Emotional Robotics in the Care of Older People: A Comparison of Research Findings of PARO- and PLEO-Interventions in Care Homes from Australia, Germany and the UK

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1. Introduction

Demographic change is an issue affecting most societies in the world although the ratios of older to younger members of society do vary: Australia with 14.7% and the UK with 17.3% of the population 65 years and older are slightly younger than Germany with 20.9% (CIA 2014). Demographic changes for these countries indicate a major increase, especially in the age group 80 years and older. Whilst it should not be assumed that all older people have dementia, the association between dementia and advancing age must be acknowledged. A recent Alzheimer's Disease International report (Alzheimer´s Disease International 2010) indicated that more than 35 million people worldwide have dementia. This number will continue to increase with the ageing of the population since, after the age of 65, the incidence of developing dementia doubles every additional five years (Alzheimer's Disease International 2010).

It has consistently been reported in the research literature that older people who live in care homes (also referred to in Australia as nursing homes or residential aged care) experience social and emotional isolation (McKee/Harrison/Lee 1999; Hubbard/Tester/Downs 2003): a factor that contributes to these outcomes is the quality and type of social interaction within a care home. This is influenced by the personal attributes of residents, which include sensory deficits, communication, mobility and cognitive abilities. The physical environment of a care home and its cultural attributes – such as the philosophy of care

https://doi.org/10.14361/9783839429570-010 - am 13.02.2026, 16:15:39. https://www.inlibra.com/de/agb - Open Access -

and interventions implemented by staff – can also facilitate or inhibit social interaction between residents, staff and visitors. In recognition of these issues, there has been an increasing body of research and associated interventions that aim to enhance opportunities for social interaction (Dunn et al. 2010).

"Traditional" care provided by family members in many countries is still the most common form of care provision, although due to socio-demographic changes, the numbers of available family members who can provide such care are expected to decline. In the last few years, a variety of "new care concepts" have been developed, such as sheltered housing, new living arrangements in flats/apartments, shared communities in combination with extramural care, and the utilization of new technologies. So far the dissemination of these forms of care is still new.

Emotional robots such as the robot seal PARO or the dino robot PLEO were developed in order to stimulate emotions and thus they have the potential to initiate social interaction between the person with dementia and the robot and / or the caregiver. This type of robot is also called a companion type robot (Broekens/Heerink/Rosendal 2009) or sociable robot (Kidd 2008). The authors of this paper choose to use the term "emotional robots", with the assumption that the robots appeal to and evoke emotional feelings regardless of the person with dementia's age and illness. Due to their highly imitative and life-like behaviour, such robots can raise ethical concerns about deceiving the person with cognitive impairment. However, these robots have advantages over living animals as they do not incur vet fees and the stress placed on staff of feeding and walking an animal. Moreover, hygiene is minimal and interaction can occur without the presence of a carer and without the fear of the animal becoming stressed or causing injury to residents.

Libin & Libin (2002) defined emotional robots as a research area focusing on the analysis of person-robot-communication "viewed as a complex interactive system, with the emphasis on psychological evaluation, diagnosis, prognosis and principles of non-pharmacological treatment." (907). Since then, a number of pilot projects have been carried out in order to analyse the effects of different artefacts of emotional robotics (reviews: Broekens/Heerink/Rosendal 2009; Bemelmans et al. 2012; Kolling et al. 2013). This contribution looks at three different approaches, all of which utilize emotional robots: PARO[1], the therapeutic seal developed by AIST in Japan which is

1 | PARO is an artificial intelligence emotional robot in the form of a baby harp seal, which was designed to interact with human beings to elicit an emotional

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utilized in Australia, Germany and the UK, as well as PLEO[2], a Camarasaurus dinosaur which has been developed as a toy.

PARO and PLEO are both emotional robots with different purposes: whereas PARO is especially designed for "therapeutic" purposes, PLEO is designed as a toy and it is therefore less robust when compared to PARO.

