

The Potential for ‘Needy’ Socially Assistive Robots in Assisted Living: Support Workers’ Perspectives

NATHAN JONES, FERNANDO LOIZIDES, and KATHRYN JONES, Computer Science and Informatics, Cardiff University, Cardiff, United Kingdom of Great Britain and Northern Ireland

MICHAEL LOIZOU, Centre for Health Technology, University of Plymouth, Plymouth, United Kingdom of Great Britain and Northern Ireland

JANE BIDDULPH and EVANGELIA CHRYSIKOU, University College London, London, United Kingdom of Great Britain and Northern Ireland

Amidst the mounting challenges posed by the ageing of worldwide populations, innovative care approaches need to be explored. Socially Assistive Robots (SARs) have emerged as a potential solution, however despite their potential benefits, they have yet to realise widespread utilisation. We conducted a mixed-methodology study to explore the perspectives of 24 support workers and other healthcare professionals on SARs and the potential integration of ‘needy’ traits to increase acceptance of future SARs. Needy traits in this context refer to the integration of traits which produce a sense of dependence from the robot to the user, with the intention of fostering similar engagements as between a person and their pet. Focus groups, questionnaires and interviews were utilised to gather valuable insights. Overall, support workers exhibited a positive attitude towards existing SARs and were receptive to the concept of an SAR with ‘needy’ traits. However, several significant barriers including privacy, technology literacy and cost still need to be addressed to allow for their widespread adoption.

CCS Concepts: • **Human-centered computing** → **Interaction design**; **User studies**; • **Computer systems organization** → **Robotic autonomy**;

Additional Key Words and Phrases: Robotics, Assisted Living, Socially Assistive Robots (SAR), Human-Robot Interaction (HRI), Support Workers, Care Workers, Assistive Technology, Healthcare Innovation, Technology Acceptance

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Authors’ Contact Information: Nathan Jones (corresponding author), Computer Science and Informatics, Cardiff University, Cardiff, United Kingdom of Great Britain and Northern Ireland; e-mail: jonesnl6@cardiff.ac.uk; Fernando Loizides, Computer Science and Informatics, Cardiff University, Cardiff, United Kingdom of Great Britain and Northern Ireland; e-mail: loizidesf@cardiff.ac.uk; Kathryn Jones, Computer Science and Informatics, Cardiff University, Cardiff, United Kingdom of Great Britain and Northern Ireland; e-mail: jonesk90@cardiff.ac.uk; Michael Loizou, Centre for Health Technology, University of Plymouth, Plymouth, United Kingdom of Great Britain and Northern Ireland; e-mail: michael.loizou@plymouth.ac.uk; Jane Biddulph, University College London, London, United Kingdom of Great Britain and Northern Ireland; e-mail: jane.biddulph@ucl.ac.uk; Evangelia Chrysikou, University College London, London, United Kingdom of Great Britain and Northern Ireland; e-mail: e.chrysikou@ucl.ac.uk.



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1 Introduction

The rising trends in ageing populations pose significant challenges for healthcare systems worldwide [58]. With a growing number of elderly and frail individuals, many countries are grappling with the strain on their healthcare infrastructures, which are often ill-equipped to meet the unique needs of this demographic. These challenges are further exacerbated by issues related to isolation and lack of social interaction among elderly individuals, leading to a host of debilitating health conditions [21, 75], including an increase in the prevalence of dementia [37].

As a potential solution to alleviate these pressing concerns, therapy pets have been explored, offering emotional support and companionship to ageing individuals [32, 38]. However, concerns regarding safety for both individuals and their pets have limited the widespread adoption of this approach [27]. Drawing upon a previously conducted literature review, our hypothesis suggests that incorporating *needy* traits in **Socially Assistive Robots (SARs)** could lead to heightened acceptance levels among elderly individuals. Needy traits, characterised by expressions of emotion, responsiveness and empathy, have shown promise in improving the efficacy of SARs [41]. Despite this potential, existing research in the field remains limited, with many studies merely considering these traits as an afterthought, rather than making them a central focus of their work.

In this research paper, we aim to explore an alternative solution to therapy pets and existing assistive technologies by focusing on the potential for the development and implementation of ‘reliant’ or ‘needy’ SARs. Although we do not yet have a robot embodying needy traits, we will pose the concept to participants, explaining which needy traits we envision will be integrated and how they can expand upon and change the existing features of our demonstrated SAR. This approach was adopted as we aimed to explore perceptions of the concept of neediness, rather than to evaluate a specific technical implementation. Our study centres on understanding the interests and needs of assisted living support workers, as they play a vital role in the care and well-being of ageing populations. By gathering comprehensive information on their preferences and requirements, we intend to evaluate functionality and design traits that can be incorporated into SARs. The ultimate goal is to create SARs that foster improved acceptance among their users, thereby enhancing their usage and achieving better care outcomes.

To investigate our hypothesis, we have formulated three key research questions:

- RQ1. What are the attitudes of support workers towards the adoption of an existing SAR?
- RQ2. What are support workers’ opinions and apprehensions regarding the concept of a *needy* SAR?
- RQ3. To what extent do the perspectives of support workers on SARs align with the **SARNY (Socially Assistive Robot Needy framework)** framework for *needy* robot design?

Our first question aims to understand how support workers perceive the adoption of SARs. Their insights into the benefits and challenges of incorporating these robotic companions into care-giving practices are vital in shaping the future of this technology. The second will explore support workers’ opinions regarding the concept of a *needy* SAR. By examining their attitudes towards SARs designed with emotional and empathetic traits, we can gain valuable insights into the potential acceptance and receptivity of elderly individuals towards such robots. We will investigate the concerns of support workers about adopting this type of SAR. Identifying and addressing potential reservations and challenges from support workers’ perspectives are crucial for ensuring the successful implementation and integration of SARs into the caregiving ecosystem. Last, we will compare the feedback from our study participants to the traits identified in the SARNY needy robot framework [41]. SARNY is a conceptual framework for SARs that outlines seven design considerations for fostering engaging yet ethically responsible interactions: neediness, character,

expression, personalisation, understanding, restraint and honesty. Further detail is provided for each of these traits in Section 2.4.

Our previous work in [41] drew upon existing literature to conceptualise the initial SARNY framework. Rather than directly evaluating the framework, this study instead focuses on how support workers interpret and evaluate the idea of a robot that exhibits characteristics associated with robotic neediness. The concept of robot ‘neediness’ as defined in [41] was introduced verbally to participants during the study. The aim was to explore whether robotic neediness is considered acceptable and appropriate in practice within assisted living environments, and whether the perspectives of participants’ aligned with, challenged or expanded upon the proposed traits. Rather than serving as a formal validation of the SARNY framework, these findings are intended to support its refinement and guide the future development and implementation of SARs that incorporate needy characteristics.

