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To cite this article: Maaike Van Assche, Mirko Petrovic, Dirk Cambier, Patrick Calders, Patrick Van Gelder & Dominique Van de Velde (2022): The perspectives of older adults with mild cognitive impairment and their caregivers on the use of socially assistive robots in healthcare: exploring factors that influence attitude in a pre-implementation stage, Disability and Rehabilitation: Assistive Technology, DOI: 10.1080/17483107.2022.2075477

To link to this article: https://doi.org/10.1080/17483107.2022.2075477
The perspectives of older adults with mild cognitive impairment and their caregivers on the use of socially assistive robots in healthcare: exploring factors that influence attitude in a pre-implementation stage

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ABSTRACT

Background: Due to increasing age and an increasing prevalence rate of neurocognitive disorders such as Mild Cognitive Impairment (MCI) and dementia, independent living may become challenging. The use of socially assistive robots (SARs) is one solution that can enable older adults with cognitive impairment to remain independent. However, at present, there is a lack of knowledge about the attitudes of older adults with MCI and their caregivers towards SARs.

Methods: This study relies on a constructivist grounded theory approach. Semi-structured interviews were conducted to gain a deeper insight into attitudes of two different stakeholder groups: older adults with MCI and their (in)formal caregivers.

Results: Forty individual semi-structured interviews were conducted with older adults with MCI (N=30) and (in)formal caregivers (N=10). Data revealed different perspectives on SARs in healthcare for the involved stakeholders. Two main topics could be derived: (1) perspectives on robot assistance, discussing different viewpoints on the potential value of robots as helpers, and (2) perspectives on implementation, revealing different factors that could affect implementation. Both topics may explain a positive, impartial or negative attitude towards SARs.

Conclusions: This study identified different factors that should be taken into account when implementing a SAR in the home environment of older adults. Despite the fact that the benefits of SARs are often recognized, many older participants currently seem not ready yet to commit to the use of a SAR.

IMPLICATIONS FOR REHABILITATION

- This study explores the attitudes towards a SAR, developed to stimulate and support older adults with Mild Cognitive Impairment (MCI) on a physical, cognitive and social level.
- The results give a deeper insight into different factors contributing to a (non-) successful implementation of SARs in the home environment of older adults with MCI.

Introduction

Globally, major demographic changes are taking place with a rapid growth in the number of older people. Whereas Europe already has one of the most aged populations, the number of people aged 65 or over is expected to more than double by 2050 [1].

Increasing age is associated with several changes (e.g., at physiological or social level). The risk of chronic diseases and multimorbidity rises significantly [2,3]. In addition, there is also an increase in the prevalence rate of age-related conditions such as Mild Cognitive Impairment (MCI) and dementia [2,4]. As a result, it is expected that the use of health care resources will only increase over the next decades. To address these challenges, the concept of “ageing-in-place” has received growing attention over the past years as it is considered a valuable approach in the context of long-term care [2,5]. Older people prefer to remain at home for as long as possible [6–8]. This may become challenging or even impossible when facing age-related problems, such as physical or cognitive decline.

Assistive Technologies are considered to have the potential to support independence and care of older adults [2,9,10]. Over the past decade, Socially Assistive Robots (SARs) became an emerging form of assistive technology within this field and increasingly more research has been done into the application of SARs in healthcare. Recently, there is also growing interest in the effectiveness of SARs in older adults with neurocognitive disorders, such as MCI and dementia.

MCI is defined as an intermediate state between healthy age and dementia, with persons suffering from this condition being at higher risk for progression to dementia [11,12]. The most
The Consolidated Criteria for Reporting Qualitative Research (COREQ) were followed to guide this research [27] and the 32-item checklist supported us in reporting the study. This study was approved by the ethical committee of Ghent University (B670201938741).

Recruitment
A purposive sampling method was used to recruit participants. First, twenty-two assisted living facilities in the province of East Flanders (Dutch speaking part of Belgium) were contacted by phone. The objective of the study was briefly explained and contact persons whom the researcher should communicate with were appointed. In most cases, this person was the resident assistant (RA). Since the RA is a permanent and easily accessible person within these facilities, involving them as formal caregivers was the most valuable option in this project. Those interested in joining the study had to provide informed consent, through which permission was given to recruit participants in their facilities.