This paper discusses a PARO group intervention and outcomes observed in an Australian[3] and UK[4] care home (see also Moyle et al. 2013a; Cook/Clarke/Cowie 2009) together with the findings of teaching research projects in Germany[5] using PLEO (see also Klein 2011, 2012). The Australian research was undertaken in 2011; the UK research in 2009, and the teaching research projects in Germany were undertaken from the summer term 2009 to the winter term 2010/11. These research projects aimed to explore whether emotional robots could contribute to quality of life of people with dementia living in nursing home care. The methods varied and this chapter explores the project outcomes in order to achieve a deeper understanding of necessities of further research of emotional robots.

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attachment to the robot (Wada/Shibata 2007). PARO has multiple sensors and a set of behavior action sequences: sensors include touch sensors over the robot's body, an infrared sensor, stereoscopic vision and hearing. Actuators include eyelids, upper body motors, front paw and hind limb motors. These sensors "recognize" behavior and trigger emotional states, while they provide the opportunity for the person to communicate with the PARO and the PARO to return the communication (Wada/Shibata 2007).

2 | PLEO is equipped with a camera-based vision system, microphones, beat detection in order to dance, touch sensors over its body, foot sensors for surface detection, a tilt sensor, infrared mouth sensors for object detection placed in the mouth, infrared communication with other PLEOs, and infrared detection for external objects (http://en.wikipedia.org/wiki/Pleo: 01.02.2015). The PLEO manual states that PLEO is a new life form, as it starts life as a baby and can develop its behavior to an adult dinosaur.

3 | The Dementia Collaborative Research Centre- Consumers and Carers funded the Australian study.

4 | The UK study was funded by DH Care Services Improvement Partnership.

5 | Frankfurt University of Applied Sciences funded a PARO and two PLEOs. The teaching research projects took place in regular courses in the Bachelor of Social Work and were therefore unfunded.

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2. Different Approaches to the Effects of Emotional Robot Therapy

2.1 The Australian Approach

Practice Development in Australia

The Centre for Health Practice Innovation (HPI) at Griffith University aims to find solutions to critical healthcare challenges and to undertake cutting edge research that results in better health, better community care and improved quality of life for patients and clients. The Centre runs a randomization service and the majority of the research undertaken is by means of controlled trials with the aim of informing evidence-based practice. The Laboratory for Assistive Technology and SociAl Robotics (LASAR) was established in HPI in 2013 and is a state of the art social robotics laboratory that enables HPI researchers to bring older people, people with dementia and carers into the lab to evaluate and develop new equipment and software. The laboratory has a one-way screen and sophisticated monitoring systems allowing participants to be observed and recorded during evaluation of robots, assistive technology and software. As well as a significant number of social robots and assistive technologies, the laboratory has a video coding laboratory and software that enables video coding to take place. The laboratory also offers a training ground for health students and postdoctoral researchers. One of the key research foci of the ageing and older people research team in HPI is improving quality of life for older people with dementia living in nursing homes through encouraging social engagement, and one area of research has been the use of emotional robots such as PARO.

The majority of nursing homes in Queensland are either non-profit or private institutions that can make decisions about whether to be involved in research or not. The researchers sought interest in being involved in research involving PARO from two large nursing home providers. One provider declined, as they viewed the robots as infantilizing older people, whereas the participating provider was interested in improving quality of life for people with dementia and viewed the PARO as offering this opportunity.

Aim

The aim of the pilot project PARO was to seek data on the effectiveness of PARO in engaging people with dementia. The researchers aimed to look at the feasibility of using PARO and, if successful, to use the data to seek further fund-

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ing to undertake a large multicenter cluster-randomized controlled trial. The researchers were recently successful in receiving funding and commenced a large cluster randomized controlled trial (c-RCT) in 2014 (Moyle et al. 2013b).

Methods

The pilot study compared the effect of PARO (intervention) to participation in an interactive reading group (control) on emotions in people living with moderate to severe dementia in a nursing home setting. A randomized crossover design with PARO and reading control groups was employed. A reading control group was chosen, as this was a usual activity used within the care home to engage groups of people with dementia in a social activity. The reading group engaged the residents in similar activities used within the PARO intervention (as outlined below). Eighteen people with mid to late stage dementia were recruited for the study.

