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Introducing the social robot MARIO to people living with dementia in long term residential care: Reflections.

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Abstract

MARIO is a social robot developed with and for people living with dementia (PLWD) to promote social connectivity and reduce loneliness and isolation by providing access to a number of applications that PLWD can access, via speech and/or touchscreen commands. These applications include My Calendar, which reminds the PLWD about daily schedules and appointments; My Music which provides access to the PLWD's personalised music and My Memories which gives the PLWD the opportunity to reminiscence by showing them photographs of family, friends and/or significant life events. MARIO was developed tested and evaluated with PLWD in a long stay residential setting over a 13-month period from September 2016 to October 2017. During the first five months of MARIO's introduction to PLWD, researchers maintained a reflective practice diary. The aims of the study were two-fold: (1) To capture the experiences of researchers of being involved in this process and (2) To help identify strategies to enhance PLWD's engagement with the robot. These reflections were analysed in NVIVO 11.4 using thematic analysis guided by a qualitative descriptive methodology. The following themes emerged from the research: (1) Level of interest in having MARIO present in long-term residential care (LTC), (2) MARIO's appearance and functionalities, (3) Engaging with MARIO, (4) Researchers' Recommendations for Introducing Robots in Dementia Care and (5) Impact on researchers. From the researcher's recommendations for introducing robots in dementia care, a number of key strategies were identified which may facilitate the engagement of PLWD with social robots. These include the use of verbal and/or physical prompting by the robot, lack of distraction, and actively engaging staff members or family members when introducing the robot to PLWD. This work highlights the important contribution of reflective practice to the introduction and development of social robots in dementia care.

Key words: Social robot, Companion robot, MARIO, Dementia, Ageing, Reflection

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residential care: Reflections.

1. Introduction

Dementia can result in communication difficulties, loss of memory, changes to
personality, and problems accomplishing tasks which were previously routine tasks [1].
These problems contribute to a third of people living with dementia (PLWD) experiencing
isolation and loneliness [2] and between 20-60% experiencing depression [3, 4]. This is a
significant problem given that the number of PLWD is expected to double in the next 20
years and dementia is expected to affect 66 million people worldwide by 2030 [1]. The
ability of social robots to help PLWD to stay socially connected may help address the
significant and progressive problems of loneliness and isolation enhanced by dementia [5].

Social robots have been defined as robots that have social skills which enable them to
communicate with human users in an acceptable manner [6]. They are currently being
developed to supplement the care provided for PLWD [7, 8], aiming to help PLWD maintain
their independence and social connectedness with other people [9]. Several studies have
found that social robots are able to increase the ability of PLWD to communicate [10, 7, 11,
9, 12, 13] and humanoid robots are also able to increase cognitive attention and verbal
interaction between PLWD, through the use of games and conversation [14]. Robots have
also successfully increased social connectivity with family and friends [15]. For example,
one study assessed the feasibility of Giraff, a mobile telepresence robot with internet
connectivity and Skype, with PLWD - Relative dyads (*n*=5) [15]. It was found that the
participants in the study exhibited positive emotions and high levels of engagement during
calls, showing the potential of robot use to promote social connectivity.

MARIO is a social robot developed with and for the use of PLWD (http://www.mario-
project.eu). This robot has applications that PLWD can control via speech and touchscreen
commands. These applications include My Calendar, which reminds the PLWD about daily

schedules and appointments; My Music which provides access to the PLWD's personalised music and My Memories which gives the PLWD the opportunity to reminiscence by showing them photographs of family, friends and/or significant life events. It also allows PLWD to keep up with the activities of friends and family through applications that utilise Voice-Over Internet Protocol technology and social media. Every stage of MARIO's development was guided by feedback from PLWD and their caregivers. This included using an initial needs assessment [16] and repeated cycles of iterative development and testing.

