"Hi, My Name is Robin" – Remotely Co-designing an Embodied Conversational Agent for Empathy with Older Adults

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Abstract. Embodied conversational agents (ECAs) have the potential to facilitate empathic relationships between older adults and eHealth coaches, but little research has been conducted on how to effectively include appearance and personality in the design of ECAs such that older adults can empathize with the agent. In this study, we aimed first to develop design requirements for ECAs that induce empathy in older adults. Second, we developed and reflected upon a remote (online), iterative co-design methodology which can be used as an alternative when traditional physical methods cannot take place (e.g. during COVID-19). Over the course of three months, five older adults (mean age 68 years) 1) received a paper booklet, 2) were invited to an Q&A session, 3) after which they were asked develop their own ECAs at home using the booklet, 4) and came back to discuss their designs online in a group setting to determine design requirements, 5) which were used to develop an interactive ECA, 6) that was individually evaluated in an online meeting. The final ECA, called Robin, was positively perceived in terms of appearance, but the participants expected the conversation with Robin to be more flexible and deeper. Overall, the current study demonstrated the feasibility of remote co-design activities for this population and presents recommendations for researchers and practitioners interested in or in need for a remote approach. Moreover, the current findings are translated in lessons learnt to inform design and development of future ECAs for older adults.

Keywords: Aging and DUXU · Remote Co-design · Participatory design and older adults

1 Introduction

As the global population ages, there is an increasing need for effective eHealth technologies that can support older adults in maintaining and improving their health and well-being [1]. The World Health Organization estimates that the number of people aged 60 years or over will more than double by 2050, reaching 2.1 billion [2]. Along with this demographic shift, there is a corresponding increase in the prevalence of chronic health conditions such as diabetes, heart disease, and obesity [3].

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Coaching interventions delivered through eHealth technologies have the potential to provide personalized and convenient support for older adults to adopt healthier behaviors and manage chronic conditions [4, 5]. Coaching interventions can take various forms, including telephone-based support, web-based programs, or mobile apps [6]. These interventions can provide older adults with the tools and support they need to make lifestyle changes, such as increasing physical activity, improving nutrition, and quit smoking [7, 8].

However, the effectiveness of coaching interventions can be influenced by the quality of the therapeutic relationship between the coach and the user, like the older adult [9]. Empathy, or the ability to understand and share the feelings of others, is an important factor in building trust and rapport with clients and can be especially important in the context of coaching for health behavior change [9, 10]. Empathy has been shown to be associated with positive outcomes in coaching interventions, including increased self-reflection, and enabling self-change [11]. Creating empathic interaction with older adults can be challenging, due to differences in perspectives and experiences between designer and target group [12]. While this relationship is formed naturally between humans, it proves to be more challenging with eHealth technologies. It is important for eHealth technologies to be designed in a way that is accessible, user-friendly, and respectful of the unique needs and preferences of older adults. To address this discrepancy, embodied conversational agents (ECAs) could provide the opportunity to facilitate such an empathic relationship [10, 13–15].

Embodied conversational agents (ECAs) are virtual agents designed for communicating with users through natural language and nonverbal cues such as facial expressions, gestures, and vocal intonation [13–15]. ECAs have the potential to be employed in eHealth technologies as a means of providing healthcare-related information, support, and interventions to older adults. The use of ECAs in eHealth has gained increasing attention in recent years, with several studies demonstrating their potential benefits for older adults, such as general ease of use and access to information, as well as feelings of companionship [16]. ECAs can be designed to promote behavior change in eHealth technologies for older adults by incorporating empathy into their interactions with users [10]. Empathy, has been shown to be an effective means of promoting behavior change, particularly when combined with other techniques such as goal setting and feedback [17].

A study by [18] found that older adults prefer ECAs with a human-like appearance and natural language, and that personalized, and context-aware responses are important for enhancing user engagement. Another study found that several characteristics, such as appearance, gender and personality can influence the relationship with ECAs [19]. Consequently, effective ECA design requires consideration of the needs and preferences of the target population, which can be elicited through user-centered approaches [20] such as user interviews, focus groups, and co-design. Overall, the evidence suggests that ECAs that use empathy can be effective in promoting behavior change among older adults, and user-centered approaches can inform the design of effective ECAs for promoting behavior change.