A trained facilitator undertook both the intervention and control activities for 45 minutes, three afternoons a week, for five weeks. Participants then crossed over into the opposite activity and the protocol was repeated following a three-week period of no activity (washout) (Moyle et al. 2013a). The intervention and control activity were undertaken in a small group of participants (n=9). The researchers drew on the descriptive PARO research of Cook (Cook,/Clarke/Cowie 2009) (see below) in designing the PARO and control intervention, designing the PARO intervention around the following concepts: discovery (examining PARO); engagement (encouraging participants to talk and touch PARO); social interaction (the facilitator encouraged questions about PARO to be discussed in the group); and touch (touching and describing the fur or PARO's eyes). One PARO was introduced in week 1 to 3 and two PARO were introduced to the group in week 4 to 5. The reading group also followed the same processes but concentrated discovery, engagement, social interaction and touch on the stories being read by the facilitator. The facilitator was an arts graduate with experience in conducting activity therapy with people with dementia. The lead researcher trained the facilitator, while the lead researcher and one other team member oversaw the conduct of the intervention.

Outcome measures were undertaken at three time points: baseline (pre-intervention), mid-point (after the first 5-week intervention arm) and post-intervention (after the second 5-week intervention arm). The primary outcome measure was quality of life using the Quality of life in Alzheimer's Disease Scale (QOL-AD, a modified version for use in a nursing home population)

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(Edelman et al. 2005). Mood states were measured with following secondary outcome measures: Geriatric Depression Scale (Yesavage 1988); Observed Emotion Rating Scale (OERS); (Lawton/Van Haitsma/Klapper 1999) Apathy Evaluation Scale (Marin/Biedrzycki/Firinciogullari 1991); and Algase Wandering Scale-Nursing Home version (Algase et al. 2001) The researchers also video recorded one session each week and these were analyzed using Noldus software for engagement and emotional response. The research was funded by the Dementia Collaborative Research Centre-Carers and Consumers.

Findings

The findings have been previously reported (Moyle et al. 2013a) and therefore this paper will provide a brief summary of the findings. The overall findings were positively in favor of PARO when compared to the reading group. PARO was found to have positive, medium- to large-effect sizes on the QOL-AD (0.6 to 1.3) and OERS pleasure subscale (0.7) in the PARO group: these scores were higher than in the reading group. The Noldus video analysis also suggested that participants in the PARO group displayed less anxiety than those in the reading group. They also displayed longer periods of positive engaging behaviors during the PARO sessions such as looking directly at PARO, smiling, laughing, touching and talking to PARO.

All sessions were conducted in small groups (n=9). As indicated above, in the first three weeks the ratio of the PARO was 1:9 and in the remaining two weeks it was 2:9. The large group size reduced the amount of individual time participants could have with PARO and this negatively influenced participants' wandering behaviors. For example, when two or three group members were engaged with PARO and the facilitator was facilitating their discussion, there were times when some of the remaining individuals lost interest in the activity. When one resident got up and wandered aimlessly around the room, or at times out of the room, this distracted the group from the PARO activity. The researchers perceived that PARO may be more therapeutic in a one on one situation rather than a large group situation. The current large cluster randomized controlled trial (c-RCT) uses one PARO with one resident.

The pilot data had some surprising findings, such as the fact that individuals classified by staff as being non-communicative began speaking to PARO, asking questions and making statements about it. Most of these statements were part of their engagement with PARO. They would address PARO in ways such as: "You are beautiful. Your eyes are lovely". Although the findings were generally positive, the researchers advocate for the need for a larger

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study to help determine whether PARO is, indeed, a short term, low risk, non-pharmacological intervention that produces tangible positive psychological outcomes for people with dementia. Further research must also consider a comparative cost analysis to determine if PARO is as cost-effective as a pharmacological intervention or an alternative activity such as music therapy, social activity with a volunteer, or cheaper alternative robotic pets/toys. The current cluster randomized controlled trial is undertaking a cost analysis.

2.2 Teaching Research Projects in Germany

Since 2009 the Faculty of Social Work and Health of the Frankfurt University of Applied Sciences has used emotional robots such as the therapeutic seal PARO, and since 2010 two toy dinosaurs PLEO in teaching research projects in the Bachelor Degree program in Social Work (Klein 2011, 2012). Students are taught the theoretical concepts of socio-pedagogic approaches in nursing care homes and they have to develop a concept for assisted activities with new technologies.