Next, the RA provided a list of potentially appropriate participants. All potential participants were contacted personally by the first author and screened using the Montreal Cognitive Assessment (MoCA) [28]. This score was a first criterion to determine whether or not the person was eligible to participate in the study. If the score on the MoCA was adequate, the other criteria were checked to determine further eligibility. The in- and exclusion criteria that were set are presented in Table 1.

Finally, an appointment with the participants was made to conduct the interview. To gain a deeper understanding of the opinions of all end-users in this project, the involved RAs and, if present, informal caregivers of the older participant were also asked to participate in the study. Besides being connected to one of the participating facilities (RAs) or older adults (informal caregivers), no specific criteria were set. Written informed consent was obtained by all participants.

Data collection
The conducting of the interviews was divided into two parts. During the first part, general questions about robotics in healthcare were asked. This was done without prior information about the robot used in the project or its aim and functionalities (e.g., “what’s your opinion about robots in healthcare?”). Follow-up questions were asked.

In the second part, the participants received more information about the specific functionalities of a SAR by watching a video (see Supplemental Online Material, Appendix 1, for a description of the content). In this video, a robot could be seen performing certain tasks (e.g., moving around, talking, playing music). This was followed by questions to gain a deeper understanding of their attitudes (e.g., “what’s your opinion about doing physical exercises with a robot”, followed by follow-up questions). The same protocol was followed to interview the formal and informal caregivers, with the questions adapted to their background (e.g., “what’s your opinion about older adults being supported by a robot to perform physical exercises?”). Interviews continued until
theoretical saturation was reached, meaning new data did no lon-
ger provide new theoretical insights.

The data-collection took place in the private homes of the
older participants and, in case of the RAs, in their offices. Each
interview was audio-recorded and transcribed at verbatim.

Data analysis

Qualitative coding is the first analytic step in the process of CGT.
This process is composed of two stages [24]. First, there is the ini-
tial coding, in which data was labelled with codes line by line.
This phase involved a thorough (re)reading of the interviews,
while taking notes with each line or segment in the interview
that could possibly be of value. Codes were assigned to frag-
ments of the data and conceptual schemes were created, consist-
ing of concepts that seemed to be most relevant to provide
insight into the topic. Emerging concepts were constantly eval-
uated and refined together with the last author (DVDV) to check
whether the analysis was credible. Next, the focussed coding took
place, in which significant codes that seem to appear frequently
were used to code future data [24,26]. This process took place
using the software program NVivo 12 for qualitative data analysis
[29]. The data and concepts were organized and integrated and
finally themes were developed out of most relevant codes.
Through regular peer debriefing sessions with the research team,
a theory was built from the constructed themes. Theoretical sat-
uration was reached after analysing 26 interviews from older partici-
pants and 7 interviews from (in)formal caregivers. Respectively,
four and three additional interviews were conducted to confirm
that no new concepts emerged from the analysis.

Materials

Within the ReMIND-project, an existing SAR called James® from
Zora Robotics plc, a Belgium-based company specialized in
robotics software, is used. A picture of James® is shown in Figure
1 and a video with its introduction can be seen via the following
link: https://www.youtube.com/watch?v=2FG9LZYM1M.

Results

Institutions and participants

Twenty-two institutions were contacted, of which nine provided
written informed consent. A total of 86 older adults was con-
tacted by the researcher. Thirty-six declined participation and 18
were excluded from the study due to not fulfilling the inclusion
criteria. Next, there were two drop-outs (withdrew from the study
before the interview). This brings the number of participants to a
total of 30 older adults.

Concerning the (in)formal caregivers, a total of 10 resident
assistants and two informal caregivers were contacted. Two
assistants declined participation, which makes a total of eight
assistants and two informal caregivers participating in this study.
Table 2 shows the participants' demographics.

Semi-structured interviews

The interviews were conducted between March and August 2019
by the first author (MVA). Forty-to-sixty-minute semi-structured
interviews were conducted with every participant. The analysis
led to different themes that seemed to influence the attitude
from older adults with MCI and their (in)formal caregivers towards
SARs. Two main topics could be derived from the interviews: (1)
the perspectives on robot assistance and (2) the perspectives on
implementation, consisting of common as well as different
themes discussed by both stakeholder groups. The second topic
will be presented for both the older adults and the (in)formal
caregivers separately to enable a focus on the different perspec-
tives. An overview of the different themes is presented in Table 3.