Co-design is a participatory design approach that involves the active involvement of intended users in the design process [21]. This approach has its roots in the field of human-computer interaction and has been widely used in various contexts, including product design, service design, and healthcare, to address complex design challenges and consider diverse user needs and preferences [21–23]. The use of co-design with older adults has the potential to benefit the development of products and services for this population by incorporating their needs, preferences, and perspectives into the design process [24, 25]. However, the use of co-design with older adults can be challenging due to constraints on mobility and accessibility, which can be addressed by remote and online co-design approaches.

There is a growing body of research on co-design, including studies that have explored the use of co-design with older adults [26–28]. Despite these advances, there is still much to be explored about the best practices for remote co-design with older adults using digital technologies. The COVID-19 pandemic has demonstrated the need for remote co-design approaches to increase accessibility and inclusivity for users who may have difficulty participating in face-to-face co-design sessions [29, 30].

In this paper, we present the results of a study that aimed to explore the potential of remotely co-designing ECAs to facilitate an empathic relationship with older adults. Our study used a unique remote co-design approach that allowed older adults to participate in the design process at a distance, overcoming limitations imposed by COVID-19 in the Netherlands. We present the findings of the remote co-design process and discuss the implications of these findings for the design and development of ECAs for older adults. Through this work, we aim to contribute to the growing body of research on the use of ECAs for coaching older adults to improve their health and well-being. The current findings are translated in lessons learnt to inform design and development of future ECAs for this population and provide practical guidance for researchers and practitioners interested in or in need for a remote approach.

2 Method

The co-design process consisted of six steps over the course of ten days with a preparation time of one week and then a usability test after three months (see Fig. 1).

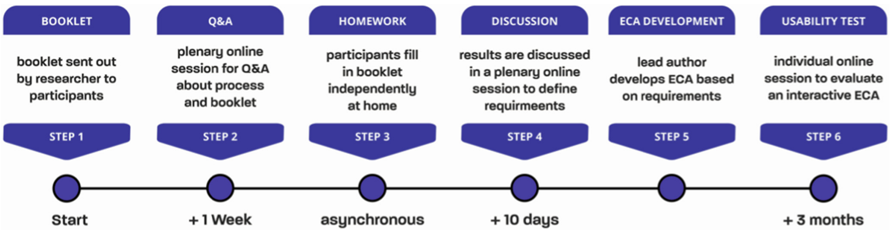

Fig. 1. Process of remote co-design activity consisting of 6 steps over the course of 3 months.

2.1 Participants

Participants were recruited through the National Foundation for the Elderly in the Netherlands by means of asking volunteers involved in organizing activities for older adults to reach out to candidates that they consider suitable. Participants were screened to ensure that they met the inclusion criteria and were representative of the target population of older adults. The inclusion criteria were age (65 + years), technology proficiency (comfortable using a computer and video-calling software *Microsoft Teams*), and self-reported good general health (no severe cognitive impairments). Ethical approval was obtained for the remote co-design activity (RP 2021–160) and usability test (RP 20201–194) separately from Ethics Committee Computer & Information Science (EC-CIS) at the University of Twente. Participants signed an informed consent for both studies.

2.2 Remote Co-Design Process

Step 1: Booklet. First, participants received a paper co-design booklet at home (see Fig. 2). The booklet consisted of 26 pages designed to guide participants through the process of generating their own ECA using three tasks. These tasks were structured to scaffold the creativity of participants and help them become "experts of their own experiences" [21] before developing an ECA, as follows:

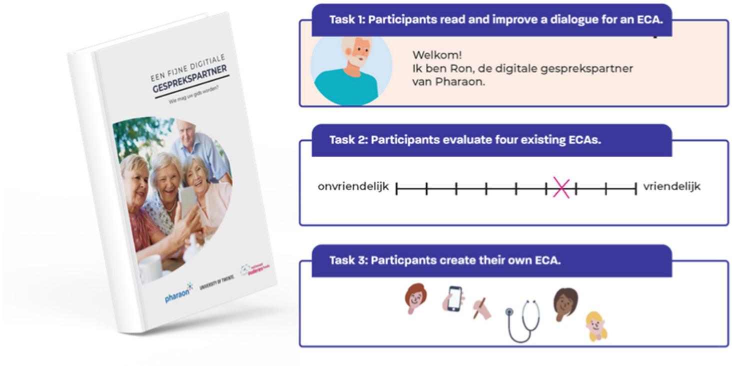

Fig. 2. The booklet contains three tasks to guide the participant from "understand" to "generate" by scaffolding their creativity, as well as gaining experience with ECAs before developing their own one.