Aims

Objectives linked with the teaching research projects are that students get into contact with their future clients, transfer theoretical knowledge into practice, develop their observational skills and explore the potential of new technologies for daily activities.

Methods

Artefacts such as the therapeutic seal PARO or the toy PLEO are implemented in teaching research projects in a module on "client-orientation and well-being in service provision of elder care". In the course module, students deal with social work in elder care and learn a variety of methods and tools for daily activities. Based on that knowledge, they have to develop an activity concept for a minimum of three sessions and implement it in a nursing care home: such sessions can be based on robot-assisted activity. Their observational skills on the effects of the intervention are developed – they have to videotape the sessions, analyse their videos, write a report on their observations and experiences, and reflect on their effects on the wellbeing of the residents.

Teams of three to five students have to carry out the project within four weeks. After having obtained informed consent of residents (or their legal custodians) and the management, they facilitate at least three sessions with

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residents in nursing care homes with the selected technology. Afterwards, they report the results and have to do a project presentation.

Findings

The course takes place twice a year. In the period between the summer term of 2009 and the winter term of 2010/11, there were a total of eleven robotic interventions in different nursing care homes: seven groups used PARO and four groups chose PLEO. Due to quality issues, only six project reports on PARO are taken into account in this chapter.

During this time period, a total of 62 residents had contact with emotional robots; 88.7% were female, which corresponds to the average sex distribution in nursing care homes. 38 of the residents had activities with PARO, 86.8% of which were female; and 24 had activities with PLEO, 91.6% of which were female.

Students undertook both group and individual interventions. Group size varied up to ten residents, as findings suggest that a group size of up to four residents can be managed more easily. Some of the students were rather skeptical towards the use of robots for interventions, but their experiences resulted in a change of their attitudes; thereafter, the students often saw potential for robot activities. Three persons out of 38 with PARO interventions did not like the seal; one person left the group intervention. In the individual interventions, two residents refused PARO by showing their dislike, either by shaking their heads or saying no. Students were instructed to respect wishes of residents not to participate in robot interventions and not to question this decision even if there is a written agreement in advance.

The findings of the reports indicate that emotional robots stimulate (positive) emotions and social interaction, most times in a positive way. The analysis of the German project reports revealed the reactions to the emotional robots described below and the opportunities the robots offered to older residents. The categorization was obtained by listing the activities students mentioned and then categories were derived, which represent qualitative different levels of social interaction:

- *Mimic expressions and gestures.* Residents expressed and gestured at the robot: They looked at the robot, but also to other persons in the room and communicated via grinning, smirking, smiling, laughing. These observations often had explanations such as “resident does not usually smile”; “resident does not usually show such positive emotions and happiness”,

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indicating that the positive reaction resulted from the introduction of the robot (Klein 2011).

- *Touching the robot*. This included stroking, cuddling and hugging. In one of the project reports, these interactions with intense skin contact are interpreted as a new basal stimulation approach (Bienstein/Fröhlich 2010) to people suffering from dementia, which might contribute to either reducing aggressiveness or to stimulate a positive mood.
- *Verbalization / talking to the robot.* Holding and touching the robot were accompanied by talking to the robot. The way residents talked to the emotional robots was seen as being similar to the way adults talk to babies and toddlers – with higher intonation and of confirmative or asking character.
- *Stimulation of social interaction*. In a similar way to the situation in England (see below), social interaction between residents is not taken for granted. Even in activity sessions, communication structures can be restricted only between residents and facilitator. However, the reports revealed examples where the emotional robots encouraged discussions between residents and, as happened with the British experiences, talks were on pets or memories of past times e.g. such as former vacations. One of the project reports mentions that two women with dementia started to talk about their health status and how horrible it is not to "recognize their own folks" or "remember the name of their husband".
- *To descend into their own world.* Two project reports observe that a resident became withdrawn in his or her own world and ignored the students and the robot, suggesting that people with severe stage dementia may not be able to display an emotional response towards the robot.
- *Caring behavior towards the robot.* In the individual robot interventions, the residents displayed caring and nurturing behavior towards the robot, such as getting a blanket to keep the robot warm or feeding PLEO with its (plastic) leaf.
- *Recreation.* PLEO displayed a range of activities beyond that of PARO. For example, PLEO is able to take little steps and its communication abilities are more developed. As a result, the residents enjoyed joining in singing with PLEO and they indicated that they enjoyed its robotic voice very much.
- *Dislike of robots.* Students were advised that if a person did not want to interact with the emotional robot, this had to be respected. The project reports mentioned that one person left the room or shook their head and said 'no' when asked if they would like to interact with the robot.