![Picture of robot James®.](image.jpg)

![Table 2. Participant's demographics (older adults N = 30; (in)formal caregivers N = 10).](table.png)
The subthemes are further clarified by illustrative quotations from the different interviews. The quotes are preceded by abbreviations (OA – P#: Older Adults and CG – P#: (in)formal CareGivers) to indicate the different participant groups.

**Perspectives on Robot assistance**

**Openness to SARS**

One important topic in the interviews was whether or not they thought the robot would be valuable at this stage of their lives. By analysing the answers, we could distinguish three groups: (1) the reluctant older adults, who were not open (yet) to having a SAR, (2) the hesitating older adults, who wanted to “wait-and-see” and experience having a robot before judging, and (3) the compliant older adults, who were open to having a SAR.

The group of older participants who were reluctant towards SARS clearly stated that they did not consider themselves in need of help (yet). It was believed that the robot could be fun in terms of entertainment and learning, but it was not yet considered necessary. Though, almost all of those who were reluctant considered themselves as potential future users in case of further physical or cognitive deterioration. The others were not sure if they already considered its presence an added value. The following excerpts show the differences in their openness for SARs:

- **[OA – P30]**: When you have experienced what its possibilities are... Only then you can actually judge about it.
- **[OA – P6]**: No, I wouldn’t need it yet. If I become more dependent, then I think I will. […] I’m not against it (the idea of having a robot), but it’s not necessary yet.
- **[OA – P18]**: I am positive about it. You always have to look at the future. It is not because people have an opinion about something… You have to think further. You have to dare to get engaged into something you are a little suspicious or unsure about.

Likewise, the carers were asked whether they would already support the implementation of a SAR within their facility. The results show that most of them would support the implementation, with only few stating that they wouldn’t (yet). Some RAs hesitated, as they were not convinced the robot would be a valuable contribution to the lives of older adults. As with the older participants, also the caregivers can be divided into the same three groups: (1) the reluctant caregivers, who were not open to SARs in healthcare and would therefore not support its implementation, (2) the hesitating caregivers, who were not convinced yet of its added value and (3) the caregivers with a positive attitude towards SARS and who would support its implementation.

**Complement staff shortage**

All the participants compared the assistance from robots to receiving care from humans. Both benefits and disadvantages were addressed. Considering the current societal context and its challenges, such as staff shortage in healthcare, the majority of the older participants agreed that robots could have a valuable contribution. It was believed that the robot could take over routine tasks from the caregivers, which would result in more time for important tasks, such as having a good conversation. One participant also noted that a robot is only a one-time purchase, while staff has to be paid monthly.

Only few participants expressed negative feelings about robots in healthcare, stating that they would take away jobs from humans.

Though real human contact seemed to remain the preferred option, some advantages of the robot compared to human caregivers were also discussed. So, the robot was seen as: “always objective” (OA-P29), “never sick” (OA-P27), “always in the same mood” (OA-P29) and “more efficient” (OA-P9, OA-P18).

Overall, all participants agreed that robots should only complement the caregivers’ tasks, and not serve as a replacement of human contact.

- **[OA – P11]**: I think that’s a good thing, because the staff is too expensive […] But actually, I think humans are still better than robots. Because they can still think.
- **[OA – P18]**: I think it’s good that, if there is no human guidance anymore, he [the robot] can take over some tasks. […] And he will probably forget less than a human. […] I think it is a valuable addition when there is a shortage of people to execute the job.

Like the older participants, the caregivers believed that the robot could be of value to complement staff shortage in healthcare. The robot should be able to relieve care burden by taking over small tasks from the caregivers, such as help with medication (intake and preparation) or provide activities for entertainment.

Some disadvantages of robots in healthcare were also brought up. For example, the robot was referred to as “emotionless” (CG-P9) and “incapable of recognizing pain or needs” (CG-P9, CG-P10). Thus, the caregivers also highlighted robots should never replace human contact, but should only serve as an addition to care.

- **[CG – P7]**: I think that they [robots] can be an added value, certainly because of current staff shortages. They can take over certain care tasks or make it easier for the caregivers, so that they can deal with the
Perspectives on end-users
The older participants often spontaneously referred to other potential target groups that, in their opinion, could benefit even more from the robot’s services. According to them, the robot was most suitable for, e.g., “people with dementia” (OA-P7, OA-P9), “people with joint pains” (OA-P7), “people living in a nursing home” (OA-P12, OA-P18) or “people becoming more physically dependent” (OA-P6).