- Task 1: Participants were presented with a dialogue for an ECA. In the conversation three health interventions (virtual diet coach, a physical activity monitoring and coaching system, and a social activity platform) were explained and offered. Participants were asked to change the text according to their preferences.
- Task 2: Participants were presented with four pre-designed ECAs that were evaluated based on seven characteristics, following [10]: friendliness, expertise, reliability, involvement, connectedness, authority, and the likeliness of following the agent's advice on a Likert scale from 1 to 7 (7 being the best). The four ECAs were designed to show a contrast between professional vs casual, expert vs peer, and young vs old (see Fig. 3). These properties were chosen to provide a diversity of ECAs and foster the creativity of the participants for the next task.

- Task 3: In the final task, participants were asked to design their own ECA. The booklet included a template and a set of images with faces, clothes, and characteristics to help them design their ECAs (see Fig. 4). They could cut out shapes and figures and make an ECA of their liking.

Fig. 3. Overview of the four presented ECAs, from left to right: Linda (female, old, casual, peer), Ron (male, old, professional, peer), Dr. Marije (female, young, professional, expert), Trainer Bart (male, young, casual, expert).

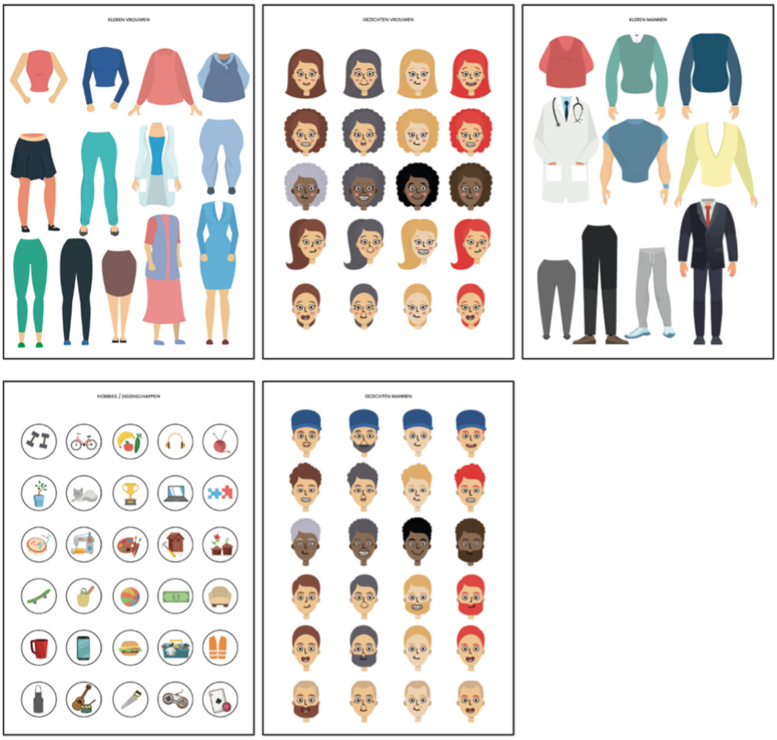

Fig. 4. The template and elements that participants could use to develop their own ECA.

Step 2: Q&A. One week after mailing the booklet, an online meeting was held in a group setting using video-calling software *Teams* (Microsoft) to manage expectations and answer potential questions. Participants were provided with instructions on how to use the software and were given the opportunity to ask questions and clarify any uncertainties before starting the co-design process.

Step 3: Homework. In the third step of the co-design process, participants were given 10 days to complete the tasks in the co-design booklet. This provided them with the opportunity to work at their own pace and allowed them to reflect on the design of their ECA before presenting it to the group.

Step 4: Discussion. The participants engaged in a group discussion in a plenary session to determine the requirements for an ECA that could elicit empathy in older adults. Each participant presented their design, and the group discussed the characteristics of each ECA, such as appearance and personality, and agreed on the key requirements for the final design. The requirements that emerged from the discussion were divided into physical attributes and personality reflected in the dialogue, with their importance prioritized according to how often they were mentioned.

