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Role of Anthropomorphic Design in Social Robots for Aged Care: A Case Study of Pepper

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Abstract

The increasing aging population in Australia necessitates innovative caregiving solutions to address the growing needs of elderly residents. Humanoid robots, with their physical embodiment and human-like attributes, offer a promising technological intervention. This exploratory study investigates the integration of Pepper, a humanoid robot, into aged care facilities, focusing on its potential to meet the needs of older adults and serve as a daily companion, thereby reducing staff workload. The research explores the anthropomorphic features of Pepper, their role in fostering connection and engagement, and the perception and acceptance of the robot as a companion among elderly residents. Findings highlight Pepper's potential to enhance the quality of care and support in aged care settings while identifying areas for improvement to ensure its successful adoption.

Keywords: human–robot interaction; social robots; aged care; pepper; anthropomorphism; social companion

1. Introduction

The inevitable demographic shift in Australia, marked by a growing proportion of older adults and a steady decline in fertility rates, is becoming more significant than ever. According to the Australian Bureau of Statistics [1], 17.1% of Australia's 25.6 million population in 2022 were aged 65 years and older, representing a 52% increase in the number of older adults between 2009 and 2022. Complementing this trend, Statista [2] reports that Australia's fertility rate has dropped to an all-time low of less than 1.63 children per woman of childbearing age. This growing disparity—fewer births alongside increased longevity—underscores the urgent need for innovative solutions to support an aging population [2].

One such solution is the advancement of social human–robot interaction studies, which are gaining momentum as researchers and developers explore ways to enhance the quality of life for older adults through robots. Robotics companies are increasingly focusing on designing robots that are both entertaining and practical, capable of assisting with daily tasks even in complex environments [3]. Entertainment robotics, such as robotic pets like Tombot and Sony's AIBO, are growing in popularity, offering companionship and therapeutic benefits to older adults. However, ethicist Sparrow [4] raises concerns, arguing that robotic pets may represent a misguided and potentially unethical approach

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to addressing human needs. These concerns are mitigated by the focus of Social Human–Robot Interaction (SHRI) studies on enhancing the human-likeness of robots, both in their external design and behavioral attributes [5]. This emphasis on creating robots that closely mimic human traits has further led to studies on the "uncanny valley" phenomenon, which explores the complex emotional responses evoked by human-like artificial entities [6].

2. Background

2.1. Human–Robot Interactions

According to Japanese roboticist Mori [6], the "uncanny valley" concept explains how increasing the resemblance of artificial objects to humans enhances feelings of pleasantness—up to a certain point. When the artificial object's resemblance to a human becomes very close but is still not perfect, a dip in the valley occurs, creating a sense of uneasiness or discomfort. However, if these imperfections are reduced so much that people can barely tell the difference between an artificial object and a human being, the unsettling feeling fades, and comfort is restored [7]. Here, artificial objects can be virtual reality avatars, computer graphics, robots, etc. In the context of social humanoid robots (SHR), a robot that closely resembles and behaves like a human can increase feelings of pleasantness among people [7]. However, any unnatural movements or strange facial expressions in the robot may lead to feelings of discomfort, creating a dip in the pleasantness curve known as the uncanny valley [6]. This dip can be minimized by addressing these imperfections, thereby restoring a sense of comfort for observers.

2.2. History of Pepper

In her book, ref. [8] provides an intriguing account of the development of Pepper, a widely recognized SHR. Pepper was developed in Japan following the 2011 tsunami and the subsequent Fukushima Dai-ichi reactor explosions. After these tragic events, Softbank's CEO, Masayoshi Son, visualized the concept of humanoid robots to provide companionship to the victims [8]. This vision led to the acquisition of Aldebaran Robotics and the eventual invention of Pepper. By 2018, Pepper had become one of the best-selling social robots in the market, with total sales reaching 12,000 units. Pepper found applications in various sectors, serving as a friendly greeter in cafés, a helpful guide in airports, and an interactive companion in shopping centers [8]. However, despite its initial success and widespread adoption, the demand for Pepper reportedly declined in recent years.

2.3. Humanoid Robots in Aged Care

Humanoid robots are driving a technological revolution, transforming industries with advanced and innovative solutions. Existing literature highlights the growing interest in the application of robots within aged care, with research spanning several disciplines, including Human–Computer Interaction (HCI), Human–Robot Interaction (HRI), philosophy, and nursing [9]. With elderly populations increasing globally and aged care practitioner numbers declining, there is increasing pressure to resolve these gaps technologically [9]. Social robots are one dimension, which is being discussed with more frequency as a supplement to the care of older adults in care settings, as they can provide valuable supplements to care practices [9,10]. The literature on social robot use in aged care is broad, including its use in improving exercise regimes, pharmacology distribution, companionship, and quality of life concerns. According to Khosla et al. [11], interactions between social robots and older people in residential care found significant improvements in observed states of well-being among residents. Similarly, Ge and Schleimer [12], found older adults' use of social robots demonstrated a marked improvement in general well-being. How social robots benefit older adults' quality of life in care transcends social interactions and companionship. Con-

sistent with Fasola and Mataric [13] and Kyong et al. [14] deploying a Socially Assistive Robot (SAR) to assist in exercise routines has been shown to provide positive motivation and outcomes to older adults in care settings. SARs can also motivate older people to engage in physical activities. According to Macis et al. [15], the deployment of a SAR into a residential aged care facility motivated residents to try to maintain a daily stretching and tai chi routine. Pharmacological disbursement is another area where SARs have been deployed with effectiveness. According to Smarr et al. [16], reminders to take medications and management systems for medications by SARs in care facilities have produced positive outcomes and a greater level of compliance.