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2.3 Practice Development in England

As part of a practice development initiative Northumbria University developed a framework known as INTERACT[6] to enhance social interaction with residents in nursing and residential care homes. The framework "raise(s) awareness of innovative ways of promoting social engagement" (Cook/Clarke/Cowie 2009: 5) The INTERACT Framework has been developed for health and social care staff and offers guidance and strategies to promote social interaction in the resident population. Using this framework in an exploratory study, PARO was introduced to five residents. This activity specifically sought to enhance social interaction between older residents with dementia through a novel intervention that involved facilitated group discussion with the emotional robot PARO.

Aims

The aims of the study were to implement facilitated PARO group discussions with residents with dementia and to observe the effect of PARO with respect to conversation and social interaction.

Methods

This was an ethnographic study of facilitated group discussions with PARO in a care home in North-East England. The care home is a modern and purpose-built centre that comprises four units, each with 20 bedrooms. Each unit has a dedicated team of staff who provides different forms of care: the PARO group discussions took place in an Elderly Mentally Infirm (EMI) unit in the centre. In addition to bedrooms, this unit had a dining area, small and large communal lounges, and bathroom facilities. The philosophy of care was person-centred, giving priority to addressing individual needs and providing a stimulating activity programme, which included music (such as playing instruments and listening), art (making cards, drawing) and gardening.

The PARO group discussions were held in an afternoon for one and a half hours in a small lounge in the EMI unit; the door was kept open during

6 | INTERACT stands for I "Individualise type and quality of social interaction; N "Notice the quiet, withdrawn resident"; T "Time to talk"; E "Environmental conditions"; R "Recognise and support relationships"; A "Assess individual problems and Action plan"; C "Create the Care Home Community"; and T "Use Technologies to support interaction".

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the session. The participants were five people with dementia (3females and 2 males between 75 and 88 years of age) who had been residents in the EMI unit of the home between 2 and 10 months. Four participants had good communication skills and one had not spoken for some time. Two participants were wheelchair users.

The researcher facilitated the sessions and was supported by a care assistant who had known the participants for at least one year. The sessions were held for a period of five weeks.

- Session 1: orientation. The PARO was placed out of sight while residents entered or were assisted to the room and were seated around a table. At this point, the facilitator explained that they had brought something about which she would like their opinion. After this introduction, the PARO was brought out, placed on the table, and turned on. The residents were told 'I have brought something for you to see today. This is PARO. It was given to us by someone from Japan. I am curious about what you think of PARO.' After some introduction, PARO is held by each member of the group. As each participant held PARO, the facilitator asked them questions such as: 'What do you think of PARO? What do you want to know about PARO? What do you like or dislike about PARO?' The session ended when the discussion ceased and PARO was turned off. Participants were asked if they would like to take part in a discussion with PARO next week.
- Session 2: PARO was turned on when the participants were seated around the table. They were asked if they could recall the PARO discussions from the previous week and were invited to interact with PARO in any way that they wanted to. The facilitator led discussions about what name should be given to PARO. They were also invited to discuss the same questions as the previous week: 'What do you think of PARO? What do you want to know about PARO? What do you like or dislike about PARO?'
- Sessions 3-5: Following initial interaction with PARO and exploration of any issues that arose spontaneously, the facilitator introduced the following topics: 'Have you had a pet in the past? What type of pet? How long did you have the pet and what did you do with it? What memories do you have of the pet? What were the most memorable moments with your pet?' At the end of the fifth discussion, the participants were asked about their views of participating in the group discussions.