2 Related Works

2.1 Introduction to SARs

SARs are robots that have been designed to facilitate support for individuals, primarily through providing social and, or, emotional support as needed [11, 28]. Traditionally, these robots are designed to address the needs of elderly or otherwise vulnerable individuals.

SARs are designed to be utilised in both domestic and industrial settings, including healthcare and assisted living. Their design and function are significantly influenced by the context of their implementation. Within the home setting, robots intended for personal use necessitate design that prioritises operational simplicity and a personable aesthetic. This is critical due to the potential absence of readily accessible technical support for end-users. This constrains the complexity of functionality that can be integrated into these devices.

In healthcare and assisted living settings, robots are required to integrate with existing care systems and may possess more direct functionality. Staff members can be expected to enable interactions with the robots and determine their applications. While a degree of technical support is anticipated, this will vary across facilities. Location also impacts how much privacy is expected. At home, individuals expect a greater degree of privacy and are less likely to be comfortable with several cameras and sensors transmitting their data. In contrast, residents within assisted living will be used to reduced privacy and may be more accepting of devices which provide further surveillance.

As with other assistive technologies [50], SARs have the potential to reduce labour costs and enhance the quality of care within assisted living facilities [12], due to their ability to streamline tasks and augment the efficiency of existing care providers. This is particularly apparent in autonomous SARs as they can provide continuous on-demand support for users, without the presence of an operator. The lack of an operator can help to preserve the users’ agency and privacy, as they can choose how and when they interact with the SAR. Autonomy paired with embodiment enables SARs to present as a companion with a character that users can potentially relate to. Introducing alternative methods of interaction, such as touch, enables the potential for users to form bonds and relationships with the SAR, which are typically harder to achieve with disembodied systems [10].

However, the integration of SARs also presents potential drawbacks. An over-reliance on these robots could lead to a perception of decreased human interaction for residents, potentially impacting their overall well-being [69]. Furthermore, while SARs are often viewed as cost-saving tools, this may not always be the case. The development and implementation costs associated with integrating new assistive technologies can be substantial. Additionally, concerns regarding job displacement among staff and the need for specialised technical expertise to operate and maintain SARs could lead to additional expenses.

2.2 Robots in Assisted Living

The integration of SARs in assisted living facilities is intended to allow them to carry out a multifaceted array of tasks. These range from direct support to residents, including companionship and physical assistance, to the enhancement of staff capabilities in monitoring and managing resident well-being. Standard features of robots in this area include the following:

Companionship. SARs provide companionship to individuals living in assisted living and other healthcare facilities. These robots are usually targeted at the elderly. One of the most notable of these is Paro, the therapeutic seal which has seen wide success, particularly with patients with dementia [39]. Robots in this capacity have shown to have a positive psychological and physiological impact on residents [1, 12].

Cognitive Support. Robots can help people with memory impairments by providing reminders for medication schedules, appointments and other daily tasks [1]. This can help to maintain their independence and reduce the burden on caregivers. In addition, robots can offer cognitive stimulation through engaging games and exercises, which can help improve cognitive function and delay cognitive decline.

Physical Assistance. Physical support can be directly provided to older adults by robots. This support may include mobility assistance, such as robot walkers [70], as well as assistance with activities of daily living using mechanical arms [59]. These robotic assistive devices can help older adults maintain independence and improve their quality of life. Research has shown that these devices are generally accepted by older adults and can effectively support their physical needs.

Supervision. Robots can serve as supervision tools within assisted living environments. Generally equipped with multiple cameras, they have the capacity to augment existing surveillance systems [22]. Furthermore, sophisticated robots possess the capability to detect falls and promptly notify caregivers or guardians when assistance is required [5]. This technological advancement not only streamlines the monitoring process but also enhances the safety and security of residents within assisted living facilities.

2.3 Barriers

Although various types of SARs are available, they have not experienced widespread adoption among consumers. While research indicates that older people are more likely to perceive benefits from robots and are more willing to have them at home, SARs are still not utilised frequently by the people that would benefit from them the most [4, 17, 81]. While some robots have seen initial success, such as Paro the robotic seal [39] and Pepper [61], these accomplishments are rare. Many SARs fall into disuse without seeing any form of widespread adoption. Over the past several years, production has been halted on some of the most popular robots, including SoftBank's Pepper which had its production stopped in 2021 [57].

At present, several barriers hinder the widespread acceptance of SARs. While resistance to novel technologies is common, the extensive utilisation of smart home devices [42, 43], such as Amazon Alexa, indicates a potential user demographic for this form of assistive technology that is not currently being harnessed. One of the primary challenges in embracing SARs stems from apprehensions that have emerged due to a lack of understanding of the underlying technology. This is particularly prevalent in older individuals, who are the target demographic for this type of technology [80]. Technology training can help to reduce this barrier; however, more lasting measures are needed to ensure widespread adoption [14]. Another challenge is that SARs are not designed with direct needs of users in mind [6]. A concerted effort is needed to align the potential capabilities of SARs with the actual needs and requirements of users.

Table 1. SARNY Traits

Trait	Description	Objective
Neediness	The robot simulates a dependence on the user through requests for user interaction.	Creates a reciprocal relationship between the user and the robot.
Character	The robot has a consistent, personable personality that makes its ‘needs’ legible and relatable.	Enables consistent and relatable companionship.
Expression	The robot uses simple cues to signal needs in response to user interaction.	Makes neediness legible to users.
Personalisation	The robot ‘need’ displays and requests are adapted to the user’s routines, preferences and boundaries.	Allows neediness to feel user-specific.
Understanding	The robot must be able to understand user intent and clearly communicate with the user.	Ensures that needy cues are socially appropriate.
Restraint	The robot self-limits to avoid requesting more attention or support than it is comfortable for the user to provide.	Prevents annoyance or emotional manipulation.
Honesty	The robot is transparent about being a machine with artificial ‘needs’.	Fosters trust and prevents deceptive dependence.

Given the significant impact of social influence, it is noteworthy that social stigma stands out as a major obstacle to the widespread acceptance of SARs. This can manifest in the form of unfavourable word-of-mouth, which, in turn, can hinder the adoption of new innovations including robots, even in instances where the negative word-of-mouth is regarding an unrelated robot [18, 80]. Notably, younger users and individuals experiencing feelings of sadness or loneliness are shown to be more susceptible to the influence of others’ opinions in this regard [16]. This is particularly problematic as lonely individuals are one of the key demographics that could see benefits from SARs.

2.4 Neediness

Neediness is traditionally defined as *marked by want of affection, attention or emotional support* [51]. Through previous work, we have evolved this definition in the context of this field as an SAR that has ‘a dependence on someone else which is shown through a request of attention and support’ [41]. Our research in the area has defined a framework for the creation of a ‘needy’ socially assistive robot [41]. This SARNY framework identifies key factors, or traits, that when successfully implemented together, current research indicates will lead to the production of an SAR with a higher overall acceptance rate. These traits of the SARNY framework that make up the positive implementation of a *needy* SAR are depicted in Table 1.

