. T., & Wouters, E. (2015). Grandma, you should do it—It's cool" Older Adults and the Role of Family Members in Their Acceptance of Technology. *International Journal of Environmental Research and Public Health*, 12(12), 15470–15485. <https://doi.org/10.3390/ijerph121214999>
- Mannheim, I., Schwartz, E., Xi, W., Buttigieg, S. C., McDonnell-Naughton, M., Wouters, E. J., et al. (2019). Inclusion of older adults in the research and design of digital technology. *International Journal of Environmental Research and Public Health*, 16(19), 3718. <https://doi.org/10.3390/ijerph16193718>
- Mannheim, I., Wouters, E., Köttl, H., van Boekel, L., Brankaert, R., & van Zaaen, Y. (2022). Ageism in the discourse and practice of designing digital technology for older persons: A scoping review. *The Gerontologist*, 144. <https://doi.org/10.1093/geront/gnac144>
- McDonough, C. (2016). The effect of ageism on the digital divide among older adults. *Gerontology and Geriatric Medicine*, 2(008). <https://doi.org/10.24966/ggm-8662/100008>
- Mitzner, T. L., Boron, J. B., Fausset, C. B., Adams, A. E., Charness, N., Czaja, S. J., et al. (2010). Older adults talk technology: Technology usage and attitudes. *Computers in human behavior*, 26(6), 1710–1721. <https://doi.org/10.1016/j.chb.2010.06.020>
- Nelson-Kakulla, B. (2020). 2020 Tech Trends of the 50+. *AARP Research*. [10.26419/res.00329.001](https://doi.org/10.26419/res.00329.001)
- Neven, L. (2010). But obviously not for me": Robots, laboratories and the defiant identity of elder test users. *Sociology of Health & Illness*, 32(2), 335–347. <https://doi.org/10.1111/j.1467-9566.2009.01218.x>
- Neves, B. B. (2012). Too old for technology? How the elderly of Lisbon use and perceive ICT. *The journal of community informatics*, 8(1), 1–12. <https://doi.org/10.15353/joci.v8i1.3061>
- Officer, A., & de la Fuente-Núñez, V. (2018). A global campaign to combat ageism. *Bulletin of the World Health Organization*, 96(4), 295. <https://doi.org/10.2471/blt.17.202424>
- Östlund, B. (2011). Silver age innovators: A new approach to old users. *The silver market phenomenon* (pp. 15–26). Springer. [https://doi.org/10.1007/978-3-642-14338-0\\_2](https://doi.org/10.1007/978-3-642-14338-0_2)
- Peine, A., & Neven, L. (2021). The co-constitution of ageing and technology—a model and agenda. *Ageing & Society*, 41(12), 2845–2866. <https://doi.org/10.1017/s0144686x20000641>
- Quan-Haase, A., Williams, C., Kicevski, M., Elueze, I., & Wellman, B. (2018). Dividing the grey divide: Deconstructing myths about older adults' online activities, skills, and attitudes. *American Behavioral Scientist*, 62(9), 1207–1228. <https://doi.org/10.1177/0002764218777572>
- Razzouk, R., & Shute, V. (2012). What is design thinking and why is it important? *Review of educational research*, 82(3), 330–348. <https://doi.org/10.3102/0034654312457429>
- Righi, V., Sayago, S., & Blat, J. (2017). When we talk about older people in HCI, who are we talking about? Towards a 'turn to community' in the design of technologies for a growing ageing population. *International Journal of Human-Computer Studies*, 108, 15–31. <https://doi.org/10.1016/j.ijhcs.2017.06.005>
- Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, 4(1), 5–18. <https://doi.org/10.1080/15710880701875068>
- Schulz, R., Wahl, H.-W., Matthews, J. T., De Vito Dabbs, A., Beach, S. R., & Czaja, S. J. (2015). Advancing the aging and technology agenda in gerontology. *The Gerontologist*, 55(5), 724–734. <https://doi.org/10.1093/geront/gnu071>
- Span, M., Hettinga, M., Groen-van de Ven, L., Jukema, J., Janssen, R., Vernooij-Dassen, M., et al. (2018). Involving people with dementia in developing an interactive web tool for shared decision-making: Experiences with a participatory design approach. *Disability and Rehabilitation*, 40(12), 1410–1420. <https://doi.org/10.1080/09638288.2017.1298162>

- Swift, H. J., Abrams, D., Lamont, R. A., & Drury, L. (2017). The risks of ageism model: How ageism and negative attitudes toward age can be a barrier to active aging. *Social Issues and Policy Review*, 11(1), 195–231. <https://doi.org/10.1111/sipr.12031>
- Tremblay, M., Latulippe, K., Giguere, A. M., Provencher, V., Poulin, V., Dubé, V., et al. (2019). Requirements for an electronic health tool to support the process of help seeking by caregivers of functionally impaired older adults: Co-design approach. *JMIR aging*, 2(1), e12327. <https://doi.org/10.2196/12327>
- van Boekel, L. C., Wouters, E. J., Grimberg, B. M., van der Meer, N. J., & Luijckx, K. G. (2019). Perspectives of stakeholders on technology use in the care of community-living older adults with dementia: A systematic literature review. *Healthcare*, 7(2), 73. <https://doi.org/10.3390/healthcare7020073>
- 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 (TOCHI)*, 22(1), 1–27. <https://doi.org/10.1145/2696867>
- Wilkinson, S. (2004). Focus group research. In D. Silverman (Ed.), *Qualitative research: Theory, method, and practice* (2nd ed., pp. 177–199). Sage. <https://doi.org/10.7748/nr.12.4.92.s9>
- Wu, Y.-H., Damnée, S., Kerhervé, H., Ware, C., & Rigaud, A.-S. (2015). Bridging the digital divide in older adults: A study from an initiative to inform older adults about new technologies. *Clinical interventions in aging*, 10, 193–201. <https://doi.org/10.2147/CIA.S72399>
- Xi, W., Zhang, X., & Ayalon, L. (2021). The framing effect of intergenerational comparison of technologies on technophobia among older adults. *The Journals of Gerontology: Series B*. [10.1093/geronb/gbab199](https://doi.org/10.1093/geronb/gbab199).
- Xi, W., Zhang, X., & Ayalon, L. (2022). When less intergenerational closeness helps: The influence of intergenerational physical proximity and technology attributes on technophobia among older adults. *Computers in human behavior*, 131, Article 107234. <https://doi.org/10.1016/j.chb.2022.107234>