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Data collection involved observing interaction between the participants and PARO, among each other, and between the group participants and others who were not part of the group (residents who came into the room and staff). Following each session, notes were made of the observation, which were validated by the supporting carer. When the sequence of discussions was completed, interviews were held with the carer who supported the facilitator and with other staff who had observed the PARO intervention when they walked into the room during sessions. A verbatim transcription was made of the interviews and thematic analysis was completed across both observation and interview data sets.

Findings

Prior to entering the small lounge, the participants were gathered in another nearby lounge. Little social interaction was observed between the nine residents in this room. When approached by the staff and asked if they wanted to join the PARO group, there was no hesitation and they quickly settled around the table. PARO was placed on the table and switched on. Attention was focused on PARO; some participants smiled and spontaneously commented about PARO. These were short exchanges such as 'Look at what it is doing;' 'Oh, it is so lovely;' and when PARO made sounds, they asked 'Is it ok?' 'What does it need?' When one participant put out their hand to stroke PARO, they were invited to hold it. As they stroked and held the robot, they kept eye contact with PARO and moved their head following its movements. Verbal interaction involved the participant making soothing comments to PARO – 'There, there;' 'Look at you, oh you like that' in response to PARO's squeaks. Other participants made strong eye contact clearly observing the interaction between human and robot.

After five minutes, other members in the group were invited to hold PARO, giving each person the opportunity to have close contact with the robot. The participant with advanced dementia stroked and cuddled PARO, and swayed back and forth as if she was rocking the robot. This behavior contrasted to her previous state where she appeared to doze, following her initial interest in PARO. Other participants throughout the whole session maintained interest in PARO, which was evidenced by their comments and questions: they wanted to know how it worked, what it needed, how much it cost. Two participants referred to PARO as a real animal, a dog, indicating that it might need to go to the toilet and that it should have a rest, suggesting they were familiar with this type of animal. This real/machine distinction was implicit in their questions rather than being a point of discussion. These types of interaction were witnessed throughout all of the PARO sessions.

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In subsequent sessions, the participants were observed advising others in the group about how to interact with and care for PARO. They commented 'He needs to be stroked in this way;' 'He is upset, talk to him more.' They endowed PARO with a masculine gender and, when asked if they wanted to give PARO a name, they agreed that he should be called 'Jimmy'.

In addition to the five residents who agreed to take part in the group sessions, other residents showed interest in what was taking place and they entered the room, joined the group and participated in discussions that related to PARO. Their comments and non-verbal interactions were similar to the participants; they wanted to hold PARO and engaged in one-sided conversation with the robot.

In one session, the woman with advanced dementia was given PARO. She sat back in her chair and constantly patted the robot and smoothed its fur. When another resident spontaneously joined the group, he was given PARO. This woman opened her eyes and watched him sitting quietly talking to the robot saying 'There, there puppy', 'Quiet now puppy'. He was very gentle with the robot and constantly patted it. His dialogue continued with positive comments to the female resident saying 'You have a lovely puppy.' In response, the woman appeared animated and she did engage in three brief exchanges with the male resident, stating 'Yes he is lovely.' She maintained eye contact whilst talking to him and moved her body forward in a positive gesture. He did likewise and smiled in response to her comments. This appeared to be a lucid moment, since these individuals were positively interacting with each other. This brief interaction was followed by the woman sitting back in her chair and closing her eyes appearing not to engage with others in her surroundings. The man continued to make positive comments about PARO and then spontaneously stated that PARO ought to be returned to the woman. When he passed PARO back to her, she opened her eyes again, maintained contact with him, and then started to stroke PARO in a slow consistent way from its head to its tail. There was one other resident in the group at this stage and he observed the episode. When the woman was holding PARO again, he also commented that she had a good pet and advised her to enjoy this because all pets were not so good.

In contrast, one of the participants appeared to be upset by the presence of PARO during the third session. She did not want to hold PARO and mentioned that they were all in danger. When asked if she wanted to leave, she responded positively. As she left the room, she appeared less anxious. She was invited to participate in the following session: however, her non-verbal behavior did not indicate agreement and therefore did not return to the group.