To summarize the literature, a recent scoping review categorizes four primary domains in which humanoid robots can offer significant benefits: entertainment, assistance with daily tasks, and the facilitation of cognitive and physical training [17]. Additionally, Bradwell et al. [18] assert that social robots can play a crucial role in narrowing the technological divide among older adults by encouraging their engagement in social activities, thus enhancing their comfort and interaction with emerging technologies. Additionally, SHRs can be a valuable asset for aged care facilities, offering support in health tracking, resident monitoring, and remote medical consultations [17].

2.4. Impact of Anthropomorphism on Acceptance of Social Robots

Existing literature highlights that robots can serve as more engaging companions compared to screen-based virtual characters [19]. One key metric for measuring engagement is eye contact during social interactions [20]. Supporting this, Khosla et al. [9] found that participants demonstrated high levels of visual engagement when interacting with a social robot.

Pepper, a widely recognized social humanoid robot, has been noted for its verbal communication abilities, which are often positively received and enhance its perceived sociability. Interactions with Pepper frequently lead to humorous exchanges, laughter, and empathetic behavior [18]. Additionally, Pepper's use of humor has proven effective in conveying health-related messages, as humor can elevate mood and improve receptiveness [21,22].

This level of acceptance among elderly individuals highlights the potential for robots like Pepper to play a vital role in promoting well-being and fostering meaningful connections, making them valuable tools for enhancing social interaction and emotional health [23,24].

2.5. Literature Gaps and Research Objectives

While there exist several emerging studies that look at social robot acceptance in aged care, the role of anthropomorphism or human-like characteristics specifically in social robot design and its role in adoption is thoroughly lacking. Therefore, it is the objective of this study to better investigate this phenomenon.

Research Objective 1: To investigate what role anthropomorphism plays in social robot adoption among aged care practitioners and older adults.

Research Objective 2: To make contributions to the extensive social robot acceptance literature, specifically in aged care.

This research uses Pepper as the specific social humanoid robot and studies its anthropomorphic behavior and its acceptability among clinicians and residents in an aged care facility in Australia. The current study presents the results of two experiments investigating users' perceptions of Pepper's anthropomorphic behavior or human likeness, alongside its gender identity, and acceptability as a companion or entity. The first study involved 14 clinicians from an aged care facility, Uniting Care, Australia, who participated in a group interview setting. An interactive application was developed for Pepper's tablet

interface, which initiated interactions by greeting the users and introducing itself through both on-screen text, verbal communication and gestures. Pepper then invited participants to engage in interactive activities, such as playing games (e.g., Tic-Tac-Toe or a Quiz) or practicing a guided breathing exercise. After the activities, participants provided feedback through a structured questionnaire. Participants took part in a researcher-administered semi-structured interview using an interview guide developed by the research team. The interview explored participants' perceptions of Pepper, including its appearance, perceived gender, usability, and acceptance as a social companion (See Appendix A).

The same application and experimental setup were subsequently used in individual sessions with 11 residents of the facility. These experiments aimed to evaluate Pepper's esthetic properties, its perceived gender, and its acceptance as a social companion, with a focus on the influence of its design and behavior within a social context.

3. Methodology

The study employed a qualitative research design, utilizing interviews as the primary method of data collection. Ethical approval for the study was obtained from the Western Sydney Human Research Ethics Committee. The research was conducted in collaboration with Uniting Care, Australia. Participants were provided with a plain language statement detailing the objectives and procedures of the study. Those who agreed to participate signed an informed consent form prior to their involvement. The following subsections highlight, for the reader, the recruitment processes, participant selections, research activities, and data analysis methods.

3.1. Participants

This research recruited 25 total participants from a single Uniting Care facility. Of these, 14 (9 females and 5 males) were clinicians and 11 (9 females and 2 males) were residents. The residents were above 65 years of age. Additionally, eight were English natives, while three were non-English natives (Table A1). On the other hand, the clinician group consisted of 14 members, including seven registered nurses, two activities coordinators, two home support officers, one service manager, one administrative manager, and one homemaker (Table A2). Participant sample size was not predetermined; rather a saturration method was employed, which concluded when all willing participants had been afforded an opportunity to join the study.

The specifications for the recruitment process were as follows: Clinicians were required to be a full-time staff member of the UnitingCare facility. The older adults were required to be residents of the UnitingCare Facility, above 65 years of age, have a comprehension of the English language sufficient to adequately engage with the activity and understand the research parameters, as well as have no physical or cognitive impairments which may limit their ability to engage with the research activities. Recruitment was facilitated by the facility management staff, who identified suitable and willing, clinicians and residents interested in participating. Participant demographics are provided in the Appendix A (Tables A1 and A2).