Deceiving reassurance
The informal caregivers as well as resident assistants raised ethical issues in this context. Concerns were expressed about the fact that the robot could create a deceiving feeling of safety within the older adults’ environment. They worried about the fact that family members or friends might skip visits to the older adults, because the robot would already be present. They stated that the robot should not be an excuse to skip visits to the older person, but feared that this might become the case.

Perspectives on implementation – older adults’ perspective
Perceived barriers
Technology reliability. A first topic that was brought up by participants was the technical part of robots and the associated risks. They were all quite aware of the fact that technology can fail and will never be fully reliable. Concerns were expressed about the possibility that externals can cause the robot to malfunction (e.g., hacking). For these reasons, appealing to technological devices, such as robots, seems to be another important potential barrier for some older adults.

Stigmatisation. A second topic was the fear of stigmatisation. Having a robot, or rather needing a robot, was seen as an admission to themselves and their environment that (cognitive or physical) problems are present. The robot was seen as an object that was clearly visible for others, in contrast to a condition that would otherwise not be visible in the first place. A clear concern was expressed among some older adults that their limitations might become even more highlighted to their environment through the use of a robot.

Cost price. A third topic that was discussed concerns the cost price of the robot. Participants wondered whether robots would be affordable for the average person. For example, the robot was referred to as a “luxury item” (OA-P5), not affordable for all. It was thought that one should pay more to live in facilities where such robots are present, as if a sort of “exclusive luxury facilities” were to be created. Affordability therefore appeared to be another important factor, implying that SARs should be accessible for all and exclusion based on income should be avoided.

Environmental adjustments. Compared to other devices, such as a tablet or laptop, the robot takes up considerably more space with its shape. As the robot must be able to move around, the physical environment in which it will operate may require some adjustments. For example, attention will have to be paid to narrow passages and carpets. This did not go unnoticed by some participants, as they started to wonder what adjustments they would have to implement to their own apartments. Some of the older adults seemed to be reluctant to the idea of having to rearrange their homes for the robot to be able to move around and create a space for it to charge at night.

Available alternatives. Participants spontaneously referred to other available technological alternatives, which often made them question whether the robot and its functionalities would be a valuable contribution to their daily lives. They referred to other devices (e.g., laptop, smartphones) or applications (e.g., Skype, WhatsApp) that they were already familiar with and that could serve the same purpose as robots. These available alternatives seem to be an important potential barrier for older adults to engage into something new and, as yet, mainly unknown.

Though many participants questioned the added value of the robot compared to the available alternatives, they believed the robot would be able to reduce loneliness in older adults. This ability was only attributed to a robot and not, for example, a tablet or laptop.

Perceived facilitators
Curiosity. A first topic that emerged from the data was a certain curiosity that turned out to be present among the participants, regardless of their attitude towards robots. As it was believed to be unavoidable for robots to become more and more embedded in healthcare, many were convinced that they would have to deal with it one day. Therefore, it was often their curiosity that convinced them to join this study and take a first step in finding out whether or not robots could be a valuable contribution to their daily lives.

Innovative tool. As a new, innovative tool to older people, robots were considered as having the potential to trigger them in new, perhaps even more motivating ways. According to some participants, the robot should be able to verbally encourage and stimulate them in the execution of tasks, e.g., performing physical or cognitive exercises. Tasks for which they may otherwise be less motivated to do.
help them carrying out more complex tasks of daily life. Adequately developed to meet the needs of the older adults and to do the tasks from the older adults. They stated that robots should not make older adults lazy or take over tasks that they could still perform themselves. Instead, the robot should motivate and activate older adults.

Perspectives on implementation – the caregivers’ perspective

Perceived barriers

Technology reliability. The possible risks that come with the use of technological devices were mentioned by both the older adults and caregivers. The caregivers expressed concern about the fact that the robot may fail at inappropriate times (e.g., during emergency call) and about the older adults’ inability to handle these problems. Therefore, it might be hard for both the older adults and caregivers to fully rely on the robot. Some caregivers also questioned the robot’s level of technical readiness and thus its ability to be of help for the older adults. They believed that the current SARs were not adequately developed to meet the needs of the older adults and to help them carrying out more complex tasks of daily life.

[CG – P7]: [...] That’s what scares me the most, it’s still a robot. He can suddenly shut down, he can have bugs, … At this moment, I will never trust it 100%. It’s still a machine, isn’t it?