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The facilitator introduced different topics to the discussion following the initial orientation session. Group members spoke of their pets, often dogs and cats. They told stories about interacting with their pets and this led onto other discussions about what they liked/disliked about interacting with animals. They spoke of places that they had both visited and which involved their pets. This prompted further discussion between the participants about what they did in those places. For example, one man spoke of times in his youth when he walked greyhounds and had gone to the racing stadium. In another situation, the two men discussed the route where one of them had walked the greyhounds: this was past the coal mine that no longer existed. They had both worked down the pit and they discussed their work: both commented on the caged birds that they took down the pit to detect hazards.

Care staff spontaneously took time out of their activities and observed the group and this led to impromptu discussions initiated by them with the residents. They were very keen on finding out what the participants thought of PARO. Two members of the staff observed the interaction between the residents that was described above and, after the session, they stated that they longed for that brief exchange to continue. They indicated that it had been a while since the female with advanced dementia had reacted in this way, that she had seemed relaxed and had enjoyed the session. They indicated that introducing PARO into the care environment promoted social interaction between residents, and between residents and staff. It was a trigger to start conversations and interactions that did not otherwise take place.

3. Discussion: Interaction through Robot Therapy?

The projects in Australia, Germany and the UK are not readily comparable, as each used different methodologies and methods, although they all seem to show indications that participants readily interacted with the robot by demonstrating emotional feelings and positive social interaction. Examples of the outcomes are presented and analysed with respect to the indicators of interaction as an outcome of the robotic intervention and the impact of emotional robots on the enhancement of social interaction in care.

The facilitated PARO group interventions in Australia provided both entertainment and stimulated engagement in a majority of participants. However, individual responses to PARO were not consistent. In some sessions,

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there were individuals who were more engaged than others and individual response could be positive one day and negative in the following session. Some of this can be explained by the fact that the researchers were unable to control for variables such as prescribed medication that may have influenced mood and response, or other influencing factors such as staff and family influences. There is a need for a larger project that tries to control some of these potential influences. The current cluster randomized controlled trial in Australia is the largest social robotic trial worldwide to explore the effect of social robots on people with dementia: with a sample size of 380 participants, the trial will identify the effect of usual care with the therapeutic robot PARO and with a look-alike plush toy (without the artificial intelligence aspects of the PARO).

The following table provides an overview on the findings:

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Table 1: Overview of the Projects' Results

Overview	Australia	Germany	UK
Year when projects were undertaken	2011	2009-2011	2009
n	18	62	5
Characteristica of the "research" use of PARO	Randomized cross over design with Paro and reading control groups	Teaching research projects in order to qualify students in observational skills and issues of social work	Ethnographic study of facilitated interaction with PARO
Information collection / Research methods	Outcome measures at baseline (pre-intervention), midpoint (after 5-week-intervention-arm); and post-intervention (after second 5-intervention arm)	Observing interactions, usually supported by videographing	Observing interaction
Instruments	QOL-AD, modified version	Additional: sociogram of the interventions, smiley-scale for residents: How did you like . . .?	Notes after each session, which were validated by the supporting carer
	Geriatric Depression Scale; Observed Emotion Rating Scale (OERS); Apathy Evaluation Scale; Algase Wandering Scale-Nursing Home version	Questionnaire or interviews with (nursing)care staff or social worker	Interviews with the carer who supported the facilitator and other staff who observed the sessions
Analysis	Video recording of one session each week, analysed using Noldus Software for engagement and emotional response	Write up in project reports	Verbatim transcription, thematic analysis across observation and interview data set
Findings			
Residents	QOL-AD: positive, medium to large effect sizes; 0.6-1.3	Students observed mainly positive reactions on PARO and PLEO	Residents were mainly positive
	OERS pleasure subscale: Cohen´s D (standardized difference in means) = 0.7 in favour for the PARO group compared to the reading group	Reactions were activities such as touching the robot; mimic expressions and gestures	Touching, stroking, smiling, following the movements; eye contact, rocking the robot
	Video analysis: participants in PARO groups less anxiety; longer periods of positive engaging behaviours	Verbalisation and talking with the robot; stimulation of social interaction, reflection on the effects of the illness;	Verbal interaction: soothing, talking about Paro,
	e.g. looking directly at PARO, smiling, laughing, touching and talking to PARO	descending in their own world; caring behaviour; recreation with PLEO	Brief exchanges between residents, but also staff
Staff	Staff observed that non-communicative individuals started to interact	In some cases students reported that a resident started to interact and talk who had not done so for some time according to staff	Staff observed that PARO promoted social interaction between residents and between residents and staff. /Trigger to start conversations and interactions that did otherwise not take place
	Indicators that group size of 9 should be minimised in order to enable all participants more time with PARO	Group sizes varied; 4 residents seem to be manageable	
Rejection of Paro	-	Dislike of PARO in 2 cases, residents did not continue their participation	One person got upset in the third session / removal from the group
Human / Machine distinction	-	Real / machine distinction was observed	Real / machine distinction was observed