Due to the general connotation of neediness being a negative trait, the most prominent factor for acceptance was that all interactions with a ‘needy’ SAR should aim to be positive. This will also increase the likelihood of continued usage, as enjoyment has a direct impact on the intention to utilise SARs [35]. Despite a lack of research into the concept, many of the traits that make up neediness have been identified as factors that lead to a greater level of acceptance when it comes to SARs. SARs ought to possess a clearly defined personality to be accepted. Research indicates that personalities that lean towards being more informal and less robotic tend to be the most effective [36]. Nonetheless, the mere presence of a well-defined character significantly enhances the acceptance of an SAR [7, 33, 36]. Furthermore, maintaining consistently friendly communication between an individual and an SAR has been observed to lead to the development of social bond in turn, contributing to a greater overall sense of satisfaction for the user [65].

Errors with enduring consequences can lead to the erosion of trust in SARs [66]. Conversely, minor mistakes that the robot acknowledges and apologises for can bolster trust, as long as the robot

conveys this to the user. Expressing tiredness and changing performance to reflect this emulated state can increase acceptance, as these gestures endear the robot to its user and reinforce positive characteristics characterised by its sense of vulnerability [19, 31, 40].

Both visual and cognitive expressions play a crucial role in perceiving SARs as potential companions rather than mere tools. Responsive communication through expressions can help to make interactions with an SAR feel natural [60]. Demonstrating fundamental human-like traits can facilitate users in feeling a sense of understanding and connection with an SAR, even in instances where the expressions do not directly mirror those of a human [78].

Although our idea of neediness expands on the companionship element popularised by robots such as Paro, our primary design goal for a needy robot differs from existing robots due to the added element of active engagement. While existing companion robots are largely reactive to user interaction, responding to vocal cues and touch, we envision that a needy robot would actively solicit interaction with the user. In turn creating a sense of mutual reciprocity between the user and the SAR, creating a more engaging relationship and opening up the potential for the SAR to be seen as an independent social partner.

2.5 Pet Alternative

Pets and therapy animals have historically been employed to offer support and promote healthy ageing [76, 82]. Research has demonstrated that they offer a range of advantages to individuals who may be more susceptible, especially in the realm of mental health. Specifically, pets have proven effective in alleviating symptoms associated with depression, as well as mitigating feelings of isolation and loneliness [11]. Due to the feeble state of these individuals, it may not be possible for them to take care of an animal [27]. For these reasons, SARs have been suggested as a suitable alternative. They have shown to be capable of performing a similar role with regards to companionship, without the safeguarding concerns present when interacting with an animal [8, 64, 74]. SARs that interact with older people that cannot care for a real pet can be made more interesting, for example, by using mythical creatures such as the robotic pet dragon recently created by Aberystwyth University's Smart Home Lab [9]. We hypothesise that the further integration of the *needy* characteristics that pets exhibit into SARs will lead to a greater level of acceptance and overall usage.

2.6 Doll Therapy

Doll therapy is the practice of providing elderly individuals, commonly those with dementia or similar conditions, with lifelike dolls to facilitate emotional connection. Recipients act in a caregiving role for the doll, providing a sense of purpose and enhancing their self-esteem. Looking after a doll can encourage social interaction, which can be lacking in care environments where doll therapy is predominantly employed. The use of this therapy has shown to provide a range of benefits including providing comfort and stimulation to recipients [53].

Despite its perceived benefits, doll therapy has faced criticism related to ethical concerns. Many critics argue that this type of interaction between elderly individuals and dolls can be infantilising, demeaning and misleading [55]. These concerns also extend to the research that has been published, as critics have highlighted the lack of empirical studies [54]. These concerns need to be balanced against the potential benefits of this therapy.

Existing SARs have provided alternative implementations of doll therapy by acting as robot companions. The most notable of these SARs is the previously mentioned Paro. The dynamic engagement offered by SARs can elevate doll therapy beyond what a static doll can achieve. This heightened engagement reinforces the perception that the SAR is something to be cared for, and helps to form the social bonds that are crucial for effective doll therapy.

2.7 Support Worker Interactions with SARs

While numerous research papers concentrate on vulnerable individuals residing in care homes or assisted living facilities, there exists a notable gap in the inclusion and engagement of support workers who play a direct role in the lives of these individuals. The studies that have been done indicate that their needs and wants differ from the needs of the people to whom they provide support. This warrants further investigation to ensure that their needs are also met, as this will ensure long-term usage of the devices.

Support workers hold a positive view of SARs when these robots offer novel and engaging ways to interact with the individuals they are assisting in care homes. Nevertheless, existing SAR models have demonstrated limited effectiveness in alleviating the workload of care workers, primarily due to the substantial amount of support and setup they demand [20]. Although anthropomorphic traits integrated into SARs are beneficial in enhancing acceptance among the recipients of care [49], it was notably less significant for caregivers. Research indicates that zoomorphism had minimal influence on the level of trust bestowed by caregivers. Instead, the key determining factors were the caregiver’s intent to use the SAR and their satisfaction with using it to automate tasks [73].

2.8 Surveillance in Assistive Living

Assisted living facilities use a range of tools and techniques in order to surveil their inhabitants. Typically, these include cameras in key locations such as communal rooms and hallways or even more personal areas like private rooms. Higher tech solutions also exist such as motion detectors, GPS tracking, fall detection sensors and electronic health monitoring systems. These assistive technologies benefit assisted living by reducing the number of negative incidents, such as falls [2], resulting in better outcomes for residents and reducing overall costs. While intended to be unobtrusive for the most part these surveillance methods can lead to individuals feeling as though they are under constant watch, resulting in discomfort for some. Despite this, when given the choice of privacy or autonomy many choose less privacy if it meant that they could live independently [77]. The balance between safety and privacy for individuals poses a persistent ethical dilemma in assisted living. There is some debate regarding whether enough emphasis is provided to the residents perspective, as a large amount of literature focuses on the interests of the institutions, rather than the well-being of the individuals that live within them [56].

Additional ethical concerns are raised when it comes to individuals with dementia or similar memory impairments who may not be able to understand the implications of the surveillance methods that are being used. In these instances whether they are able to provide informed consent is questionable. Decisions are regularly made by legal guardians in these instances; however, it can be difficult to assess whether the individual’s preferences are taken into account. Berridge and Wetle [13] found that older adults were more concerned about the privacy implications of camera surveillance than their children. Many parents indicated that they would alter their behaviour in response to the decreased privacy. These differences in perception indicate that the registered legal guardians, in this case their children, may not act in a way that matches their preferences.