MARIO uses a KOMPAI robotic platform (See Figure 1 below). MARIO's software applications were designed to make MARIO acceptable to PLWD and to encourage their engagement and interaction with the robot. Design and development of this was informed by a needs assessment which was undertaken with PLWD, their relatives and nursing staff [16]. More details about MARIO is available in a previous paper conducted by the MARIO research team [17].
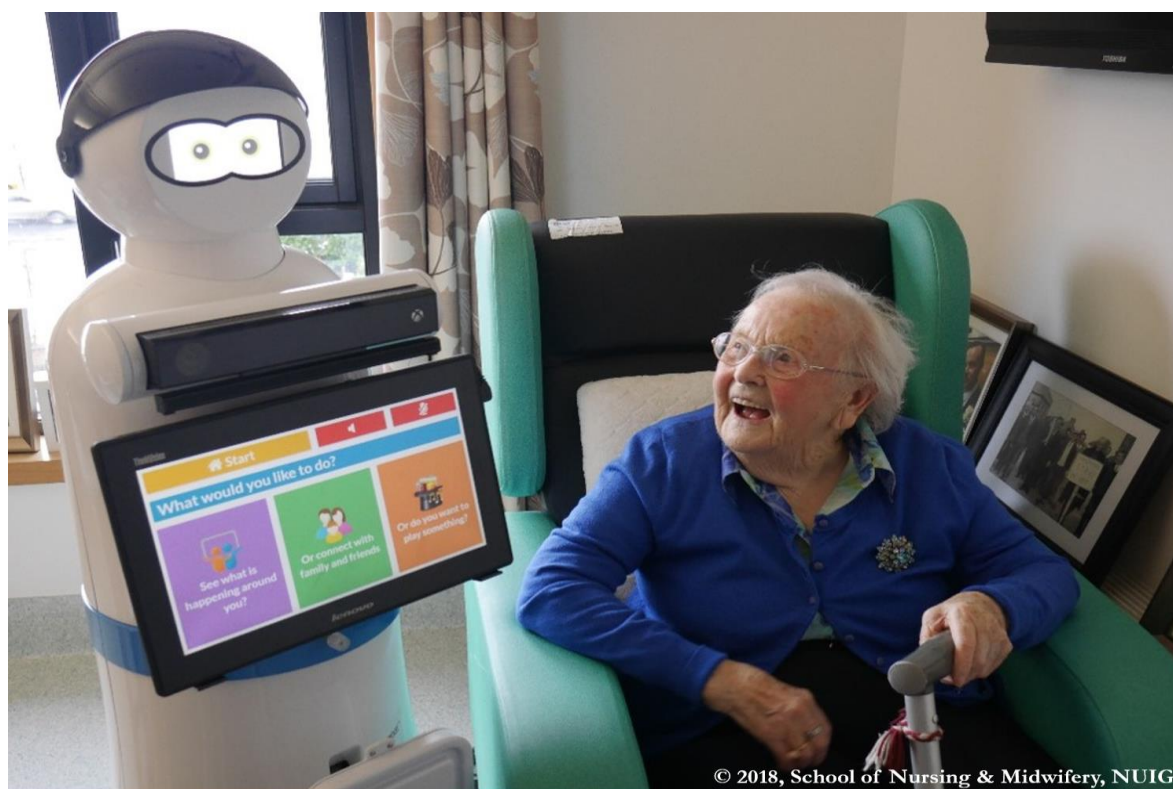
Figure 1. Image of MARIO with a person living with dementia.

Research with PLWD often uses surveys, observational tools, field notes and interviews to ascertain the impact of the social robot on the PLWD. Few studies however have focused on the experiences and reflections of the researchers who are actively involved in the research, and the learning that may be gained from their accounts.

Levett-Jones [18] highlights how reflective practice is important for both professional activity and professional learning. Rather than introspection alone, reflection is acknowledged as a deliberate and structured questioning of the unfamiliar [18]. In this way, reflection lends itself to both the realm of learning from professional practice (e.g. teaching, nursing) [19] and research, as it creates a unique window of opportunity to gain insight and understanding into the epistemology of an individual's experience. Insight of this nature, derived from reflective thinking allows us to understand an individual's perception of the experience and understand the influence of what, why and how, within an experience [18, 20].

Researcher reflection is a technique requiring substantial skills, particularly when having to simultaneously employ this while interacting with PLWD [21]. Equally, researchers who aid or conduct participant reflections need to be very skilled in the delivery and execution of this technique [21]. These challenges must be addressed in order to be able to capture authentic lived experience while simultaneously realizing effective data collection. Capturing participant reflections adds value to the literature through the transparency and rigour which it lends to qualitative research [22]. Thus, the use of reflections in qualitative research facilitates an enriched account of participants' opinions and thought processes [22].

Reflections of participants have been utilised in some studies involving technology in dementia care. Olsson, Engström, Skovdahl, and Lampic [23] gathered data on relatives' reflections about information and communication technology. However, minimal previous research, to our knowledge exists which specifically features the reflections and first-hand

experiences of the researchers as they introduce social companion robots. Indeed, even less is known about how these reflections can be used to inform the introduction of social robots within the real world of clinical practice.

One study by Hebesberger, Dondrup, Koertner, Gisinger, and Pripfl, [24] evaluated a new deployment area for long-term autonomous robots in elder care by using a mixed methods design consisting of observations, interviews and rating scales. The research team established an observation protocol, to explore experiences of participants (e.g. errors of the robot) allowing them to identify findings using an inductive frame of reference. Rather than participants' own reflections, the research team identified meaning and implications from participant experiences, on their behalf through interview analysis and the observation protocol. This differs from the current study, as the participants in the later study did not engage in an established model of reflective engagement to uncover recommendations for future practice.

However, though the findings of the Hebesberger et al. study are useful, the current paper differs to the work of Hebesberger et al. [24] as the research participants conducted their own reflection after their direct experience, which was then further analysed by the research team. It is anticipated that this may allow more advanced, deeper meaning to be derived from these authentic experiences, which might then be more empirically meaningful in terms of reporting lived experience rather than observed.