Step 5: ECA Development. The lead author (ST) developed a digital ECA based on the input from all participants. The ECA was developed using WOOL, a software platform to create ECAs [31]. The ECA can be accessed through a link and opened in any web browser. The interaction consists of reading what Robin says and choosing a pre-defined response (see Fig. 5). A first version of the text was written by the lead author in collaboration with two experts from the National Foundation for the Elderly in the Netherlands (i.e. Nationaal Ouderenfonds). It was then revised by the participating older adults in the first task of the booklet. We took their suggestions into account and further improved it by adhering to the requirements defined by the participants.

Fig. 5. Example Screenshots of the web-app showing Robin with a speech bubble saying "Sure! How can I help you?" and three potential answers to choose from.

Step 6: Usability Test. In the final step of the co-design process, the participants were asked to interact with Robin, who started the conversation with 'Hi, my name is Robin'. In this online session, participants individually evaluated the usability of the digital ECA by using Robin and the three health interventions and were asked to provide comments on their experience with the platform using the thinking-aloud method. To quantitatively measure the usability of the ECA called Robin, the participants were asked to complete the System Usability Scale (SUS) [32]. The SUS is a widely used measure of usability that consists of 10 items rated on a 5-point scale, with higher scores indicating better usability (best imaginable: 91, Excellent: 86, Good: 71, OK: 51, Poor: 36, Awful: 20, Worst imaginable: 13) [33]. The verbal comments were used as feedback to improve the ECA.

3 Results

Seven persons expressed interest in the study. One person dropped out due to health reasons before the study started, and another dropped out after receiving the booklet because the tasks were too "simple" and "childish". So, a total of five older adults participated (mean age 68 years).

3.1 Design Requirements (Step 1–5)

Physical Attributes of the ECA. Looking at the participants' individual designs (see Fig. 6 for two examples), the ECAs are at least middle aged (40 +), White and prefer activities like riding a bike or being creative. Only one woman designed a tan, young fitness coach to interact with "because I prefer talking to fit young men". Three participants stated that their ECA is "based on a dear friend". One said that the ECA should be gender neutral. After proposing this, four out of five participants agreed that they preferred talking to someone of their own gender. Overall, all participants agreed the ECA should "look friendly and neutral" and "not look funny". Through a discussion, they all confirmed that they would appreciate the display of facial expressions that match the displayed text. "A head to show this is enough, we do not need the whole body" was then added. One participant highlighted that the ECA should "not wear a suit, that makes

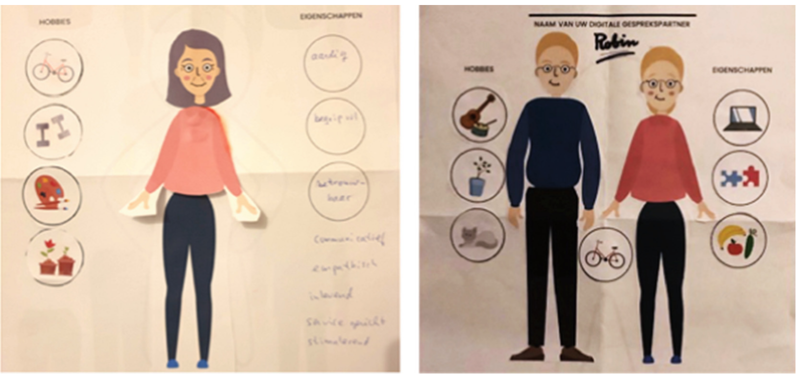

Fig. 6. Two examples of ECA as designed by two older adults. Photographed by them and sent to us via e-Mail or Whatsapp.

it easier to talk". At the same time "he should not wear gym clothes either, that is not appropriate". Near the end of the discussion, a suggestion was made to include the voice of the ECA to make it more realistic "but it can absolutely not sound robotic, then I would immediately stop using it".

Table 1. List of physical attributes of the ECA and their importance.