Generational characteristics. A topic that was seen as one of the major challenges in the context of older adults and SARs, was the fact that the current generation of older adults might still be too unfamiliar with modern assistive technology, such as robots. Some believed that the robot could scare or stress out older adults, as its intentions might be unclear. It was often said that the next generation of older adults would definitely be more open to the use of technology, while the attitudes of the current generation towards robots might vary.

[CG – P1]: This generation did not grow up with those objects, those modern techniques. […]. It can be stressful [for the older adults], I think. They’re going to be afraid to touch something wrong, or press the wrong buttons.

Personal factors. A last barrier that emerged concerns some personal factors of the older adults that might influence their attitude positively or negatively, such as interest, the level of cognitive decline and experience with technology. Interest and experience were often mentioned by the caregivers as the two most influential factors. They believed that the presence of these factors (e.g., the person shows interest in and/or has experience with technology), increases the level of technology acceptance in older adults and therefore their openness to SARs.

However, in their opinion, these two factors were often still missing within the current generation to ensure an effective implementation of SARs. The level of cognitive decline was also discussed, as concerns were expressed about the learnability of older adults. They doubted whether or not older adults might be able to learn how to operate the robot and be able to remember this.

[CG – P9]: They forget quickly. If someone explains to them how the robot works, they will forget about it the next day. […]. They even forget how to use the microwave.

Deskilling. Another interesting pitfall was mentioned by the caregivers, i.e., the risk of deskilling when the robot would take over tasks from the older adults. It was believed the robot could take over routine tasks from the caregivers, so there would be no reason for them to perform these tasks any longer. This might lead to a decrease in the older adults’ ability to carry out daily tasks on their own. Some caregivers also questioned the risk of deskilling when the robot would take over routine tasks from the caregivers, so there would be no reason for them to perform these tasks any longer. This might lead to a decrease in the older adults’ ability to carry out daily tasks on their own. Some caregivers also questioned the risk of deskilling when the robot would take over routine tasks from the caregivers, so there would be no reason for them to perform these tasks any longer. This might lead to a decrease in the older adults’ ability to carry out daily tasks on their own.

Perspectives on Robot assistance

In line with previous research on this topic [23,30], both groups acknowledged the potential of robots to serve as a valuable contribution to complement staff shortage. It was believed the robot could take over routine tasks from the caregivers, so there would be no reason for them to perform these tasks any longer. This might lead to a decrease in the older adults’ ability to carry out daily tasks on their own. Some caregivers also questioned the risk of deskilling when the robot would take over routine tasks from the caregivers, so there would be no reason for them to perform these tasks any longer. This might lead to a decrease in the older adults’ ability to carry out daily tasks on their own. Some caregivers also questioned the risk of deskilling when the robot would take over routine tasks from the caregivers, so there would be no reason for them to perform these tasks any longer. This might lead to a decrease in the older adults’ ability to carry out daily tasks on their own.

Discussion

The aim of this study was to explore the attitudes of older adults with MCI and their caregivers towards SARs through conducting semi-structured interviews. The results of the present study shed a new light on the possible barriers and facilitators to the use of SARs in people with MCI residing in assisted living. Two main themes could be derived from the data: (1) perspectives on robot assistance and (2) perspectives on implementation. The first theme gave us more insight into different topics which may explain a positive, negative or impartial attitude towards SARs in healthcare. Therefore, three groups could be distinguished based on their opinions about SARs in healthcare: (1) the reluctant older adults and caregivers, who were not open (yet) to having a SAR and would not support its implementation, (2) the compliant, who already showed a positive attitude and believed in the potential of robots to stimulate older adults in their daily lives, and (3) the hesitant, who were not convinced yet and had no outspoken opinion.

The second theme discussed specific potential barriers and facilitators according to both stakeholder groups. They gave us a deeper insight into the factors that may impede or promote the implementation of SARs in the home environment of older adults.

The perspectives on robot assistance and on implementation are discussed in the following paragraphs.
be more time left to focus on more complex and psychosocial matters. However, both groups agreed that it should never replace human contact. Subsequently, different characteristics of the robot were compared to humans. The robot was referred to by the older participants as being more neutral than humans (e.g., always objective, never moody). Such characteristics were also mentioned by the caregivers, but with a mainly negative connotation (e.g., emotionless, not able to recognize pain). Whereas the older adults considered these characteristics rather positive, it was mentioned by the caregivers as a shortcoming.