Similarly, another paper which explores the implementation and feasibility of robotics in a long-term care facility was conducted by Moyle, Jones, Cooke, O'Dwyer, Sung, and Drummond [15]. Though, Moyle et al. [15] consider the experience of residents with dementia and their engagement with a telepresence robot, including family and staff interviews to assess their perceived facets of feasibility and acceptability, Moyle et al. [15] neglect to incorporate a reflective element. The researchers documented observations and

notes regarding implementation difficulties, technical difficulties, and the subsequent steps taken to address these. However, the steps taken to address technical difficulties were not reported in the Moyle et al. paper. Findings from Moyle et al. are pragmatic in nature and although important, show little availability for other practitioners to learn and adopt these findings in a way that can be tailored to unique centre needs. This impacts on the practical replicability for others when introducing companion robotic technology to PLWD and thus inhibits deeper exploration of suggested resolution for best practice.

The process of identifying how meaning is derived from experiences and used to inform implementation adds transparency to research procedures. In addition to this, reflective practice also requires participants to more actively engage in their lived experience during the time of implementation. The current paper seeks to build on previous research by incorporating an established reflective protocol, which engages participants to robustly explore their experience of introducing a companion robot to PLWD and extrapolate meaningful recommendations for future implementation.

This paper reports on the reflections compiled by members of an interdisciplinary research team who participated in the European Union Horizon 2020-funded project, MARIO H2020 project. The reflections were recorded during the first five months of MARIO's introduction in a long-term residential care facility setting. The focus of this research was chosen because examining the reflections of researchers provides a valuable opportunity to address current gaps in the literature that concern how best to introduce social robots to PLWD in order to optimise their engagement with them. Indeed, research conducted with PARO, a robot shaped as a baby harp seal, suggested that relatives of PLWD wanted ideas and a structure to advise them how to use PARO [25]. Similarly, Shibata [26] found PLWD benefitted from researchers and carers modelling for them how to interact with a robot. Therefore, the aims of this exploratory study are two-fold: (1) To describe the experiences of the researchers during the introduction of the social robot to older PLWD in

this real world clinical practice setting and (2) To identify strategies for enabling PLWD to engage with social robots.

2. Method

2.1 Design

A qualitative descriptive design [27] was used in the current study because this method aims to understand and provide an in-depth description of phenomena using the meanings ascribed to it by participants in the research [28]. In this case, the researchers' reflections were used to understand the meanings that researchers ascribed to MARIO's introduction into this clinical real-world context. The assumptions of qualitative research enable a greater focus on the words and meaning of the research; research studies generally have fewer participants and they provide greater insight into the experiences of participants [29]. Using participant reflections as data to inform research processes (from the introduction of the companion robot in this clinical context), places this study within a naturalistic research paradigm due to the concern with investigation in real-world clinical settings [30]. A qualitative methodology of inspection can be applied to different research paradigms dependant on the facets of design [31]. In the current study, the naturalistic paradigm acknowledges that reality is not a fixed phenomenon, but participants, who are active within the research context, including the researcher, subjectively interpret it [30]. Therefore, qualitative methodology was deemed the most appropriate for the current research design complimenting a naturalistic paradigm. Research led by a naturalistic paradigm also allows for interpretation of deeper meaning from findings and personal reflections about the lessons learned [30, 31].

2.2 Participants

Participants were from a range of disciplinary backgrounds including engineering, nursing and psychology. Information on discipline, number of years of research experience

and number of years of clinical experience is included in Table 1. Participants were also co-authors in the current study. However, in order to avoid potential biases, these co-authors did not contribute to the analysis of the results of the research. The participants based their reflections on the interactions which they had directly observed or experienced between PLWD and MARIO. Reflections were also made on observed wider interactions between MARIO and individuals without dementia, family members and staff members.

MARIO was deployed in the long-term residential care facility where it resided for the entire duration of the project, whereas the researchers visited between one and 18 times during which they observed MARIO interacting with PLWD for between 15 minutes to six hours duration. There were 7 PLWD, 4 female and 3 male, who were aged between 70 and 89 years (6 of the PLWD were over 80 years). Their Mini-Mental State Examination scores ranged from three to nineteen, indicating that they had moderate to severe levels of dementia [32].

Table 1.

Discipline, Research Experience and Clinical Experience of Researchers.

Participant ID	Discipline	Number of Years of Research Experience	Number of Years of Clinical Experience
P1	Engineering	8	2
P2	Psychology	2	1
P3	Nursing	2	30
P4	Nursing	12	25

2.3 Measures

2.3.1 Development of the Reflective Framework. During the research process the research team met weekly to review the previous weeks' events. During one of the first meetings, one of the researchers shared a reflection from the previous week. The team determined collecting this reflection as well as future reflections would benefit the research. It was hoped that this would also enable the research team members, who were from various academic and clinical backgrounds, to record their reflections. Doing this within a structured framework would facilitate developing the team's discussion from a descriptive account to one that generated more critical thinking and analysis.