3.2. Pepper Application Development

The second author developed a custom interactive application that was developed using HTML v2.x, JavaScript v 2.x, Python v2.7, Choregraphe v 2.8, and the NAOqi v2.0 Software Development Kit. The application integrated Pepper's speech, gestures, and tablet interface to deliver a consistent interaction sequence. First, Pepper greeted the participants and invited them to choose from three given activities: a quiz, Tic-Tac-Toe, or a guided breathing exercise. With the help of the application, the authors ensured that all the

participants experienced the same interaction protocol before engaging in the face-to-face semi-structured interviews.

3.3. Data Collection and Interviews

Researchers conducted 11 semi-structured interviews with residents of an older people's care facility and a group interview with 14 clinicians. Each individual interview lasted approximately 40 min, while the focus group with clinicians lasted about 2 h. The rationale for the focus group setting for clinicians was due to time constraints. As each clinician was effectively on duty, this precluded individual interviews.

At the outset, participants were asked to introduce themselves by providing brief sociodemographic information, including their name, age, gender, and language background. Clinicians were additionally asked to provide their occupation (Table A4).

Following this, participants were introduced to Pepper and provided with instructions on how to interact with the social robot. This introductory phase and training on the Pepper robotic system took approximately 5–10 min, to ensure each participant could familiarize themselves with the program and what was required of them (Tables A3 and A4). For the focus group with clinicians, this introduction and training were completed in a group setting, with 2 clinicians volunteering to demonstrate with researchers (Tables A3 and A4). They were briefed on the importance of making eye contact, maintaining an appropriate distance from Pepper, speaking clearly, and engaging with Pepper's tablet interface. With their consent, they engaged in activities of their choice with the robot. The available options included playing two games—a quiz or a tic-tac-toe game—or participating in a guided breathing exercise. Participants had the option to select all, either, or neither, of these activities (Figures A1 and A2). The activity pool consisted of four activity choices: a 50-50 split simple quiz, tic-tac-toe, a guided meditative breathing exercise or a conversation with the robot (Figure A1). Each activity was designed to take no more than 5 min each. Researchers observed that the predominance of the participants from both the focus group (Clinicians) and the interview group (Older Adults), selected the quiz or tic-tac-toe. Every participant from both sample sets completed the breathing exercise after the game activity. All questions asked during both the focus group and interviews can be found in the Appendix A (Tables A3 and A4).

After their interaction with Pepper, participants were asked a series of questions regarding their experience. These questions focused on their initial impressions of Pepper, including their thoughts on its appearance, voice, friendliness, perceived scariness, and human-likeness. In cases where elderly residents had difficulty articulating their responses, researchers repeated their answers for clarification and asked follow-up questions to ensure accurate understanding. We have included images from the interview to provide visual context for the readers. All images were taken by researchers and have their consent to be published. Furthermore, consent was received from the participants, about the use of their images in published work. Participants have been de-identified. Accompanying theme descriptions, exemplars, and accompanying field notes from researchers have been included in the Appendix A (Table A3).

3.4. Data Analysis

All interviews were recorded in their entirety using Zoom audio recordings and a phone recorder. The audio files were transcribed using Notta AI software, v2.3 with phone recordings utilized in cases of unclear or ambiguous responses. This research utilized the thematic analysis approach of Braun and Clarke [25] for its data analysis. Manual content analysis was decided as the most suitable approach for data analysis, as it provided the researchers with the opportunity to familiarize themselves with the interview and

focus group transcripts [26,27]. The interviews and focus group sessions were transcribed using Notta AI software. This was because Notta AI is a simplistic and free-of-charge transcription program. In total, the transcription yielded 432 pages from all interviews and focus groups. Adopting a deductive approach, with themes predefined, the researchers sought specific key words within the data sets. Following the 6-step approach of Braun and Clarke [25], the researcher ensured that the transcripts were read and re-read carefully. After multiple readings of the transcripts and connecting patterns across responses, initial codes were generated inductively. These codes were subsequently grouped and categorized into relevant themes, allowing for the construction of broader overarching themes. All authors contributed to the review and refinement of the codes and themes, reaching a consensus on the results. Two primary themes emerged from the analysis, which are discussed in the Section 4, Findings below.

4. Findings

4.1. The Importance of Anthropomorphism in Pepper Within Aged Care Facilities

In this theme, we discuss how residents of an older people's care facility perceived the robot for the first time, their interaction with it, and how their perception changed after the interaction. We also explored the narrative they created regarding the presence of Pepper in their day-to-day lives.

Our conversations with the interviewees were marked by enthusiasm, curiosity, and interest. We began with warm-up questions, such as whether they had heard of or used robots before. Almost all respondents indicated that they had heard of robots, primarily in industrial or factory settings, and had seen them online. However, none had anticipated that robots would enter their lives and have an impact on them. A collection of themes, exemplars and researchers accompanying field notes can be found in the Appendix A (Table A3).