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In these three studies, the focus was to find out whether this new robotic tool had any effect on the participating residents in the nursing care homes. The studies were undertaken between 2009 and 2011. The methods are not comparable, as no common assessment instrument was used throughout the studies: it is also not possible to compare the demographic variables of residents and staff. However, all three studies reported that the participating residents reacted mainly positively towards the PARO intervention.

In all three studies a facilitator moderated the interaction with PARO. In Australia, they were trained employees of the nursing care home; in the UK, the researcher took up the role as facilitator; in Germany, students facilitated the project in order to gain experience. The role of the facilitator seems to be crucial for the design of the interventions such as handing PARO over to the resident, giving a fair share of time with PARO for each resident, initiating topics to talk about, etc. These experiences can be brought into practice development (Klein/Gaedt/Cook 2013). They also open up a variety of issues still under researched such as how long, how often, and in what intensity interventions should be designed in order to contribute to wellbeing.

4. Conclusions and Recommendations for Future Research

All three projects demonstrate a number of positive findings for using emotional robots. However, the projects also raise more questions than they answer.

In particular, the question is raised whether it is the robotic characteristics that help to engage interaction or whether it is the novel appearance of the robots. Furthermore, the question of whether robots can produce the same or more enhanced engagement than living animals needs to be addressed, as well as the question of whether a person or a stuffed (non-robotic) animal can produce similar outcomes. PARO and PLEO are more interactive than a stuffed toy. If the perception and acceptance of those emotional robots is comparable with living animals, they might be an additional choice or even an alternative for some nursing care homes. In all participating countries, social activities comprise a variety of choice (e.g. reading groups, cooking, sports, music, etc.) for residents, although residents may not be able to or want to participate in such activities. Emotional response robots can offer a new activity to individuals living in nursing care home and robot therapy can thus extend the range of interventions that can be used in a care setting. There is little doubt, however, that introducing

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robots into nursing homes has the benefit of a new and stimulating opportunity that may help residents during those inevitable times when they are left alone and with limited comforts around them. There is little question that the novelty of the robots can induce joy and pleasure in residents: opportunities for enjoyment can potentially increase quality of life – even if it is only for a short time.

However, there was also a small number of residents in the UK and Germany who rejected PARO. In the UK, one person got upset after the third of five sessions and left the group. In Germany, one person did not want to get involved in the PARO interactions. Neither in the UK nor in Germany are more details known on the causes why people rejected involvement with PARO. Future research should collect data on the causes of resident rejection of PARO.

Caring for people with advanced dementia can be a challenging task for staff and relatives: opportunities to engage people with dementia in social interaction and to do something that is pleasurable may thus also have a positive impact on staff and family. Therefore, further research must consider the impact of robots not only on the person with dementia, but also on those around them.

There is a need for studies involving larger numbers of participants and where conditions are controlled so that we can identify the effect of such robots. Gender and cultural background should also be considered in order to get more insight on their role in acceptance.

More work has to be done to develop conceptual frameworks and models on the causes why emotional robots impact on people with dementia. Ethical issues also have to be analyzed in more depth. Discussions such as "robot replaces human beings and real emotions" around the robot seal misconceive the actual capability and "skills" of this particular robot as practice experience in German care homes actually shows that the robot seal is used together with professional staff. Additionally, European sales and distribution go along with staff training in robot assisted activities or therapy. Such issues cannot be dismissed, as they are relevant for further emotional robotic development and acceptance on a wider scale.

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