Over subsequent collaborative team meetings the reflective framework was developed. The resulting framework was derived from Johns [33] Model of Structured Reflection. Its design was also influenced by its purpose, to facilitate recording the reflections of the participants, and the researchers' knowledge of the clinical context into which it was to be deployed.

The reflective framework was divided into two sections; 1) Reflections on general incidents occurring when MARIO interacted with relatives, staff and residents as he moved about the unit; and 2) Reflections on sessions when MARIO worked with individual residents. The goal of this framework was to facilitate a move from a descriptive account to a more in-depth analysis and help identify the most important aspects when conducting the observations and what could be learned as a result of reflecting on these observations. Having completed this work, support from the literature was then obtained and collated into the reflection. This helped to enhance the analysis of the initial observations and place them within an academic discourse. Thereby enabling the generation of evidence-based research to facilitate understanding as to why some PLWD reacted in the way they did. The reflective framework is displayed in Table 2 below.

Table 2.

Data Collection Reflection Document Questions

Part 1. Reflections on general incidents occurring when MARIO interacts with relatives, staff and residents as he moves about the unit.	
Descriptive Details	Date, Time, Duration, Who was present and what was their role, Where incident took place, Aim/Plan of session, Expected outcome, Description of what happened.
Prompt Questions	'What if anything surprised you?', 'What do you think was significant?' 'How did it make you feel?' 'What did you learn? What if anything would you do differently next time? Which literature supports your decision. Additional comments.
Part 2. Reflections on sessions when MARIO works with individual residents. (Included Descriptive and Prompt Questions as above)	
Additional Questions	'How was MARIO introduced to the resident?' 'What mood was the resident in?' 'How did the resident respond to MARIO?' 'What happened during the session?' 'What strategies did you use to engage the resident that you may have learned from previous sessions with this resident? (e.g. reminiscence, cues, body language, attention to task). 'What level of support did the resident need to use MARIO? (with options being 1. Independent, 2. Supervision, 3. Limited Assistance, 4. Extensive Assistance, and 5. Total Dependence) 'How did the session end?'

2.4 Procedure

The four researchers recorded their reflections in a notebook following each observational session of MARIO with the PLWD. They then independently completed a reflection transcript after each visit to the nursing home. The questions outlined in Table 2 were used by each researcher to structure their reflective record. Over a 5-month period, between

September 2016 and February 2017, a total of 26 reflective transcripts were generated by the

four researchers.

2.5 Ethical Considerations

The MARIO Project received full ethical approval from the Research Ethics Committee

of the National University of Ireland, Galway. Informed Consent was obtained from all

PLWD involved in this research and confidentiality was maintained.

3. Findings

3.1 Thematic Analysis

N-Vivo V.11.4 was used to store and manage the reflection records of each

participant and the reflections were analysed using thematic analysis. This followed the six-

stage process described by Braun and Clarke [34], which is based on a process of drawing

connections between and within each dataset. In the first instance, the researcher (AM)

became immersed and highly familiar with the data, by reading the transcripts several times

and noting down ideas in the form of initial codes. These represented interesting features that

occurred in the data and were pertinent to the study aims. A second and third researcher (SW

& MB) also reviewed and independently coded a subset of the transcripts. The researchers

discussed their coding and then agreed coding framework. This was used by AM who then

read each line of all the transcripts and coded the data against the coding framework.

Following this, AM combined codes that related to one another into five preliminary themes

and collated all the data relevant to each theme. Then the themes were discussed amongst the

researchers (AM, SW and MB) and a 100% agreement between the researchers was achieved.

This ensured that the data within the themes had good coherence (internal homogeneity),

while also maintaining distinctions between the themes (external heterogeneity) [35].

The five key themes that emerged from the data are presented in Table 3 and are fully

described below. In the themes below, the letter 'P' followed by a number is given to

differentiate between Participant 1, Participant 2, Participant 3, and Participant 4. The letter

'T' followed by a number is given to differentiate between the transcripts of each participant.

Table 3.

Five key Themes

Name of Theme
1. Level of interest in having MARIO present in long-term residential care (LTC)
2. MARIO's appearance and functionalities
3. Engaging with MARIO
4. Researchers' Recommendations for Introducing Robots in Dementia Care
5. Impact on researchers

3.2.1 Level of interest in having MARIO present in long-term residential care (LTC)

This first theme describes the research team's reflections on the level of interest

shown by PLWD, family members, staff, and older people without dementia. Interest was

shown by the PLWD interacting with MARIO or the observations of PLWD while they

watched other individuals interacting with MARIO. Residents of the care facility without a

diagnosis of dementia also displayed an interest in MARIO.