Physical attributes of the ECA	Importance
The appearance of the ECA should be friendly and neutral, avoiding any look that might be considered funny	High
The ECA should display facial expressions that match the text being presented, so as to add emotional context to the message	High
The ECA should just present a face, and preferably look realistic	Medium
The appearance of the ECA should not be too formal, such as wearing a suit, nor too casual, such as gym clothes. A neutral and appropriate appearance should be maintained	Low
The ECA should have a natural voice that reads the text, avoiding a robotic or monotonous tone. The voice should sound engaging and human-like	Low

Personality of the ECA. Participants placed the highest importance on the ECA's ability to show empathy and understanding towards their experiences. They emphasized that the ECA should be "a good listener" and respond appropriately to their input. The ability to summarize the participant's story or to use phrases like "I understand what you mean" to show that the ECA is paying attention and understanding their perspective was also considered crucial. Additionally, the ECA "is an expert and knows more than I do about the topic" and should provide additional information about the health topics. Still, while doing so "using simple language is important because some older adults might for example not understand what a platform is".

Table 2. List of personality attributes of the ECA and their importance.

Personality attributes of the ECA	Importance
The ECA should be empathetic, showing understanding and concern for the user's needs and feelings	High
The ECA should confirm its understanding and ask about the user's preferences in order to provide a personalized experience	High

(*continued*)

Table 2. (*continued*)

Personality attributes of the ECA	Importance
The ECA should be a good listener, paying attention to the user's needs and responding appropriately	High
The ECA should be able to provide additional information according to its expertise	Medium
The language used by the ECA should be simple, avoiding technical or overly complex terms that may confuse the user. The ECA should aim to communicate in a clear and concise manner	High

3.2 Evaluation of the Digital ECA (Step 6)

Based on the requirements a new digital ECA was made with a gender-neutral name: Robin. According to the requirements of the participants, we decided to show only the face and a bit of the upper body. Robin can show six facial expressions (being happy, neutral, surprised, friendly, annoyed, and caring) by means of changing their mouth, eyes and eyebrows depending on the dialogue. Robin is designed as being a bit older and White, similar to the ECAs designed by the older adults themselves. The clothes are neither professional, nor casual. The dialogue itself included additional information related to older adults' health and phrases to express understanding and confirmation in relation to the user's choices. We tried to adhere to all requirements apart from the requested voice-over, as it was not in the scope of the project.

Fig. 7. Robin, the final design of the ECA showing the six emotions from left to right: happy, neutral, surprised, friendly, annoyed, and caring.

System Usability Scale (SUS). The results of the SUS indicate that the participants had a positive experience with Robin, with an average score of 75 out of a possible 100. Four out of five participants scored Robin as having *good* to *excellent* usability, with scores ranging from 77,5 to 90. One participant felt that robin did not approach the explanation and choice of interventions appropriately, which might be the reason he scored 37,5 resembling a *poor* usability.

Qualitative Feedback. The qualitative feedback provided by the participants was generally positive, with several participants noting that they found Robin to be friendly and easy to use. However, most participants also suggested that Robin could be improved by having more diverse options for answers and a more flexible conversation flow. The conversation flow does not allow for much personalization. While the number of answers and responses are limited, the tone of voice was perceived positively. Only one participant would prefer a different terminology at some points in the conversation in order to display a better understanding of the user, rather than categorizing them. For instance, Robin summarizes whether a user wants to work on their physical activity or not. Instead of categorizing this in yes or no, the participant preferred to assign *priorities*, so it does not feel black and white.

Table 3. Verbal feedback provided by participants about their interaction with Robin (translated from Dutch).

Participant	Feedback
1	"Robin looks nice and how he explains things is simple and clear."
2	"It would be nice if Robin could be more flexible. But overall, Robin looks good and is easy to interact with."
3	"Everything was clear, and it was fun to interact with Robin to see the different answers."
4	"It is strange that the answers are so limited. Instead of saying 'yes' or 'no' to an intervention, it would be better to use the term 'priorities' for deciding what to work on."
5	"It is a good feature that Robin helps us choose between eating behavior and physical activity. Just sometimes the text was a bit long."