3 Methodology

3.1 Study Design

This research paper took a mixed-methodology approach to comprehensively investigate the attitudes and ideas of support workers regarding the adoption of existing SARs and the concept of future SARs with ‘needy’ traits. We choose this approach to obtain a holistic understanding of the topic through both qualitative and quantitative data. This study utilised a combination of focus groups, questionnaires and semi-structured interviews to obtain insights from support workers and

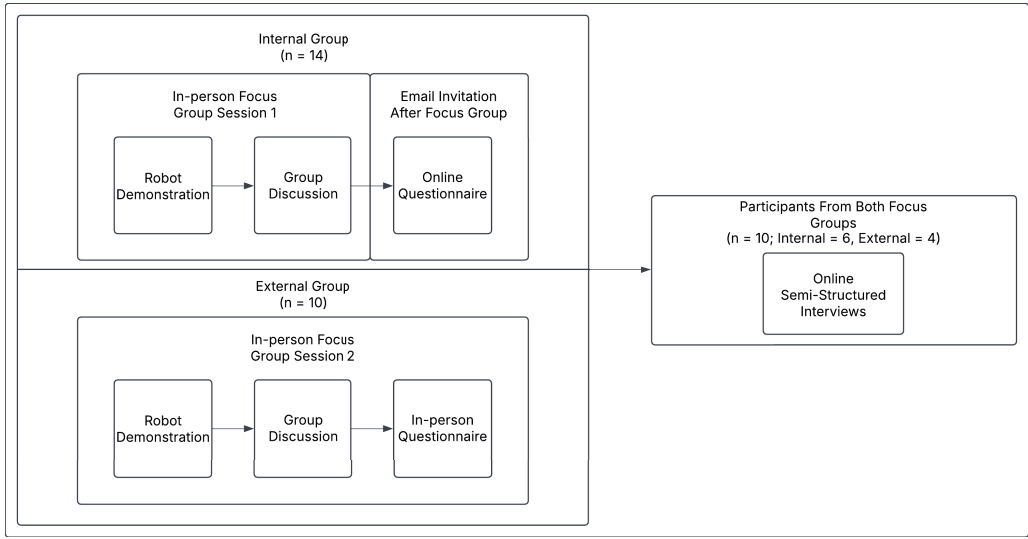


Fig. 1. Diagram of the study process.

other professionals in the field. Their insight will prove invaluable for identifying the requirements of vulnerable individuals. The design of the study is illustrated in Figure 1.

Focus groups were used to facilitate in-depth discussions and capture the perspectives of support workers in a group setting. By gathering support workers together, we aimed to encourage dynamic interactions and exchanges of ideas related to the adoption of SARs and the concept of a *needy* SAR. The focus groups are guided by a technology demonstration along with a limited number of predetermined open-ended questions, allowing participants to express their thoughts, concerns and experiences freely.

Structured questionnaires were distributed after the focus groups. The questionnaires are designed to assess support workers' attitudes and perceptions in a more standardised manner. Utilising a Likert scale and multiple-choice questions, we could quantify responses and identify common trends and patterns among the participants.

To gain further insights into individual perspectives and experiences, semi-structured interviews were conducted with several of the participants that volunteered to take part. These interviews allow for a more personalised and in-depth exploration of their thoughts on SAR adoption and the notion of a 'needy' SAR. The open-ended nature of semi-structured interviews permitted the exploration of unique viewpoints, potentially revealing valuable nuances that might not emerge in larger group settings, or through a stricter set of questions.

3.2 Robot Overview

For this study, we used the Mylo SAR, as shown in Figure 2. Mylo is a companion robot designed to support people living with dementia. Built on top of the existing Sanbot Nano design, it can be extensively customised to suit the users' needs and requirements. It is 2 feet and 8 inches tall and has a humanoid design with zoomorphic features that aim to emulate the appearance and appeal of a household cat.

Mylo is an autonomous robot which is capable of being left alone with residents, without the consistent presence of a carer. Users can interact with Mylo using a limited set of voice commands, a touch screen and various touch sensors located around the robot. Through these, the robot can



Fig. 2. The Mylo robot.

be told to move around the property and answer basic questions, as well as provide audio-visual feedback when stroked as though it is a cat. Cameras and sensors provide it with a method to navigate naturally while ensuring that it does not collide with objects or people. It is also able to provide reminders through audio. Calendar reminders can be set through the app which Mylo will then announce at the appropriate times. This is intended to allow users to set reminders for medications and important events. Individuals can take direct control of the robot remotely through a mobile application, allowing them to see through the cameras, navigate and communicate with the robot's user. Through the robot's screen the individual taking control over the robot can project their face to communicate directly with others. This feature is intended to enable support workers, friends, and family members to communicate with the user from a distance. A complete overview of the features that Mylo demonstrated during this study is provided in Section 3.4.

The Mylo robot used for this study had not been programmed with any particular needy traits. Instead of demonstrating a fixed implementation, we introduced the concept of needy traits and their potential integration into future SARs verbally during the focus groups. Many of the robots existing functionalities were explained in relation to their potential to integrate with needy elements in the future. Examples of functionalities that were discussed as part of the focus group were the idea of the robot prompting for attention at set periods with basic questions, such as what the weather is. While not a strenuous task for the user, this is intended to encourage them to check the weather before engaging with the robot.

This approach allowed us to test the concept of neediness in SARs, without focusing on a single limited implementation. By avoiding a single fully realised technical implementation, we could ensure that participants felt free to suggest their own interpretations and ideas, unconstrained by an existing design.

3.3 Participants

A total of 24 participants were recruited as part of this study (see Table 2). Participants were recruited from **Gloucester City Homes (GCH)**, a UK housing association based in Gloucester and the UK's **National Health Service (NHS)**. Potential participants were selected because they provide support or frequently directly interact with individuals living in assisted living facilities. The study participants were separated into two distinct groups. These groups met on two different days where they were split into two smaller cohorts of equal sizes for scheduling purposes. The first

Table 2. Study Participants (n = 24)

Participant Number	Role	Interviewee Number
Internal Group (n = 14)		
1	Community Investment Lead	N/A
2	Specialist Housing Manager	N/A
3	Specialist Housing Manager	1
4	Specialist Housing Manager	N/A
5	IL Support Coach	N/A
6	Head of Housing and Communities	N/A
7	Homes and Neighbourhood Manager	N/A
8	Homes and Neighbourhood Lead	2
9	Income and Sustainment Manager	N/A
10	Tenancy Sustainment Manager	3
11	Customer Experience Manager	N/A
12	Customer Relationship Adviser	4
13	Compliance Officer	5
14	Compliance Manager	6
External Group (n = 10)		
15	NHS Deputy Director—Strategy and partnerships	7
16	Health and Social Care Commissioning Manager	8
17	Wellbeing and Community Capacity Performance Manager	N/A
18	Community Circles Project Officer	N/A
19	Head of Sector Innovation	N/A
20	Memory Assessment Nurse	N/A
21	Community Dementia Nurse	9
22	Dementia Adviser	10
23	Clinical Commissioning Manager	N/A
24	Community Mental Health Nurse	N/A

group was entirely made up of employees from the housing association. While the second group involved a mixture of GCH, NHS and other health professionals that regularly contribute to assisted living. Participants were offered a gift card with a value of £20 for participation in this study.