The PLWD displayed positive interest in interacting with MARIO. A researcher

reflected that most PLWD: *"were intrigued by him".* (P1, T3) or appeared to display positive

emotions toward MARIO

 "MARIO was nice and lovely, very happy to work with them {MARIO}." (P1, T8)

While some PLWD immediately reacted positively towards MARIO, others were more cautious and preferred to watch MARIO as reflected by a researcher who said:

"A staff member came by and pointed out MARIO to this resident. The resident did not verbally acknowledge MARIO but did look at MARIO and nod his head". (P4, T2)

"The resident stood and watched the interactions of staff with MARIO. This was the same resident who walked by earlier without making contact. Now, he is watching MARIO." (P4, T2)

Another researcher commented on the fact that they felt that the PLWD's interactions with MARIO made a positive difference to the well-being of the PLWD.

"The presence of MARIO made a (positive) *difference for each of the residents who observed him".* (P4, T4)

While the majority of PLWD displayed positive reactions towards MARIO, some researchers reflected that other PLWD showed a lack of interest and during the observations some PLWD commented that they felt they would not be capable of using MARIO.

"Her {PLWD} persistence is that she would be incapable of working with the robot. Despite repeated attempts to assure her that she would be supported in every interaction with MARIO, she still believed it was beyond her capabilities and did not wish to be involved with MARIO in any way." (P2, T2)

A researcher also commented on similar issues with a different PLWD, this researcher believed the age of the PLWD impacted her ability to interact with MARIO:

"Thinks it is too complicated, they are too old". (P1, T7)

The reflections revealed that family members and grandchildren visiting the PLWD displayed a positive interest in MARIO. Significantly, when family members and children

engaged with MARIO, the engagement of the PLWD was more prominent. A researcher observed that one person with dementia:

"is much more interested in MARIO when his family is there." (P1, T10)

Another researcher commented on how one PLWD was:

"fully engaged in watching his grandchildren work with MARIO was significant because of his lack of response initially and now he was fully engaged and receptive to MARIO." (P4, T4

All researchers commented on the interest of staff members in MARIO, reflecting that they felt that staff were proud to be involved and part of the project.

"I got the impression that most staff think it is a cool project and they are proud to be involved. Involvement with MARIO is interesting and it may give them kudos. This I think – observing and hearing them introducing MARIO to people who were not familiar with it. They liked the fact they were knowledgeable about what was going on and they were 'in the loop'." (P3, T1)

Staff regularly asked researchers how MARIO was each day indicating that they may not think of MARIO as an object or a machine but personified him. A researcher commented that staff:

"{Staff member A} Always ask me how MARIO is and if they can introduce him to other staff in the hospital." (P1, T1)

Older people without dementia also appeared to be very interested in MARIO, in particular what he could or could not do.

"People were more interested in general than the usual residents in the dementia specific ward. The people of the day centre were more intrigued about what he can do and interacting with MARIO." (P1, T15)

The researchers also reflected on how MARIO could be useful for older people without a diagnosis of dementia:

"They (older people without dementia) represent elderly people that are lonely and isolated and come to the day centre for companionship. For example, some people showed signs of interest in using MARIO but they do not fit the exact criteria" (i.e. the inclusion criteria to be included to participate in the study). (P1, T16)

3.2.2 MARIO's appearance and functionalities

This second theme describes MARIO's appearance and functionalities, and how PLWD, staff, and family members commented on the appearance of MARIO and his functionalities. The reflections indicated that PLWD had very positive comments about the physical appearance of MARIO and how he looked.

"Had only positive things to say about his physical appearance (size/color/eyes, etc)" (P1, T3)

Despite the reflections noting a positive view of MARIO's appearance, there was also some confusion observed and reflected on by the researchers on how some staff members did not understand MARIO's functionalities. Staff members displayed confusion over the difference between companion robots and service robots. A researcher commented that:

"Staff want to know what he can and can't do? (They) *Still have issues knowing whether he is a companion robot or service robot."* (P1, T4)

PLWD also exhibited confusion over the role of MARIO and said that most PLWD:

"were intrigued by him, asked if he could do some tasks for them". (P1, T3)

The data revealed that most researchers felt that the applications on MARIO were positively received by PLWD, including the use of a 'My Music' application. The use of a 'My Music' application which would play their preferred music was a feature of MARIO that

appeared to be viewed very positively by PLWD. One researcher recorded how a PLWD became animated and engaged with the use of the music application.

"A female resident who makes a repetitive verbal sound walked by the nurse's station. She looked at all of us as well as MARIO but did not acknowledge us verbally except for the repetitive sound she was making. During one of her passes of the nurse's station, MARIO was playing Irish music and she stopped making the repetitive verbalization and began clapping her hands in time with the music. She appeared to be fully engaged for a few minutes enjoying the music. The music stopped and she stopped clapping her hands and began making the repetitive verbalization again as she walked away." (P4, T4)

This researcher further expanded on the importance of music for PLWD stating that:

"The female resident who stopped making the repetitive verbalization in response to MARIO playing music was significant in keeping with research indicating that playing music for PLWD helps them engage with their surroundings and others. The smile on her face added to the impact MARIO had on her." (P4, T4)

3.2.3 Engaging with MARIO

This third theme describes how the researchers reflected on how PLWD engaged with MARIO, including what limited and facilitated PLWD's engagement with MARIO. One issue that limited PLWD's engagement with MARIO was their level of severity of dementia. Researchers reported that PLWD who had more advanced dementia had greater difficulty using MARIO than those who were at earlier stages of dementia. One researcher also reflected that PLWD who had used technology previously may be more suitable candidates for MARIO.