Describing one resident's interest and curiosity, she said:

> *"I like these hands. I would like to know what the hands can do. Are they going to touch people or do physical things for people? I like her eyes. It has beautiful eyes."*

Another resident's initial reaction to the robot was particularly intriguing. She expressed an interest in movies like Star Wars and referred to Pepper as Fred from Star Wars. However, when the activities began, she chose not to participate, stating:

> *"It's not my cup of tea. You're boring (looking towards Pepper)."*

A couple of interviewees, one of whom had a wife with hearing difficulties, displayed contrasting reactions to Pepper. When asked whether she found Pepper friendly, the wife responded:

> *"No. It doesn't look friendly. It looks a bit scary. If I see it, it looks scary."*

When asked whether she could think of Pepper as a girl or a boy, she answered:

> *"It doesn't look like anything, not at all human. It looks odd or queer."*

In contrast, her husband had a very positive perception of Pepper. A religious person and once a pastor, he suggested using Pepper for educational purposes, particularly for children. When asked for suggestions on how to make Pepper more functional and usable for older adults, he said:

> *"Obviously, the eyes are important mechanically. I think it looks good. Right. You could try putting hair on it."*

Reflecting on the clinicians' experience with Pepper, they discussed the potential benefits it could offer to the residents, particularly those with mild dementia, who might

find the interaction with Pepper challenging. They also shared their views on how to make Pepper more acceptable to older residents.

Starting with a brief introduction, we proceeded with warm-up questions. For most participants, it was their first interaction with a robot. One registered nurse remarked on Pepper's voice:

> *"It's like a kid's voice, and elderly residents normally catch really good because they love kids, you know."*

In contrast, another nurse felt that Pepper's voice did not sound human and suggested:

> *"It sounds like a speaker. Make it a normal voice, like a human's."*

The clinicians collectively agreed that Pepper should be able to speak multiple languages, as many of their residents do not speak English fluently and prefer to communicate in their native language. They believed that Pepper could help bridge this communication barrier between residents and clinicians. They also expressed concerns that residents with dementia might find interacting with Pepper challenging. One service manager noted:

> *"Because our residents do have dementia, not the high end but mild, completely affected by dementia, the way they see it could be scary for them as well when they see a roadblock."*

Another clinician pointed out the difficulty for residents in bed to engage with Pepper, particularly regarding eye contact:

> *"As eye contact is mandatory. The residents who are staying in their bed, maybe they cannot see by themselves. I don't think making eye contact is possible for those residents the way they are lying in bed."*

4.2. Perception of Pepper's Identity in an Aged Care Facility

In this theme, we explored participants' perceptions of Pepper's identity and the symbolism they associated with it. Participants varied in how they identified Pepper; some viewed it as a companion and expressed a willingness to integrate it into their daily lives. They showed interest in having Pepper perform tasks such as reminding them to hydrate, take medication, and assist with their day-to-day activities. Most participants agreed that Pepper could be a valuable addition to their group, serving as a helper in dining halls, providing entertainment through music, and guiding them in assistive exercises.

However, a few participants perceived Pepper as an entity or a scary creature, emphasizing its mechanical and non-human nature.

The symbolism of Pepper elicited both positive and negative interpretations. Many participants were initially hesitant but felt more confident and positive after interacting with it.

A key question posed to each participant was whether they found Pepper frightening. All residents, except for one, responded that they did not find Pepper scary. Similarly, clinicians did not perceive Pepper as intimidating, but voiced concerns about how residents with dementia might react. One nurse commented:

> *"They might see Pepper as a scary creature."*

One resident described it:

> *"I think it's an entity."*

However, when asked about their perception of Pepper after interacting with it, participants shared many positive responses, such as:

> *"I feel a bit more positive about robots now. I think that will grow." "I believe in progress, of course."*

"I found it challenging because it's been a long time since I was challenged, anyway. It's making me think."

5. Discussion

This study revealed several interesting and thought-provoking findings. Within aged care facilities, Pepper shows significant potential to benefit both elderly residents and staff. However, there are areas where Pepper requires improvements to become an ideal fit in this sector.

We found that Pepper's appearance significantly influenced users' acceptance of robots. Participants frequently commented on Pepper's hands and movements, with some even touching its fingers out of curiosity. This underscores the importance of gestures and body language for older adults, as these features can enhance engagement and make Pepper appear more approachable. Gestures such as open-handed greetings or guiding users could foster a sense of connection, making Pepper more relatable and interactive. These findings are consistent with those of Robinson and Nejat [28]. Additionally, several participants found Pepper's child-like voice appealing, associating it with their love for children and longing for their grandchildren. Pepper's voice was seen as a way to fill that emotional gap, aligning with the findings of Seaborn and Frank [29], who noted that Pepper's colloquial tone fosters a cheerful and empathetic personality [15]. However, some users perceived Pepper's voice as overly robotic and machine-like, which could potentially scare elderly residents, particularly those with dementia. This concern aligns with Thunberg [8], who emphasized the importance of a human-like voice for robots interacting with older adults, especially those with dementia.

In some cases, participants discontinued their interaction with Pepper or perceived it as an odd, non-human entity. This reaction was particularly noted among participants with hearing or speech impairments, which finds similarities in studies conducted by Liao et al. [30]. The lack of acceptance may stem from technological barriers, as identified by Holthe et al. [31]. Conversely, some participants displayed a positive attitude toward technology, particularly when engaging in quiz games. These activities challenged them intellectually by expanding their knowledge and encouraged interaction with Pepper's tablet, motivating them to explore and adapt to the technology. This observation is supported by the findings of Manca et al. [32] and Kang et al. [9] whose studies found similarity in residents and practitioners in studies with SARs.