The internal group were predominantly individuals working directly for the housing association and within the community support sector. These individuals have experience engaging with the tenants in assisted living on a regular basis and are involved in the management and well-being of these individuals. Many of these staff members work on site in the assisted living facilities and would be involved in their daily operations. These include the ‘Specialist Housing Managers’, ‘Homes and Neighbourhood Managers’, ‘Income and Sustainment Manager’ and ‘Tenancy Sustainment Manager’, who are in charge of the day to day operations and resident support within the housing sites. While the ‘IL Support Coach’ works with individual residents directly, providing independent support to meet their needs. Other participants in this group primarily take on an administrative role, but would have regular communication with direct support workers and residents.

The external group was primarily made up of members from the health and social care sector. These individuals work across healthcare delivery, dementia support, mental health and innovation. They can provide insight into direct clinical care and health care strategies. While their roles extend beyond the context of assisted living, they all engage with or impact individuals in assisted living settings, either directly or indirectly. Of this group the ‘Memory Assessment Nurse’, ‘Community Dementia Nurse’, ‘Dementia Adviser’ and ‘Community Mental Health Nurse’ regularly interact directly with patients, including residents living in assisted housing. The remaining participants

within this group are focused on a higher level implementation of health and innovation schemes within the local community to improve the well-being of residents. These particular participants were selected because they frequently work closely with the staff and residents at GCH.

3.4 Focus Groups

All participants were involved in in-person focus groups, which were organised into two distinct groups held across two separate days. These were held in groups with the intention of creating dialogue between the various participants that were present. Due to scheduling challenges, there was a short delay between the two focus groups. This meant that the fall detection feature of the robot was only able to be implemented in time to be shown for the external group participants.

The focus group was made up of an initial group discussion of SARs and how they might fit into the assisted living environment. During the initial discussion, participants were engaged with investigative questions to gauge their knowledge and expectations of a robot companion.

This was followed by a live demonstration of the robot and the current capabilities that it possesses, which were shown to the participants in turn. Throughout the demonstration, participants were encouraged to interact with the robot and inquire about the potential of these functionalities. The features demonstrated were as follows:

- *Conversational Capabilities.* Participants were invited to speak with Mylo using a limited number of key phrases. Depending on the phrase Mylo would either respond through audio or by performing a basic action, such as moving or turning.
- *Touch.* Participants were invited to physically touch and stroke Mylo. Mylo would respond to this through soft sounds and facial expressions as though it was a cat.
- *Navigation.* Participants were shown the navigation abilities of Mylo. Mylo moved around the room. Importantly, this also included a demonstration of the robot’s object detection and avoidance.
- *Charging.* Participants were shown that Mylo can detect and navigate back to the docking station to charge through a magnetic system, removing the need for the user to manually connect it to a charger.
- *Reminders.* Mylo was set up to prompt regular reminders to stay hydrated and take medication. These were scheduled to provide reminders during each of the focus groups to ensure that all members saw this feature.
- *Calendar Notifications.* Participants were shown the ability to set and receive calendar notifications. Participants were invited to set an event notification through the calendar function on the mobile app which Mylo would then announce at the specified time.
- *Remote Operation.* Participants were shown the ability to take control of Mylo remotely through the mobile app. They were given the opportunity to use this functionality to navigate Mylo around the room.
- *Telepresence.* Participants were able to take control of the camera, screen and speakers on Mylo. Allowing them to have a remote call through the robot. Members of the focus groups were invited to communicate with other participants in their group through this.
- *Fall Detection.* Demonstrated by a researcher lying on the ground to simulate a fallen person, prompting the robot to respond by asking whether a call to an emergency contact is needed. This was only displayed for the external group as it was not fully implemented in time for the internal group.

Following the demonstration participants were provided with another opportunity to discuss the robot. During this time, they were able to independently examine the robot and test any features that they were particularly interested in. As part of this conversation the researchers verbally

introduced the potential of these features to be expanded to encompass our concept of neediness. The core feature we proposed was to expand the reminders beyond the current prompts to also include regular attempts to engage in social engagement, to elicit a sense of neediness from the robot. We explained that the conversational abilities could be expanded from the currently limited exchanges, to more open-ended and proactive dialogue that aims to keep the user engaged. Touch was proposed as a reciprocal interaction, wherein the robot could act like a real pet seeking comfort.

The primary objective of this session was to gather valuable feedback regarding the needs and expectations of care givers, with a particular focus on whether their views aligned with our proposed needy features. Through the verbal explanation we aimed to explore whether they had any specific ideas regarding neediness implementation and potential use cases. Additionally, the demonstration aimed to provide an overview of how a socially assistive robot could enhance their caregiving roles.

3.5 Questionnaires

A questionnaire was provided to gauge the acceptance and opinions of the care and housing professionals about the SAR that was demonstrated. The internal groups received e-mail-based questionnaires after the focus group and demonstrations were conducted. However, this approach had the drawback in that not all participants from these groups responded to all questions on the online questionnaire. To rectify this, the external groups were provided with paper-based questionnaires in person, to be completed immediately after the demonstration. This also had the advantage of the demonstration being fresh in their memories when answering. All 24 participants responded to the questionnaire. The 14 participants from the internal group responded to the e-mail questionnaire, while the 10 external group participants completed the in-person questionnaire.

The questionnaire was designed based on the constructs reported in the ALMERE model [34], a modified version of the **Unified Theory of Acceptance and Use of Technology (UTAUT)** tailored specifically for assessing the acceptance of SARs. The ALMERE model includes several other parameters that impact technology acceptance that are specific to assistive social robots. Alongside the constructs identified in the UTAUT, they also found that Perceived Enjoyment, Perceived Sociability and Social Presence were important factors for social robot adoption, while Perceived Adaptability was important specifically for elderly users. The defining constructs of the ALMERE model are detailed in Table 3.

We incorporated relevant example questions from the suggested ALMERE model toolkit, along with additional questions we devised based on the existing ALMERE criteria. Any irrelevant questions from the original template were either omitted or reworded to fit the context of this study appropriately. To capture participants' responses effectively, we employed a Likert-type scale where participants were asked to indicate the extent to which they agreed or disagreed with the provided statements using a 5-point scale.