The positive connotation by the older adults may be explained by the fact that they already experienced how it feels to be “being cared for”, which may have already led to negative experiences (e.g., associated feelings of becoming more dependent, rushed caregivers). Therefore, they might be more likely to see the benefits of a robot.

Both groups also reflected on whether or not the robot would be valuable for them. Results showed that many older participants did not yet consider themselves in need of help from a robot. However, they did refer to themselves as potential future users in case their situation would deteriorate. This line of reasoning was described in various other studies that included older adults with different cognitive levels. Previous research from Wu et al., involving older adults with MCI as well as cognitively healthy older adults, demonstrated similar results. All participants showed low intention to use a SAR as they were still independent. However, in contrast to the results in the current study, the majority of the participants were also reluctant to robot use in the future, with the cognitively healthy older adults showing the most negative attitudes [22]. Furthermore, the reference to future use was also described in a study involving older adults with mild to moderate Alzheimer’s Disease, where the robot was mainly considered a future possibility as well [31].

The fact that the older adults in the current study do not perceive the help of the robot as valuable, might be explained by their current physical environment. As all participants lived in assisted living facilities, the accessible help within these facilities can reduce the need for robot assistance. The fact that the participants in this study only experienced limited functional and cognitive problems, might also explain why they do not consider the help from a robot as valuable (yet).

A last topic concerns the creation of a deceiving feeling of reassurance. Some caregivers were worried that the presence of the robot would cause the older adults’ environment to visit less in real life. They phrased it as “causing a deceiving feeling of safety”. This ethical concern was also mentioned in a study from Sharkey and Sharkey, where they raise and discuss some ethical issues that come with the use of robotics in healthcare [32]. They state that, despite the fact that it would be easier for caregivers and relatives to virtually check on medication adherence, it would also mean a reduction of real human contact. Fewer real visits might take place, and although this may reduce feelings of loneliness in older adults, it should not be considered an equal alternative to visiting the older adult in real life. As the authors clarify: “[…] If you could use a remote-controlled robot to virtually visit your elderly mother, you might well be less likely to get in the car and go over to see her”.

**Perspectives on implementation**

**Older adults’ perspective**

The older participants brought up some potential barriers to the use of SARs in their daily lives. They were most concerned about stigmatisation that might come with the use of a robot, its cost price, environmental adjustments they’d have to make and available technological alternatives (e.g., laptops and smartphones).

There was one common barrier among the two groups, e.g., the technical reliability. Both groups agreed that it might be insidious to rely on robots and were aware that technology could fail at inappropriate times. Especially the caregivers questioned the technical readiness and doubted whether this level was already adequate to be of help for older adults. Although both groups expressed concerns about reliability, it is worth noting that none of the older participants mentioned to be worried about privacy issues when using a robot. In other research this is a barrier that is often brought up, especially by older adults [23,33–35]. The fact that the participants in this study did not mention privacy issues, might be explained by the fact that the majority had experience in the use of technology, and might
therefore be more informed about the risks that may come with it. A second explanation might be that there is a lack of awareness among older adults in the importance of handling privacy. However, this explanation is less plausible given their experience with devices such as tablets and smartphones.

A second topic concerns the fear of stigmatisation. However, this seems a very common topic in studies exploring the attitudes of older adults, both cognitively healthy or cognitively impaired [22,23,34,36]. In the current study, participants saw the robot as a visible object that may highlight their limitations to their environment. They naturally associated its use with being in poor physical or cognitive health, worrying about what others would think. This confirms that acceptance in older adults might be strongly associated with the acceptance of technology within their environment (e.g., children, co-residents) [33].

The cost price of the robot was also mentioned as a barrier, as many wondered whether the robot would be affordable for the average person. The reason to perceive this as a barrier is probably contributed to by the fact that some older adults considered the robot as a luxury-item and not a necessity. Also in previous studies the cost of technology was seen as a predominant factor affecting acceptance [17,33,36,37]. Research in development of assistive robots should therefore focus on affordability of the products. There are strong indications that, regardless of how useful a technology is perceived, it will not be accepted if it’s not affordable [36].