3.3 Overall Experience with the Remote Co-design Process

Overall, the participants found it pleasant to do the remote co-design activities. They appreciated the opportunity to collaborate with each other and contribute to the design of the ECA and found the group discussion to be engaging and productive. Most participants also reported feeling comfortable and supported during the online meetings, despite some initial challenges with navigating the video-calling software, such as entering or leaving the meeting, as well as turning on their cameras or unmuting their microphones. However, while two considered the co-design activities "fun to do" and one participant indicated that it "gave me a new perspective that changed my way of thinking", the others found it to be "neutral" and completed the booklet rather quickly. One participant dropped out after receiving the booklet because the tasks were considered childish and disrespectful, as if "you purposely made it so simple because you think we are stupid". Overall, the booklet was clear, and all participants could complete the tasks independently. All participants agreed that it did not take long to complete the booklet and that they would have preferred to meet again faster, even on the same day or the day after.

4 Discussion

The aim of the study was to explore the potential of remotely co-designing ECAs to facilitate an empathic relationship with older adults. We found (1) design requirements for the ECAs personality and appearance that should provide the foundation for an ECA that can evoke empathy, as well as (2) that co-designing with older adults remotely using a combination of analogue and digital elements is feasible. Below we will discuss the design requirements for appearance and personality in the design of such an ECA and we will reflect on the potentials and limitations of co-designing with older adults remotely.

4.1 Design Requirements for ECAs Personality and Appearance

We divide the requirements in personality and appearance traits. The requirements mostly comply with findings in existing literature.

Appearance of the ECA. In our user test, it became apparent that the appearance of the ECA we developed was perceived positively. The ECA was designed to look at least middle-aged and to look White. The appearance and name intended to be gender-neutral, so users could interpret this for themselves. This might contribute to observer-target similarity as proposed by Paiva et al. [13], which is also confirmed by [34], who found that older adults prefer an ECA image that is similar in age and gender. While it was requested that the general appearance is neutral, the ECA should be expressive and show a range of emotions through their facial expressions. This requirement complied with the findings of [35], stating that "emotionally effective and socially competent agents are more likely to build a successful relationship with a human user".

Another priority was that the ECA should not look funny. This requirement emerged in the discussion with the participants because we provided participants with stylized faces rather than realistic ones to develop their own ECA, although literature states that older adults prefer a realistic ECA [18]. This choice was made because participants can feel connected to an animated ECA [36] and we did not want to cause the misconception that the ECA they are interacting with was a real person. Creating an animated ECA also allowed us to develop a gender-neutral personality with consistent images of a range of emotions.

Personality of the ECA. Overall, the content was perceived as easy to understand, since the ECA used simple language and avoided jargon. However, while Robin was described as "nice", the participants noted that the neutrality of the looks translated to the conversation with the ECA due to the standardized conversation flow. Although sentences like "I understand your choice" might create the impression that Robin processes the answers of the users and "is a good listener", in fact Robin does not. This makes the personality appear shallow rather than "empathetic", as it was requested by the participants. This means that personalization is a highly relevant aspect to an empathetic ECA, which is confirmed by several studies [4, 5]. Therefore, it is not sufficient to create a 'nice' ECA, but the technology behind it must be sufficiently mature to also mimic an authentic interaction.

4.2 Recommendations for Co-designing with Older Adults Remotely

After this exploration of remote co-design activity with older adults, we provide a reflection and cautiously distill lessons learnt related to (1) participants, (2) study process, and (3) level of participation.

Participants. The recruitment process was challenging due to the effects of the COVID-19 pandemic on mental and physical health on people, including older adults. We wanted to include at least 10 participants, but the response was low. This might also be linked to the fact that we were looking for older adults with high digital literacy as they needed to be able to use corporate video-calling software *Microsoft Teams*, while the general population might be more familiar with consumer-video-calling software like *Facetime*. Additionally, we asked volunteers to specifically target potential participants that they consider suitable in order to satisfy our inclusion criteria. In turn, the recruitment strategy and inclusion criteria led to a selection of participants who might not be representative of our target group.

This also became apparent during the design process, when some older adults made remarks such as "I am not sure whether they understand the word 'platform'", speaking of *they* rather than speaking from their own perspective. One older adult even felt offended by the simplicity of the tasks in the booklet and decided not to participate in the study. The older adult suggested that we did not "treat them like children" but take them seriously. However, the tasks defined in the booklet are based on traditional co-design activities, involving cutting and sticking things to each other to create a prototype [see 37, 38]. To avoid this in the future, we recommend involving the older adults already in the development of the method and employing expectation management, explaining why the study is built up in such a way.