"PLWD represents, in my opinion, more of the target population for the robot. Someone who has used computers/technology in the past, is at ease with using computers, and has early stages of dementia." (P1, T6)

Despite some PLWD displaying difficulties using MARIO due to their stage of dementia, there were still some PLWD who appeared to have successful engagements with MARIO. The researchers particularly commented in their reflections on the engagement of PLWD who were at earlier stages of dementia with MARIO.

"The fact that this resident is permitted to spend time unsupervised outside suggests that he may be at an earlier stage of dementia, compared to others in the care home. This makes his encounter with MARIO much more significant because the resident was intrigued by MARIO and seemed to be comfortable in his presence. This incident marks the possibility that MARIO could be well received by others who are able better able to understand him." (P2, T1)

PLWD also exhibited some difficulties remembering their interaction with MARIO. A researcher commented in their reflection on the PLWD and expressed concern:

"Third time interacting with MARIO and no memory. What will happen after the month off? Will the person with dementia forget about these experiences since they will not see MARIO/researcher multiple times per week?" (P1, T13)

However, other PLWD demonstrated improved ability to use MARIO over time. This was demonstrated despite some PLWD, who had engaged with MARIO, saying that they did not think they had seen MARIO before. After using MARIO for a few weeks, some researchers noted in their reflections that the PLWD started to remember MARIO more:

 "M4 is starting to recognize MARIO and myself, and is starting to actually remember that we have met and spoke before and seems to be having positive memory of past interactions." (P1, T12)

PLWD also remembered how the appearance of MARIO had changed and a researcher discussed this in their reflection:

"He made note of the fact that he (MARIO) *looked visually different from how he had imagined seeing him last time* (modifications had been made since)*."* (P2, T1)

3.2.4 Researchers' Recommendations for Introducing Robots in Dementia Care

The fourth theme described the recommendations that the researchers' discussed for introducing robots in dementia care. Although researchers were not asked specifically to give recommendations, these recommendations emerged as a theme from their reflections. Researchers reflected that some PLWD required prompting in order to engage with MARIO. A researcher observed the prompting required with PLWD to use MARIO, stating in their reflection that the:

"Person with dementia is hesitant to use MARIO, will read screen and details about what they can do but doesn't want to interact with MARIO unless prompted." (P1, T9)

A researcher also observed other PLWD interacting with MARIO without prompting, reflecting:

"New resident had thorough interaction with MARIO, demonstrated unprompted use of MARIO for music application, changed volume and choice of song, etc."

"Potential participant in the trial was the first to demonstrate unprompted interaction with the MARIO by playing/changing music." (P1, T10)

Researchers reflected that there were distractions related to PLWD and interactions with MARIO, and the lack of distractions was very important for encouraging interaction:

"Day room, even when quiet, can have additional distractions that pop up (other residents making noise/moving. Should try to avoid interactions in these areas unless PLWD can focus clearly and avoid distractions." (P1, T18)

"It is possible that having two researchers present might not be very beneficial as the second researcher might pose a distraction to the PLWD." (P1, T12)

When staff were serving food, this also served as a distraction for PLWD as noted in a researcher's reflection:

"Perhaps not the best time (late afternoon) to introduce robot to residents." (P1, T1)

To deal with these distractions when introducing MARIO, the researchers outlined strategies in their reflections such as the use of staff members to introduce MARIO to PLWD:

"I was surprised that during the time frame we were there, this resident went from ignoring MARIO to watching MARIO when staff introduced MARIO to him." (P4, T2)

"For me this emphasised the importance of spending time with participants/ residents and explaining how to use a technology such as MARIO at a slow, incremental pace. The importance of repeated exposure to advanced technologies like MARIO became apparent while observing this encounter." (P2, T1)

Members of the research team identified a number of strategies independently in their reflections that could be used to engage PLWD in their interaction with MARIO when distractions were present. As the work ensued it became evident that researchers, by reflecting on their experiences, began to identify strategies that might promote the PLWD's engagement with MARIO. A researcher suggested the use of verbal and/or physical prompting:

"Maybe (I should be) *more direct with asking PLWD to use MARIO, ex. Can you touch here for me/ Can you press this button, etc. instead of asking what they want to do."* (P1, T9)

"Body language and cues, moving the resident's hand to touch the screen to demonstrate what they can do." (P1, T8)

3.2.5 Impact on researchers

The fifth theme describes the impact that MARIO had on the researchers while conducting this research. Based on the researcher's reflections, it was evident that the experience of conducting the research and observing the interactions of PLWD and MARIO had both a positive and negative impact on the researchers. This is demonstrated in the following reflections whereby the researcher reported that they felt good when the PLWD enjoyed their interaction with MARIO. Often, researchers displayed positive emotions in their reflections when the PLWD reacted positively towards MARIO or demonstrated success with MARIO:

"M4 is starting to recognize MARIO and myself, and is starting to actually remember that we have met and spoke before and seems to be having positive memory of past interactions.