3.6 Interviews

Following the focus group sessions, participants were invited to engage in semi-structured interviews as part of the research study. A total of 10 participants willingly opted to participate in these interviews, with 6 individuals from the internal group, and 4 individuals from the external group. Conducted remotely via Microsoft Teams, each interview session lasted between 20 and 40 minutes, providing ample time for in-depth exploration of participants' perspectives. Each interview was recorded and transcribed with the explicit written and verbal consent of the participants, adhering to ethical considerations regarding data collection and participant confidentiality. The interviews followed an open-ended approach, wherein participants were encouraged to elaborate on their answers, allowing for comprehensive insights into their thoughts and opinions. As the interviews

Table 3. Almere Model Constructs

Code	Construct
ANX	Anxiety
ATT	Attitude
FC	Facilitating Conditions
ITU	Intention To Use
PAD	Perceived Adaptability
PENJ	Perceived Enjoyment
PEOU	Perceived Ease Of Use
PS	Perceived Sociability
PU	Perceived Usefulness
SI	Social Influence
SP	Social Presence
Trust	Trust
Use	Use/Usage

occurred sometime after the initial demonstrations, the interviewer provided reminders of the Mylo robot’s core features and aesthetic that were previously presented.

Participants were eased into the interview process with initial questions centred around their personal technology usage and how it had evolved before and after the COVID-19 pandemic, this also provided an opportunity to gain an understanding of their technology literacy. They were then asked questions that aligned with the main goals of this study which was to obtain their opinion of the SAR that was demonstrated and how it could be further improved to meet their specific needs. Rather than ask a set list of questions, several themes were produced from which questions could be provided. This allowed for a more flexible approach to the interviews, allowing the interviewer and interviewees to elaborate on specific topics. Questions were asked with the following themes:

- The technology literacy of the interviewee
- Whether the robot can assist with their role
- The design of the robot
- Features, both existing and suggestions
- Perspective on identified needy characteristics
- Acceptance of individuals within assisted living facilities
- Concerns about SARs

To take a neutral stance and to reduce potential bias in our approach, the concept of ‘neediness’ was not reintroduced to the participants until midway through the interviews. By allowing participants to express their opinions on various features without direct reference to ‘neediness’, we ensured a more natural and unguided exploration of their perspectives. It is worth noting that, on several occasions, interviewees spontaneously mentioned some of the concepts that we define as ‘needy’ features without any prompting.

An open coding approach [67] was employed to meticulously analyse the statements made during the interviews. Open coding allowed for the identification of initial categories, or codes, which served as the building blocks for organising and understanding the data. Through this process, each statement was thoroughly examined and assigned a relevant code that captured its essence. Following the open coding phase, the next step involved the use of axial coding to further refine and group the initial categories based on similar traits or patterns. This systematic process allowed for

the identification of prominent themes that emerged from the data. By connecting the categories in a more structured manner, axial coding facilitated a deeper understanding of the relationships and connections between different codes, leading to the emergence of overarching themes.

4 Findings

4.1 Focus Groups

We conducted focus groups which provided support workers and other healthcare professionals with an opportunity to experience the SAR first-hand. This approach enabled participants to share their perspectives collectively, fostering discussions that would be hard to replicate through questionnaires and individual interviews. Mylo was introduced and presented as a child-like entity in the process of learning and development. While it possessed existing functionalities, the focus groups emphasised the adaptability and expansiveness of these features based on individual needs.

Several potential features were suggested for integration into the SAR. Among these, the incorporation of an integrated music player garnered significant interest. This feature was envisioned as a means to play songs from the user's past, invoking feelings of comfort and nostalgia. This would involve asking participants to recall their favourite songs so that they can be played. An emphasis was placed on playing music in the user's native language, considering instances where individuals with dementia might revert to their first language.

Participants were enthusiastic about engaging with Mylo, with several actively getting up to interact with the SAR during the demonstration. The touch sensors around the device, which prompted emotive responses mimicking those of a cat when stroked, garnered particularly enthusiastic responses. This initial positivity reinforces the significance of SARs exhibiting immediate responsiveness to user engagement, aligning with previous research on the topic [15].

Another well-received feature was the ability to take direct control over Mylo through an Android or iOS mobile application. Users can remotely control the robot's movements and actions, which was seen as useful for a variety of different use cases. The potential for two-way communication with loved ones was seen as a potential means to reduce loneliness, while the capacity to access the cameras remotely appealed to support workers seeking to monitor vulnerable individuals from a distance. Past work has shown that telepresence in this way has the potential to improve quality of life and promote social inclusion for the elderly [30]. Despite the perceived benefits of this feature, there were concerns regarding the amount of privacy that is sacrificed to enable this.

Despite the overall appeal of Mylo's design to most focus group participants, a consistent critique related to its voice emerged. Unlike the zoomorphic design that portrays Mylo as a pet, the voice employed was perceived as inconsistent due to the expressionless, older feminine voice that stood apart from the cat-like aesthetics. Participants expected a softer voice that more accurately portrayed the character that the aesthetic portrayed. This critique emerged independently in the different focus groups, indicating that this was not simply a case of individuals influencing each other within the groups.

An NHS staff member raised concerns regarding prior investments in costly technologies that ultimately went unused. This was centred around existing SARs like Paro, which exhibited promise in trials but have since fallen into disuse. Comparisons were also made with existing solutions, such as the sensors already installed within assisted living facilities, which may have a lower overall cost.

In summation, the focus group findings provided valuable insights into participants' interactions with Mylo and their impressions of its features. The participants' enthusiasm for tactile interactions, suggestions for enhancing functionality and critiques on design elements contribute to a holistic