Fourthly, it was made clear from the interviews that not all older participants were willing to make adjustments to their homes to enable the robot to move around. The negative connotation they often hold about having a robot (e.g., stigmatisation) and the fact that many of them do not perceive themselves as current users might explain this attitude. The importance of the physical environment was also reported in a study exploring the perspectives of older adults towards smart home technology [38]. This study described different factors that influence the perceptions of the need for smart home technology. The physical environment was one of them. Several participants noted that their houses were not appropriate for certain types of technology, affecting their perceptions of needing this type of technology negatively. Another recent study from Peek et al. also emphasized the importance of the physical environment [39]. The results of their study show that participants were reluctant to use technology which made adjustments to their home necessary. A mismatch between the robot and the physical environment might therefore affect the acceptance negatively. This highlights the importance of conducting trials with robotics in real life situations, i.e., the home environment of the older adults, as laboratory set-ups might lead to less reliable results.

Many older participants compared the robot to other technological devices that they currently use, such as tablets and laptops, questioning the added value of the robot. These alternatives make the robot seem redundant, and is therefore considered a fifth barrier. An example that was often given by the participants is the availability of Skype on their tablets, reducing the need for a video call-application on the robot. Therefore, it is important for the robot to offer things differently than the available alternatives, e.g., an easier operation method. As findings of a previous study suggest, systems with a simple interface are more likely to be accepted by older adults [36]. Though, they believed that the robot would be able to reduce loneliness in older adults, and this ability was only attributed to SARs.

Caregivers’ perspective
The caregivers also discussed some potential barriers that could impede the use of SARs within older adults, i.e., the generational characteristics, personal factors and risk of deskilling. According to the caregivers, “interest” and “experience with technology” were considered the two most important factors that could negatively influence attitude towards SARs if not present. Though, they were often believed to be missing within this generation’s older adults. This ties in with the other topic that was considered a barrier (“generational characteristics”), where they doubted whether the current generation of older people was ready for assistive robots. The role of experience with technology was also discussed in previous studies, where results showed that a lack of experience was seen as one of the most important barriers to SAR adoption [23,40]. Results from a study from Bedaf et al. (2018) show that this also holds for secondary users of the robot, i.e., the formal and informal caregivers [41]. They report that caregivers with previous experience with technology tend to have a more positive attitude towards robots.

Lastly, the risk of deskilling is another possible pitfall that might come with the implementation. Some caregivers indicated that the robot should not take over too many tasks from older adults, especially when it could have been performed by the older adult himself. In a study from Wu et al., older participants raised the same issue during a focus group exploring the willingness of the participants to use an assistive robot [22]. They wondered whether using a robot actually does promote autonomy. Instead, the user might risk losing capacities as he doesn’t bother to use them anymore. The robot should motivate and activate older adults to engage in different activities.

Facilitators that may affect the attitude towards SARs positively were also discussed.

A first facilitator that was present in the older participants was a certain curiosity for robot, as this was often referred to as the main reason for participating in the study. This was also contributed to by the fact that most believed that robots in healthcare are an unavoidable evolution in the current societal context of limited human resources. Most participants seemed to experience this unavoidability in a positive way, as it was an extra encouragement for them to participate in the study and to learn more about robots.

Another topic, one mentioned by the older adults as well as the caregivers, was the belief that robots could stimulate older adults in activities of daily life. Both groups mentioned the motivational aspect of the robot, as it was considered a promising way to perform certain tasks for which they otherwise would be not so motivated to do. This finding correlates to a study from Werner et al. (2012), where they aimed to evaluate the human-robot-interaction of a prototype of a humanoid robotic system [42]. The results showed that the older participants considered the robot as a motivator in daily life.

Towards a meaningful implementation
The results of this study reveal different factors that should be taken into account when implementing a robot in the home environment of older adults. Although many older participants recognized the benefits of SARs in healthcare, it is important to consider the fact that many of them referred to themselves as future users only. This would imply that, despite a positive attitude, they currently see no added value in purchasing a SAR. Likewise, the caregivers believed in the robot’s potential, but at the same time often indicated factors that may keep them and older adults from using it. Developing a robot that matches their needs and expectations may influence their perception on the necessity of the robot positively, as well as informing the end-
users properly about the preventative role a SAR may play in further deterioration.

The COVID-19 pandemic may also have influenced the attitudes of older adults and caregivers towards SARs, with the related containment measures making the functionalities of a SAR potentially more interesting to these end-user groups. On short notice, SARs and other technologies were deployed in the healthcare sector to combat COVID-19, with SARs also proving their worth in aged care, e.g., alleviating feelings of loneliness or being a valuable contribution to meaningful activities [43,44].