Limitations and Future Research Directions

Our study has several limitations due to its exploratory nature. First, our findings are based on interviews conducted with a specific demographic from a single aged care facility in Sydney, Australia, involving both residents and clinicians. As such, the results may not be generalizable to the broader global population of older adults or to other aged care facilities. Different demographics and cultural contexts could influence the outcomes. Furthermore, trends observed by researchers during this study could be part of the 'Hawthorne Effect', i.e. pure novelty. This further highlights the necessity to broaden the sample size to observe if these trends translate to a larger sample size.

Second, the study focused on only one type of social robot, Pepper. Future studies that involve multiple types of social robots could yield different results. Furthermore, participants interacted with Pepper for a relatively short period and primarily engaged in games and guided breathing exercises. This limited interaction may not have fully captured Pepper's broader capabilities in supporting daily activities and could have influenced participants' perceptions. Third, the sample size could be expanded to enhance the robustness and generalizability of the findings.

In future research, scholars could explore how more advanced robots with improved communication and decision-making capabilities might further enhance the quality of care for older adults. Additionally, studies could examine factors influencing the acceptance or rejection of social robots among various groups of older residents, particularly those with varying degrees of cognitive impairment. Longitudinal studies involving repeated interactions and a wider range of activities may provide a more comprehensive understanding of users' perceptions and acceptance of social robots over time.

6. Conclusions

This paper presents the findings of a study conducted with elderly residents and staff at an aged care facility in Sydney, Australia. Participants engaged in interactive activities with Pepper, followed by interviews to gather their perceptions. The study explored how older adults perceive a humanoid robot, the significance of anthropomorphic features in fostering acceptance, and the potential for Pepper to be considered a companion.

The results revealed mixed perspectives. Our findings suggest that Pepper has the potential to contribute meaningfully to the care practices of aged care practitioners and the lives of elderly residents' lives. However, the limitations of this study must be recognized, as it is limited to primarily perceptions of individuals, in a select aged care facility setting. This is a barrier to understanding and instituting a new technology like a social robot into a care setting. Ultimately, the objective of Pepper as an aged care companion for the elderly and the importance of modifying its anthropomorphic design warrants further investigation.

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Institutional Review Board Statement: The study was conducted by the Declaration of Helsinki, and approved by the Human Research Ethics Committee of Western Sydney University reference number: H15666 on 14 December 2023 for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. This included their deidentified appearance in images.

Data Availability Statement: Data are contained within the article.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Participants (Residents) demographic information.

Participant Number	Age	Gender	Language Background
P1	73	Female	English Speaking Background (ESB)
P2	88	Female	English Speaking Background (ESB)
P3	77	Female	English Speaking Background (ESB)

Table A1. *Cont.*

Participant Number	Age	Gender	Language Background
P4	86	Female	Non-English-Speaking Background (NESB)
P5	84	Female	English-Speaking Background (ESB)
P6	82	Female	English-Speaking Background (ESB)
P7	84	Female	English-Speaking Background (ESB)
P8	85	Female	Non-English-Speaking Background (NESB)
P9	86	Male	Non-English-Speaking Background (NESB)
P10	87	Male	English-Speaking Background (ESB)
P11	89	Female	English-Speaking Background (ESB)

Table A2. Participants (Clinicians) demographic information.

Participant Number	Occupation	Gender	Language Background
P1	Service Manager	Female	Non-English-Speaking Background (NESB)
P2	Activities Co-Ordinator	Male	Non-English-Speaking Background (NESB)
P3	Home Support Officer	Female	Non-English-Speaking Background (NESB)
P4	Admin Officer	Male	Non-English-Speaking Background (NESB)
P5	Home-Maker	Male	English-Speaking Background (ESB)
P6	Registered Nurse	Female	English-Speaking Background (ESB)
P7	Activities Co-Ordinator	Female	Non-English-Speaking Background (NESB)
P8	Home Support Officer	Female	English-Speaking Background (ESB)
P9	Registered Nurse	Male	Non-English-Speaking Background (NESB)
P10	Registered Nurse	Female	Non-English-Speaking Background (NESB)
P11	Registered Nurse	Female	Non-English-Speaking Background (NESB)
P12	Registered Nurse	Female	Non-English-Speaking Background (NESB)
P13	Registered Nurse	Female	Non-English-Speaking Background (NESB)
P14	Registered Nurse	Male	English-Speaking Background (ESB)

Table A3. Content Analysis Exemplar Summary Tables.

Theme/Concept (Anthropomorphic Design Characteristics)	Selection Criteria	Exemplar/Researcher Field Notes
Eyes	Any reference to Pepper's eyes	P1: "I like her eyes. It has beautiful eyes." Participant made direct reference to Pepper's eyes.
Hands	Any reference to Pepper's Hands/Arms	P1 "I like these hands. I would like to know what the hands can do" Participant made direct reference to Pepper's hands and physical capabilities.
Sex/Gender	Any reference to Pepper's Sex/Gender	P1 "I like her eyes." Participant made unconscious reference to Pepper's sex/gender as female. Likely
Voice	Any reference to Pepper's Voice, voice intonation or speaking	P9: "Make it a normal voice, like a human's." Participant made a direct reference to Pepper's voice intonation. P1 "It's like a kid's voice, Participant made a direct reference to Peppers voice, Child-like.
Appearance	Any reference to Pepper's appearance	P7 "it's an entity." Participant made direct reference to Pepper's appearance. Referencing non-human like. P9 "not at all human. It looks odd or queer." Similar reference made by P9 about Pepper's appearance.