Study Process. The study was designed to include older adults from start to finish in the design process for an empathetic ECA. To define requirements for an ECA, we guided participants through a set of tasks and invited them to a plenary session in which we discussed their preferences. Through the tasks, they became experts of their own experiences. Overall, it was a good decision to send them material to work on at home. This reduced the time to learn additional technology and each participant could contribute equally, as their submissions were all of a similar quality. At the same time, participants indicated that they did not need 10 days to fill in the booklet. They said it would have been more effective to agree to meet again after one hour rather than picking an additional date.

The implementation of remote group sessions worked well. Participants could first work individually and then respond to each other. They clearly appreciated the plenary setting and the social aspect of the sessions. Each participant prepared a short presentation and could show their work and a discussion was held at the end. However, using Microsoft Teams proved to be challenging, as we did not prepare instructions on how to use it. Participants initially did not manage to mute or unmute themselves or to turn on their camera. The researchers guided them through this process, which was challenging in the first online session but went smoother in the following sessions.

Level of Participation. Several studies have established that a high level of participation of target users leads to better products. One way to measure the level of participation in the design process are the levels of participation in citizen science as proposed by [39] (see Fig. 8). Considering that the older adults were involved in the data collection and analysis, defining the requirements for an ECA, as well as evaluating the outcome and providing feedback, we can consider the process to be '*Level 4: Extreme Citizen Science*'.

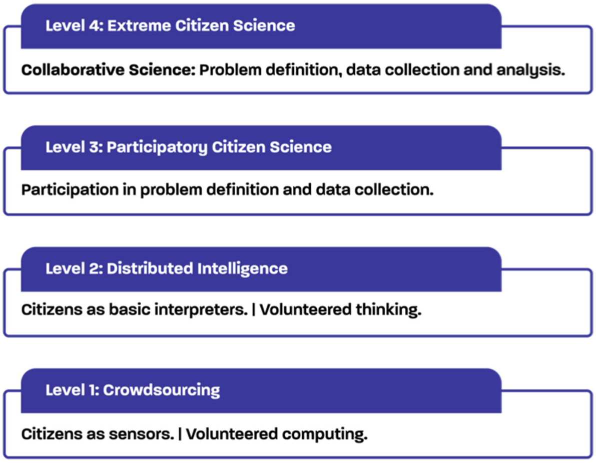

Fig. 8. Overview of the levels of participation in citizen science adapted from [39].

Although we employed the highest level of participation, and we did include older adults defined as persons older than 65 +, the reflection in the section 'Participants' shows that the included user group was not representative, and therefore it is not guaranteed that older adults would adopt Robin despite scoring good usability. Additionally, the study design involved some biases, such as not using realistic faces, so older adults do not think that they are interacting with a real person, although research found that they preferred real faces. Therefore, researchers must clearly be aware of their biases before taking any design decisions.

Lessons Learnt. The following best practices could be defined based on the learnings from the design study:

- Avoid selection criteria that might result in a biased selection of participants
- Involve older adults in the development of the study method to avoid misunderstandings and offense, as well as manage their expectations
- Engage older adults from start to finish in the design process, first making them experts of their own experiences and lastly allowing them to give feedback to what was developed

- Reduce the learning time of new technologies and ensure an equal level of participation by sending participants materials to work on at home
- Schedule sessions that are both individually and socially focused, with a plenary discussion at the end
- Provide clear instructions on how to use the video-calling software and use software that is familiar to the users rather than convenient for the researcher
- Avoid biases in the design process by being aware of one's own biases

5 Conclusion and Future Recommendations

We conclude that older adults prefer an ECA that resembles themselves. This is backed up by previous studies in the field of ECAs. Additionally, personalized answers and an engaging dialogue are important. Next to defining design requirements for an ECA, we also found that remote co-design with older adults is possible and can be an efficient and COVID-19-proof way to collect design requirements. Future studies should investigate which communication software, wording and language better match older adults with lower digital literacy to make sure that the actual target group you design for is represented. The presented lessons learnt can provide a starting point to develop guidelines for conducting remote co-design studies with older adults.

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