M5 used MARIO for the first time without his family present.

The above made me feel good/positive as it seems there is starting to be some tangible impact." (P1, T12)

"The fact that two separate residents did get close to MARIO at the nurse's station given that MARIO is new to them. I was pleased with the responses of the residents given both have dementia and could have continued ignoring MARIO." (P4, T2)

"Some of these new participants are much more excited by the MARIO project and keen to work with MARIO. Very positive, happy about the potential for the project." (P1, T18)

"Made me feel reassured that though MARIO is at an early stage of development, he is still capable of providing some form of distraction or companionship for elderly residents." (P2, T3)

As well as PLWD reacting positively to MARIO and this having a positive effect on the researcher in their reflections, a researcher displayed positive emotions when staff members and family members, including children reacted positively towards MARIO:

"Positive response from family, staff, and residents has a positive impact." (P1, T5)

"It is good for the younger generation to be made aware of dementia, its effects, and some methods that are being researched to combat it." (P1, T14)

Alongside these positive emotions, negative emotions were also experienced by the researchers, as evident in their reflections. When a person with dementia withdrew their consent and decided not to participate further in the project, negative emotions were demonstrated by a researcher, where they felt:

"Disappointed, but (the) person with dementia *was very friendly."* (P1, T7)

When PLWD were displaying difficulties with the use of MARIO, concern was expressed in a researcher's reflection:

"Concerned if person with dementia does not adapt to MARIO (what time scale do we expect?)." (P1, T9)

When family members expressed concern about their relatives interacting with MARIO, researchers demonstrated negative emotions:

"My initial instinctive reflexive feelings were shock, surprise and disappointment. These feelings evolved during the encounter as we continued to discuss it (with the relative).. *Surprise, as this negative feedback was out of context with the rest of the event, which had all been so light hearted and positive… I recall feeling anxious about the project, particularly as it is so difficult to get participants who are able to use MARIO as their dementia is so severe. Disappointed initially as just the previous week I had witnessed this participant enjoying the use of MARIO and enjoying participation in the project."* (P3, T1)

4. Discussion

To our knowledge, this study is the first to analyse reflections of researchers' experiences as they introduced a social robot to PLWD in a clinical setting. Researchers who engaged

with the PLWD were in a prime position to comment and reflect on their experiences and observations during the introduction of the MARIO social robot in a long-term residential care setting. The study had two aims: (1) To describe the experiences of researchers during the introduction of MARIO to PLWD in a clinical setting, and (2) To identify strategies for enabling PLWD to engage with social robots. Analysis of the researchers' reflections on their experiences revealed a number of themes including (1) Level of interest in having MARIO present in long-term residential care, (2) MARIO's appearance and functionalities, (3) Engaging with MARIO, (4) Researchers' Recommendations for Introducing Robots in Dementia Care and (5) Impact on researchers. These findings are discussed below in the context of the literature on the use of social robots with PLWD.

The researchers reflected that MARIO's physical and functional features were important in facilitating its use with PLWD. This finding concurs with other literature addressing the acceptability of robot companions within the older population [36, 37], suggesting that the robot's design can have a profound influence on its appeal and acceptance among users [36, 37]. The use of a needs and preferences assessment to inform the design of acceptable robot companions has been shown to protect against adverse attitudes which can lead to non-acceptance of the technology [38]. Such an assessment had been previously conducted to determine what PLWD wanted MARIO to look like and what functions for MARIO would be most useful to PLWD [16]. This may account for the fact that the researchers recorded that most PLWD were accepting of MARIO.

The findings revealed that researchers reported that a key feature of MARIO was its capacity to offer music to the PLWD. They reflected that MARIO's music facilitated the robot's acceptance by PLWD and encouraged their engagement with the robot. This finding is supported by previous research that suggests music is able to enhance the well-being of PLWD, aid their ability to communicate with others [39] and contribute to the maintenance or rehabilitation of cognitive and sensory abilities [40]. In addition, it has been found to

reduce the agitated behaviour of PLWD [41] and their anxiety levels [42]. The researchers'

reflections on their observational experiences support this body of knowledge and endorse

that music can be important and help PLWD engage with their surroundings and in this

incident a social robot.