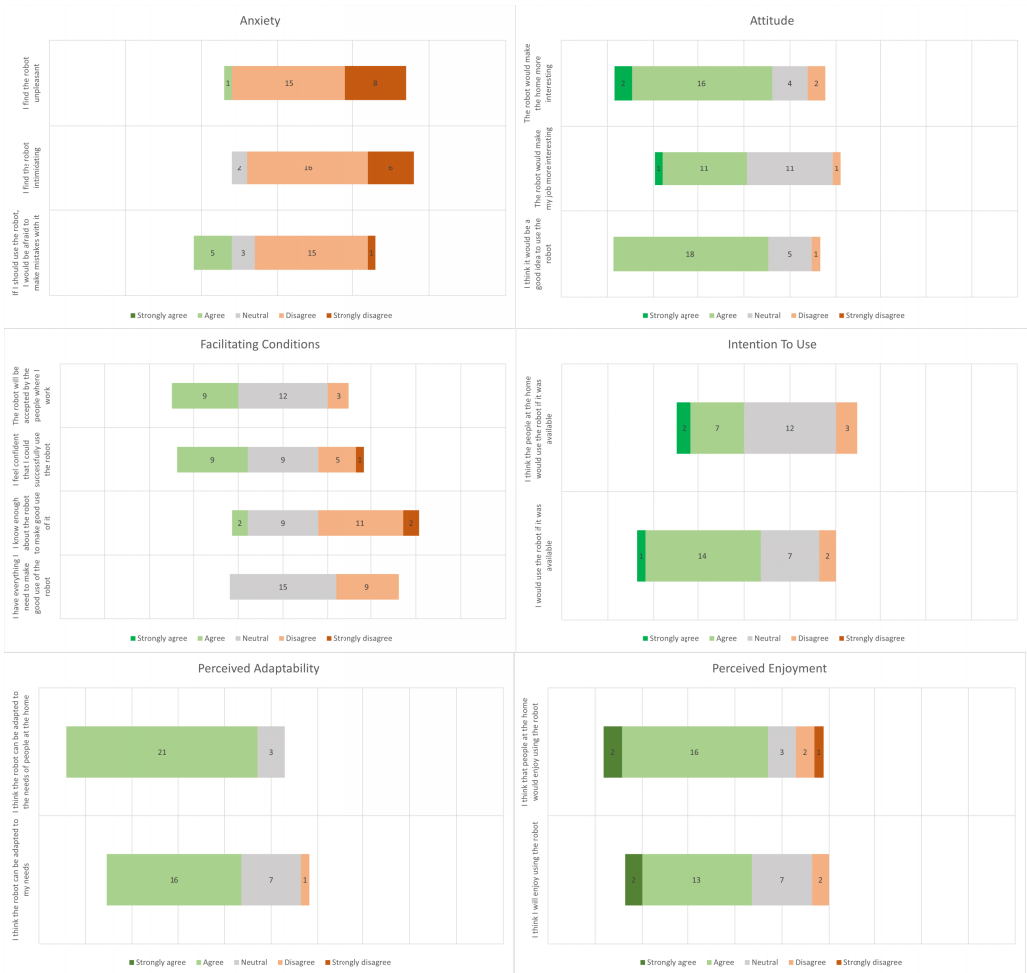


Fig. 3. Questionnaire results for anxiety, attitude, facilitating conditions, intention to use, perceived adaptability and perceived enjoyment questions.

understanding of the potential impact of both *needy* SARs, such as Mylo, and other more general SARs in caregiving scenarios.

4.2 Questionnaires

4.2.1 Overview. Details of the questionnaire results have been collected based on the ALMERE model constructs, as shown in Table 3. The results of the questionnaire and their corresponding constructs are presented in Figures 3 and 4 and Appendix A. Overall, the questionnaires indicate that participants were very positive about the concept of SARs and their potential usage in assisted living. Participants showed the most apprehension regarding the facilitating conditions, ease of use, perceived usefulness, social influence and intention to use the SAR. Despite this, most participants were neutral on these topics, rather than outright negative. These constructs indicate that users may be more inclined to use the robot with more information on the SAR, how to effectively use it and its potential assistance capabilities.



Fig. 4. Questionnaire results for perceived ease of use, perceived sociability, perceived usefulness, social influence, social presence and trust questions.

The questionnaire data were analysed by assigning numerical values to responses on the Likert scale, with ‘Strongly Agree’ scored as 5, ‘Agree’ as 4, ‘Neutral’ as 3, ‘Disagree’ as 2, and ‘Strongly Disagree’ as 1. The mean scores for each item and construct were then calculated to determine the general sentiment expressed by the participants. A detailed breakdown of these results is provided in the Appendix A.

Table 4 shows the average scores for each of the constructs that were included as part of the questionnaires. While these results indicate a generally positive response to the robot and the concept of SARs as a whole, it is notable that none of the averages are at the very upper or lower ends of the scale. This indicates that there was no overwhelming feeling from the groups either positively or negatively towards the concept. The workers demonstrated low anxiety, high trust and perceived the sociability and enjoyment to be particularly high. Technical confidence and intention to actually implement an SAR were slightly less robust, indicating the need for further explanation and technical training.

Table 4. Average Scores of Almere Model Constructs Based on Questionnaire Responses

Construct	Weighted Average Score	Responding Participants
Anxiety	2.03	24
Attitude	3.65	24
Facilitating Conditions	2.85	24
Intention To Use	3.46	24
Perceived Adaptability	3.75	24
Perceived Ease Of Use	3.45	23
Perceived Enjoyment	3.65	24
Perceived Sociability	3.72	23
Perceived Usefulness	3.38	23
Social Influence	3.46	24
Social Presence	2.88	24
Trust	3.76	24

4.2.2 Acceptance Drivers. Most participants agreed that using the robot would be a good idea (75%; $n=18$) and that it would make the care home more interesting (75%; $n=18$), as shown in Table A2. Perhaps unexpectedly, only half of the participants felt that it would make their own job more interesting, instead indicating that they felt that there would be a greater benefit to residents than to staff. The participants were highly comfortable with the robot's presence as indicated by the low levels of perceived intimidation (0%; $n=0$) and unpleasantness (8.7%; $n=2$), shown in the anxiety in Table A1. These factors indicate that the participants can see a potential benefit to introducing SARs to assisted living residents, even if this will not directly benefit their own enjoyment. Notably none of the participants felt intimidated by the robot, and very few found the robot unpleasant, indicating that technophobia from assisted living staff would not pose an initial barrier in this context.

Trust was the highest-scoring construct of the questionnaire (Table A12). Likely influenced by the demonstration and explanation of these features provided during the focus groups, participants were particularly confident in the ability for robots to provide notifications (91.67%; $n=22$), detect falls (79.17%; $n=19$) and work consistently (70.83%; $n=17$). While the fall detection feature was only directly demonstrated to participants from the external group, it was explained verbally to participants in the internal group. As shown in Table A13, 90% ($n=9$) of participants in the external group and 71.43% ($n=10$) in the internal group agreed or strongly agreed that they would trust this feature. None of the participants in either of the groups suggested that they would not trust the robot to detect falls. Most participants also believed that robots would not impede their work (70.83%; $n=17$) or the lives of residents (75%; $n=18$). The relatively high trust scores may indicate participant openness to robots with a greater degree of autonomous behaviours in assisted living contexts.

Table A11 indicates that participants did not think of the robot as a 'living creature' (16.67%; $n=4$); however, most were positive (45.83%; $n=11$) or neutral (45.83%; $n=11$) about the idea of having a robot present in assisted living. They generally found the robot pleasant to interact with (78.26%; $n=18$) and believed that residents would feel the same (78.26%; $n=18$), as shown in Table A8. These findings indicate that the perceived sociability of SARs was already fairly positive, thus indicating the potential for the robot to keep users engaged in a social setting. This is important for perceiving the robot as a social being worthy of interaction and care.