Table A4. Focus Group Questionnaire Guide–UnitingCare Clinicians.

FOCUS GROUP OVERVIEW | PROTOCOL
• The Focus group will run for approximately 45 min
• The session will be recorded via Zoom and Zoom recording software v7.1.5.
• Any interviewee may discontinue at any time during the interview.
• The focus group will be conducted in compliance with the approved ethics application: H16032.
INTRODUCTORY QUESTIONS
• Request name, age, country of origin, native language, position, and duration of working at UnitingCare Westmead.
INTRODUCTION TO SOCIAL ROBOTS
• Open to the group: Has anyone ever encountered, seen or used a social robot?
If yes, Probe:
Where did you use, encounter, or see the social robot? What is your perspective on the interaction you had with the social robot?
• Open to the group: Has anyone ever encountered this model of Social Robot: PEPPER
If yes, Probe:
Where did you use, encounter, or see PEPPER? What is your perspective on the interaction you had with PEPPER?
SESSION COMMENCEMENT | ENGAGEMENT WITH PEPPER
• Reiterate session outline.
• Introduce the group to PEPPER.
• Open to Group: Request 1–3 clinicians to complete a run-through of the prototype.
• **If multiple sessions are required with the activity, the time allowance could be anywhere from 5 to 10 min.**

Table A4. *Cont.*

ACCEPTANCE AND USE CONCEPTS	ENGAGEMENT WITH PEPPER
• Open to the group: In other research, we found that older adults can be hesitant to use robots. Did you feel hesitant and do you think your residents would be hesitant to try Pepper?
Probe: Why/Why not? What would be needed from Pepper to overcome this hesitancy?
• Open to the group: Do you think if a social robot were recommended by a clinical person or professional such as yourself at the facility, this would make the residents more likely to try Pepper?
Probe: Why/Why not?
• Open to the group: If a social robot were used in a group setting among the residents in the facility, do you think this would make them more likely to try Pepper?
Probe: Why/Why not?
QUALITY OF LIFE CONCEPTS	ENGAGEMENT WITH PEPPER
• Open to the group: Before we talk about the prototype, do you find that some of the residents at UnitingCare Westmead are lonely or socially isolated?
If yes, Probe:
Why do you feel this is? What do you do as clinicians to minimize/alleviate this?
• Open to the group: Do you use activities individually or in group settings in your daily practice with the residents to help with loneliness and social isolation?
If yes Probe:
Do they find these activities meaningful to their daily lives? Do you find that these activities alleviate social isolation and loneliness among these residents?
• Open to the group: Based on your interactions with Pepper and your experience as a clinical specialist, do you feel that a social robot could be as effective as a person in running an activity individually or for a group?
Probe: Why/Why not?
What are your thoughts or concerns about social robots?
• Open to the group: Based on your interactions with Pepper and your experience as a clinical specialist, do you feel social robot-guided activities could bring meaningful improvement to socially isolated and lonely residents?
Probe: Why/Why not?
• Open to the group: In some of our research, people often felt that a social robot would replace humans. We have explained that something like pepper would only be a supplement for other people. Do you think pepper could be a suitable supplement for people such as companions for the residents or for helping the carers here at the facility?
Probe: Why/Why not?
• Open to the group: Having now viewed a social robot and its capabilities, do you feel more positive about social robots and their application to care settings?
Probe: Why/Why not?
Esthetics CONCEPTS	ENGAGEMENT WITH PEPPER
• Open to the group: In some of our experiments with Pepper, our participants have said that it is ‘scary.’ Did you feel this way?
Probe: Why/Why not?
• Open to the group: Did anyone have any comments or feelings about the way Peppers’s arms, head and body moved, or about its voice?
Probe: Why this feature?
• Open to the group: A robot’s appearance/esthetic features can be important to some users. If you could change one thing to make it more ‘friendly’ to you, what would it be?
Probe: Why this feature/esthetic?

Table A4. *Cont.*

USABILITY CONCEPTS	ENGAGEMENT WITH PEPPER
• Open to the group: In some of our experiments with Pepper, our participants have said it is 'difficult to use.' Did you find this also?
Probe: Why/Why not?
• Open to the group Do you feel that your residents would find pepper difficult to use?
Probe: Why/Why not?
• Open to the group: Who found the voice activation better than the touch activation?
Probe: Why is this?
• Open to the group: You may have noticed we had 2 games and 1 exercise program. Who found the exercise program would be more beneficial than the games?
Probe: Why is this?
• Open to the group: Making a robot that is easy to use is important to some users. If you could change one thing to make it more accessible for yourself and older adults, why would it be?
Probe: Why this?
CONCLUDING QUESTIONS
• Open to the group: As clinical aged care specialists, if you had a magic wand. What is one thing you would change in your roles using robots?
• Open to the group: Do you have any concluding thoughts, feelings, opinions, or feedback based on our session today?

Table A5. Interview Group Questionnaire Guide–UnitingCare Residents.