Findings also revealed the opinions and attitudes towards the robot held by all the

stakeholders within this clinical context: relatives, care staff and the PLWD themselves. The

researcher's reflections revealed a positive attitude towards MARIO, including its appearance

and functionalities. These findings are also reflected in the literature whereby the views of

'significant others' are known to impact how the PLWD uses the social robot [43, 44]. These

important findings can potentially be used to inform the future development social robots and

their introduction into clinical contexts.

The findings also suggested that interactions between younger family members and the

robot, if witnessed by the person living with dementia, could potentially increase their

engagement. Researchers noted that the acceptance of and engagement with the robot by

family members sparked the interest of the PLWD. This was witnessed in the case where the

person living with dementia watched his grandchildren interact with MARIO, resulting in

him moving from disinterested to full engagement with the robot. This suggests that future

research should evaluate the impact of directly involving younger people who are

emotionally connected to the PLWD, when social robots intended for the older person are

introduced.

The researchers' reflections also revealed their concerns and the concerns of some

stakeholders that the ability of PLWD to use a robot like MARIO is likely to be influenced by

the severity of the participants' dementia and the presence or lack of prior technology

experience. They considered that this would impact the PLWD's ability to utilise MARIO

and the level of support needed in order to do so. These are issues which previous research

[45- 48] has also highlighted when PLWD navigate technology based recreational systems. Indeed, it is recommended that facilitators be present when the technology users have moderate to severe dementia as was the case in this study [48].

This study's findings have implications for how social robots should be introduced to PLWD and this provides an opportunity to suggest a variety of strategies which could potentially be used in the future to introduce and enhance the engagement of PLWD with social robots. These include (1) verbal and/or physical prompting, (2) lack of distractions, and (3) the use of staff members and/or family members to introduce the social robot to PLWD. All of these techniques were used when introducing MARIO to PLWD and researchers found these to be useful. Future research could benefit from the use of these techniques in order to successfully introduce social robots to PLWD.

The researcher reflections allowed researchers to acknowledge their feelings and anxieties during the introduction of MARIO into this complex clinical setting. The analysis revealed that they initially expressed concern about the vulnerability of the overall research project when some participants appeared to be unable to interact with MARIO due to the severity of their dementia. This anxiety later reduced when the researcher gained confidence and in enabling and supporting PLWD to interact and engage with MARIO. The findings suggest that it is likely that the reflection framework provided researchers with a platform from which to acknowledge their feelings of concern and that it helped facilitate their own problem solving and the development of strategies to facilitate PLWD's engagement with the robot. The framework of reflections also provided an audit trail which clearly allowed researchers to describe their observations and record their feelings and responses to them in the field.

While observational data is useful with PLWD, the current study expanded on the use of observations by utilising reflective diaries to facilitate the reflections of researchers in order to record their emotions and experiences when considering their observations. Using this methodology provided useful data which contributed to the examination of the clinical setting

during the introduction of MARIO. It is therefore recommended that reflection is used to support the introduction of robots into clinical environments for vulnerable populations.

Limitations

The study has some limitations. The authors acknowledge that 4 researchers gave reflections, which could be considered a small sample size. Yet, there were 26 transcripts provided by these four researchers. The research was conducted within a single long-term residential care setting, which may restrict valid transfer of the findings. However, it provides a valuable detailed in-depth examination of the introduction of one social robot to PLWD in this context, which adds to our understanding of the complexities surrounding the introduction of social robotics to PLWD. A further limitation is that participants were not interviewed prior to conducting their reflections. Participants could have been interviewed prior to conducting their reflections, which may have added more detail and depth to the reflections they then gave. Alternatively, participants could have been interviewed as to follow up to the individual responses that were given after they conducted their reflections. This would have enriched the data even further and allowed for clarifications to have been made during the interview process.

Future Research

Future work could use a similar reflective framework to collect data. This may provide new perspectives on issues arising during the introduction and use of robots in such settings. Alongside using a reflective framework, researchers could also be interviewed following their reflections as outlined above. The current study could also be expanded through the use of a larger sample of researchers. Further research could also evaluate and determine the effectiveness of the various strategies identified as researchers' recommendations for introducing social robots in dementia care in this study.

Conclusion

In conclusion, this study used a novel approach through analysing the reflections of researchers whilst a social robot was introduced to PLWD living in a long-term residential care setting. This technique provided useful data, which can inform future practices with regard to the introduction of robots to care settings with PLWD. These reflections generated knowledge about the experiences of researchers in the introduction of social robots to PLWD in a long-term residential care facility setting, with significance for how social robots should be introduced to PLWD, especially with regard to what strategies are most useful for the introduction of social robots for PLWD.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest:

The authors declare that they have no conflict of interest.

Research involving Human Participants and/or Animals:

This article does not contain any studies with animals performed by any of the authors. The MARIO Project received full ethical approval form the Research Ethics Committee in National University of Ireland, Galway. The study followed all procedures in accordance with the ethical standards of our University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent:

Informed Consent was obtained for all PLWD that took part in the MARIO project.

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