The fact that robots were able to offer solace and solutions in times when people were compelled to seek alternatives in order to continue their daily activities provides promising perspectives. This may confirm the older adults’ statement about them being future users, i.e., that a SAR is perceived as a valuable tool when they need to look for alternatives due to limitations in daily life. On the other hand, the COVID-19 pandemic may have already positively changed the attitudes of older adults and caregivers due to the increased use of technology, including SARs, in healthcare. An in-depth comparison of the attitudes towards SARs pre- and post-COVID-19 pandemic would be an interesting topic for future research.

**Study strengths and limitations**

This study was designed to better understand the potential for the robot used in the ReMIND-project to stimulate and support older adults cognitively, physically and socially during daily life. Investigating the attitudes of older adults with MCI and their caregivers in a pre-implementation stage gives researchers a chance to increase technology acceptance through modifications. In literature it is even considered a precondition of the actual technology adoption [45]. Therefore, the results of this study will guide the further development of James® and beyond. The fact that we introduced a readily available robot made it possible to think about the practical side of having a robot, such as the environmental adjustments that were not often described in other studies. This advantage was also discussed by Chu et al., where the expectations of older adults were explored and the acceptance-rate of two commercially available robots was studied [46]. The use of an available robot ensures that the participants can base their opinions on something they know what to expect of, causing the results to be more relevant for the researchers. On the other hand, the fact that they already have a clear image of the robot’s appearance and its features, may also have been disadvantageous. If the participants would have adverse thoughts about the robot (e.g., thinking that the robot looks intimidating or childish), it might influence their attitude negatively prior to experiencing it.

The results need to be interpreted with caution due to some study limitations.

First, the recruitment of the participants involved elements of self-selection, risking a selection bias which may have led to a specific group of older adults to be interested in participating in this study, such as those interested in SARs and/or those already having experience with any form of technology. This may have influenced the results of this study.

Second, this study also has a weakness with regard to the recruitment. Our eligibility criteria took into account several factors that may influence cognitive functioning and the MoCA has been proven to be adequately sensitive to detect MCI [28,47]. However, solely relying on screening instruments or self-reported subjective complaints is not recommended. A collaboration for the recruitment of participants with, for example, memory clinics would have provided a more reliable sample. From a practical viewpoint, this was not feasible in the current study.

Third and last weakness of this study is the involvement of only two informal caregivers. This may be explained by the fact that older adults with minor neurocognitive disorders only experience slight degrees of functional limitation in daily life [15,48], which means that they are still largely independent. In the current study, only four older participants mentioned having a partner or family member taking care of them. This shows that the majority is not in need yet of having an informal caregiver, which may explain the limited number in this study. Subsequently, the fact that this group only experiences slight degrees of functional limitation, may also explain why many of them refer to themselves as future users and don’t perceive the robot as necessary (yet). Therefore, it might be valuable to also investigate the attitudes towards James® in other target groups (e.g., older people with more severe cognitive decline) to demonstrate its necessity more evidently.

Nevertheless, this study contributes to the literature by a better understanding of the attitudes of older adults with MCI and their caregivers, using an affordable robot that is already available on the market. As also stated by Peek et al., it remains important to pay attention to the attitudes and acceptance of older adults in the post-implementation stage [33]. Therefore, we are aware of the possibility that within the next phases of the ReMIND-project, other facilitators and barriers might emerge than expected from these interviews. For future research, it might be valuable to explore the specific expectations older adults with MCI and their caregivers hold regarding SARs, as well as the factors that contribute to a persistent use of assistive robots.

**Acknowledgments**

The authors would like to thank the older adults and their (in)formal caregivers who participated so willingly in this project. The authors are also grateful to colleagues in the ReMIND consortium: Technical University of Cluj-Napoca, Romania; Universitatea medicina si farmace Victor Babes Timisoara, Romania; Ovos Media GmbH, Austria; FH campus Wien, Austria; The Medical University of Vienna, Austria; Zora Robotics plc, Belgium.

**Disclosure statement**

No potential conflict of interest was reported by the author(s).

**Funding**

The work described in this project was partially funded by the AAL-project ReMIND (Robotic ePartner for Multitarget INnovative activation of people with Dementia) [grant No. AAL-2017-026].

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