INTERVIEW OVERVIEW	PROTOCOL
• Each interview will run for approximately 60–75 min.
• Each interview has been scheduled previously with the consent of the participant.
• Each interview will be recorded by Zoom and Zoom recording software.
• Extra questions by researchers may be permitted to request interviewees to expand upon their responses.
• Any interviewee may discontinue at any time during the interview.
• All interviews will be conducted in compliance with the approved ethics application: H16032.
INTRODUCTORY QUESTIONS
• Request name, age, country of origin, native language and duration of living in UnitingCare Westmead Residential Facility.
INTRODUCTION TO SOCIAL ROBOTS
• Have you ever seen or used a social robot?
If yes, Probe: Where did you see or use the social robot? What did you use/see it doing? What is your perspective on the interaction you had with the social robot?
• Have you ever encountered this model of Social Robot: PEPPER
If yes, Probe: Where did you use, encounter, or see PEPPER? What is your perspective on the interaction you had with PEPPER?
BASELINE QUALITY OF LIFE	SOCIAL ISOLATION, LONELINESS and ACTIVITIES
• Do you have close relationships here at UnitingCare?
Probe: Who would you say is your closest social interaction (Spouse, friend, clinical person).
• Do you often feel lonely or socially disconnected living here at UnitingCare?

Table A5. *Cont.*

Probe if yes. Why do you feel that is?
• What kind of activities do you like to do here at the facility?
Probe: Do you do these activities alone or in a group? Do you find these activities meaningful to your daily life?
• Are there any specific activities that you do that make you feel less lonely or socially isolated?
Probe: What are they? Why do you feel that they do?
SESSION COMMENCEMENT	ENGAGEMENT WITH PEPPER
• Reiterate session outline and introduce participant to PEPPER.
• Request they engage with the prototype and run through each game and exercise activity. (Researcher to help if needed).
• **If multiple sessions are required with the activity, the time allowance could be anywhere from 5 to 10 min.**
ACCEPTANCE AND USE CONCEPTS	ENGAGEMENT WITH PEPPER
• In other research, we found that older adults can be hesitant to use robots. Did you feel hesitant to use Pepper?
Probe: Why/Why not? What would be needed from Pepper to overcome this hesitancy?
• Do you feel other residents would be hesitant to use Pepper?
Probe: Why/Why not?
• If a social robot were recommended by a clinical person at the facility, would this make you more or less likely to want to use Pepper?
Probe: Why/Why not?
• If other residents used a social robot in a group setting in the facility, would this make you more or less likely to want to use Pepper?
Probe: Why/Why not?
QUALITY OF LIFE CONCEPTS	ENGAGEMENT WITH PEPPER
• Based on your interaction with Pepper, can you please explain how you feel about them? Do you find pepper to be a companion, a friend, or an entity?
Probe: Why this choice?
• Did the games/breathing exercises with Pepper help you feel more relaxed, calm, or focused?
Probe: In what way? Why is this?
• You mentioned that you engage in meaningful activities at the facility, do you feel the activity you engaged in with Pepper was as meaningful?
Probe: Why/Why not?
• Do you think that Pepper could be as effective as a human at guiding an activity here at the facility?
Probe: Why/Why not?
• Do you feel that other residents who are more socially isolated or lonely would benefit from having a companion like Pepper?
Probe: Why/Why not? (Do you feel less lonely/socially isolated from your interaction with Pepper–Why/Why not?)
• In some of our research, people often felt that a social robot would replace humans. We have explained that something like pepper would only be a supplement for other people. Do you think pepper could be a suitable supplement for yourself or other residents such as companions or for helping the carers here at the facility?
Probe: Why/Why not?
• Having now viewed a social robot and its capabilities, do you feel more positive about social robots and their use in a care setting like this one?
Probe: Why/Why not?

Table A5. *Cont.*

USABILITY CONCEPTS	ENGAGEMENT WITH PEPPER
• In some of our research, some older adults have said Pepper is 'difficult to use.' Did you find this also?
Probe: Why/Why not?
• Do you feel that other residents would find pepper difficult to use?
Probe: Why/Why not?
• You may have noticed that Pepper had voice activation and touch activation. Which one did you prefer?
Probe: Why is this?
• You may have noticed we had 2 games and 1 exercise program. Which one did you prefer?
Probe: Why is this?
• Making a robot that is easy to use is important to some older adults we have found in our research. If you could change one thing to make it more accessible for yourself and other older adults, what would it be?
Probe: Why this?
AESTHETICS CONCEPTS	ENGAGEMENT WITH PEPPER
• We have found in other studies that some other older adults found PEPPER "scary." Is this something you experienced?
Probe: Why/Why not?
• Were there any of Peppers's appearance features that you would like to comment about? (What about their eyes, facial features, voice, hand, head, body movements?)
Probe: What are they and why this?
• A robot's appearance/esthetic features can be important to some older adults. If you could change one thing to make it more 'friendly' to you, what would it be?
Probe: Why this feature/esthetic?
CONCLUDING QUESTIONS
• As a resident of UnitingCare Westmead, if you had a magic wand. What is one thing you would change about this facility using a social robot like Pepper?
• Do you have any concluding thoughts, feelings, opinions, or feedback based on our session today?



Figure A1. PEPPER Demo Activity Pool.

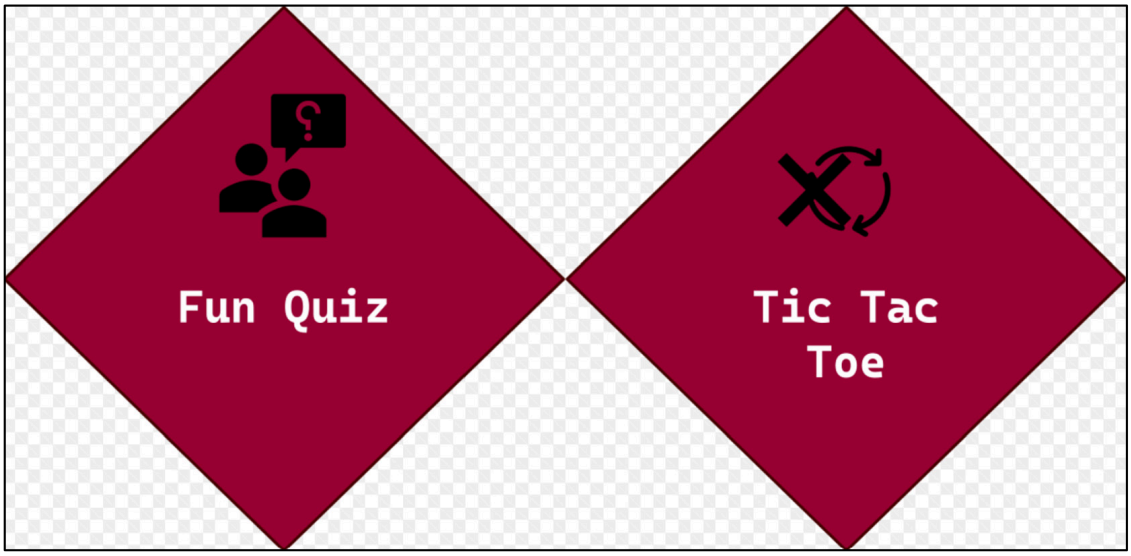


Figure A2. PEPPER Demo Activity Selection.



Figure A3. UnitingCare Clinician Demo (Credit: Images Provided by Authors).

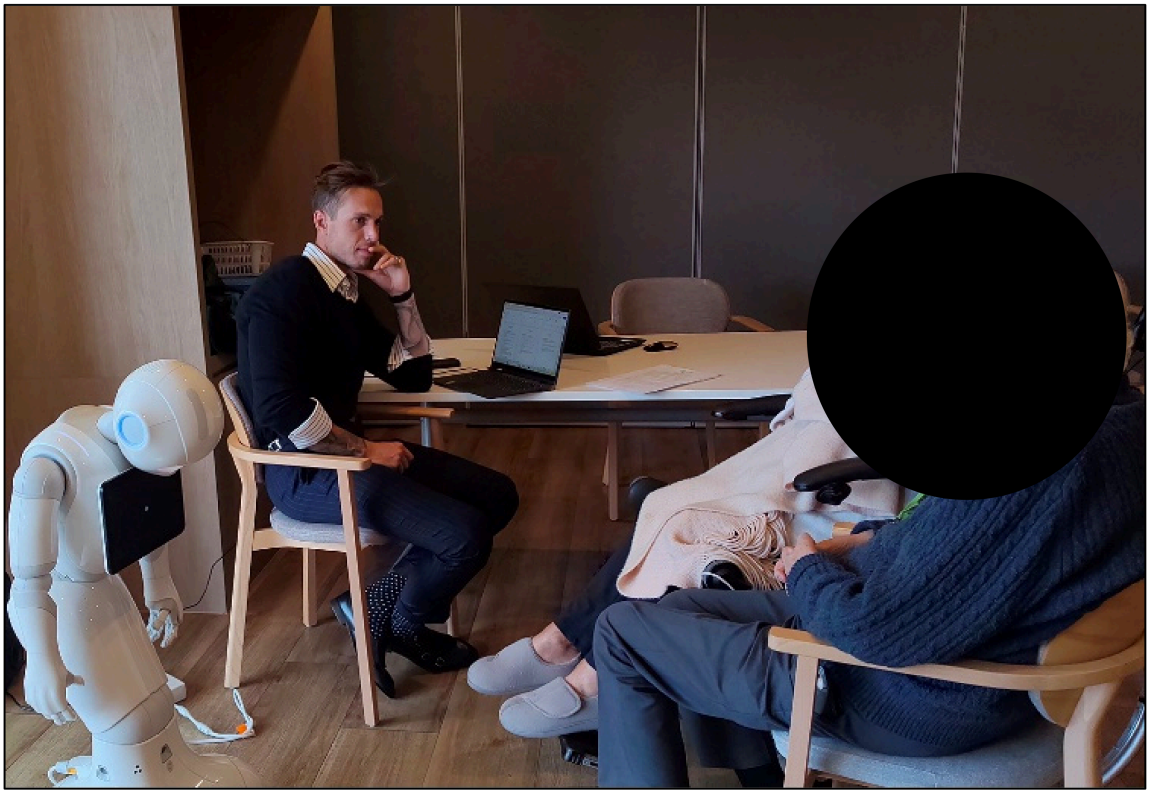


Figure A4. UnitingCare Resident Demo (Credit: Images Provided by Authors).

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