4.2.3 Acceptance Barriers. Although general sentiment towards the robot was positive, the perceived usefulness of the robot was more moderate (Table A9). Staff rated the robot as more helpful to residents (60.87%; $n=14$) than to themselves (39.13%; $n=9$), suggesting that they see this as a tool to improve the experience of residents, rather than directly impacting their own workload. This may be influenced by the ratings for Facilitating Conditions, which indicated that participants were unsure whether they had sufficient knowledge, tools or resources to use the robot confidently. While 37.5% ($n=9$) of the participants believed that they could successfully use the robot, only 8.33% ($n=2$) felt that they knew enough to make good use of it, and none of the participants felt that they had everything that they need to make good use of it (Table A3). Highlighting a critical need to ensure that staff are provided with robust on-boarding, guidance and training to ensure that they are able to facilitate the use of the robot. This is particularly important for the non-technical staff who may need extra assistance.

4.3 Interviews

Ten participants from the focus groups chose to be included in the interviews, six members from the internal group and four members from the external group. This mixture of interviewees represent frontline and managerial perspectives from both the housing and health care sectors. These participants will be able to provide a holistic view into how SARs may fit into real-world care and support settings, which is vital for their implementation in assisted living.

Axial coding [67] was used in order to discover codes that were present in our interviews. From these codes, we have been able identify key themes. These themes are:

Barriers to Acceptance. Encompasses factors which may hinder the acceptance of the SAR among assisted living staff and residents. Successful integration of SARs in assisted living will require these barriers to be overcome. The codes identified as part of this theme highlight some of the key challenges that must be addressed.

Relationship. Relates to the relationships that may develop between the user and the robot. The codes identified highlight different aspects of these potential relationships, and how the user may choose to engage with and use the robot. Careful consideration must be given to ensure that the relationship remains supportive, rather than burdensome.

Support. Explores the ways that SARs may provide practical and functional support within the assisted living environment. The codes identified include various features and methods for the SAR to integrate within the current support practices. These may include supplementing, or replacing, existing technologies.

Characterisation. How the perception of the robot is shaped by both its physical design and behavioural traits. These consider factors beyond pure functionality that influence both usability and acceptance.

Details on the codes that make up these themes can be found in Tables 5–8. As with the results from the questionnaire, study participants noted many positive aspects of SARs in their current implementation. However, unlike the questionnaires, participants also identified several disadvantages and potential barriers to their usage. The most notable barriers to acceptance were potential concerns surrounding privacy, technology literacy and negative preconceptions of SARs. The design of the robot, especially its zoomorphic features, appealed to participants. They also appreciated the SAR's potential to serve as a companion for those living independently, as well as the robot's ability to assist individuals in taking care of their own needs through reminders and by acting as a motivator. In terms of functionality, many participants were favourable of the ability to monitor individuals and detect falls remotely.

Table 5. Identified Interview Themes Relating to ‘Barriers to Acceptance’

Theme	Participants	Description	Quote
Confusion	2 (20%)	Elements that could cause confusion among users	‘So I’m kind of thinking more that if let’s say that person with dementia happens to go into another room, Mylo starts wandering around, the person comes back, you know, they and they could actually get quite distressed not knowing where Mylo is’.
Demanding	2 (20%)	The demands of the robot inconveniencing the individual if they are too frequent.	‘On the other hand, there are sort of limitations cause you can only be so needy can’t you before somebody turns around and goes, I ain’t listening to that thing, and turn it off’.
Privacy	6 (50%)	Private information accessed by others.	‘There’s always people who are a bit suspicious about things, aren’t they, like, thinking that the government’s watching them through it or, you know, that sort of thing’.
Technology Literacy	5 (50%)	Older individuals may not understand the technology and its implications.	‘And I think as well and again I’m sure this is a consideration, but let’s say the older generation are using this, do they understand, do you know what I mean? Because there’s a lot of technology in that’.
Safety	1 (10%)	Potential risks to the individual’s well-being.	‘On either side of the periphery of the peripheral vision, they wouldn’t be able to see Mylo as well as we would, and that could cause, you know, a bit of a bit of concern’.
Negative Pre-conception	4 (40%)	Individuals with negative preconceptions of SARs	‘I think it would depend, it may not be for it won’t be for everyone, but I think there might be a cohort who would benefit from this’.

Table 6. Identified Interview Themes Relating to ‘Relationship’

Theme	Participants	Description	Quote
Caring	6 (60%)	Caring for the robot	‘For a person who’s on their own, and then there’s a there’s a drive to have to care for it. And so you know that there’s almost putting a purpose for that person’.
Codependency	4 (40%)	Reciprocal relationships between the robot and individuals	‘Reciprocal arrangements sort of. Things seem to work better than offering someone something that was gonna. Yeah, look after them or something like that, which I understood’.
Companionship	5 (50%)	The robot acting as a companion	‘I mean but, but yeah, and and from a companionship point of view, particularly for people who are on their own or who are more isolated, I can. I can, cause that’s reciprocal for me. So that’s that whole bit around you know, what am I getting out of it and if I acknowledge it well, I’ve got someone to talk to even if it is a cat faced robot. I’ve got someone I can interact, or something I can interact with and that I can also then call my son on the phone and say “You know. No one put the bins out today, can you come and do it” sort of thing’.

Table 7. Identified Interview Themes Relating to ‘Support’

Theme	Participants	Description	Quote
Automating Tasks	3 (30%)	The potential for the SAR to provide assistance by automating common household tasks.	‘You know a range of disabilities is not just older people. It could be someone who just lives independently and then Mylo just helps with some of the some of the low level tasks’.
Fall Detection	8 (80%)	Detecting when an individual has fallen and reporting that information to a relevant party.	‘Fall detection is, you know, falls is, falls are a massive driver for people being admitted into hospitals, which is a lot of our business’.
Management	1 (10%)	Helping individuals to manage themselves.	‘So people that don’t necessarily use online banking or anything to keep on track keep on top of that. It could help them, you know, just prioritise their spending or maybe just warn them when they’ve got larger payments coming out and things to’.
Monitoring	6 (60%)	The ability for the SAR to monitor the individual living in an assisted living facility.	‘Then it kind of helps them and reassures them that actually they know that Mylo will detect falls, prompt the medication, you know, do all those things which they would do’.
Reminders	5 (50%)	Reminders of regular tasks	‘And yeah, I thought this would be a really good tool to remind our elderly, who can quite often forget. Ohh did I do that today or did I do I need to do that in two weeks and you know that sort of thing’.
Replacing Existing Solution	2 (20%)	Assisted living facilities already utilise a number of technologies. An effective SAR could replace some of these.	‘So with the medication prompts, you’ve got medication clocks, you’ve got telecare for the full detection, but it kind of needs that person to press the button to tell someone that they have fallen. And I think what’s so great about Mylo is that of course a lot, some people, and I know this, they don’t want to press that button if they feel they can get themselves up or something like that’.
Self-care	5 (50%)	Encouraging and assisting the user to take care of themselves	‘I thought, something to help someone want to get up in the morning’.

Table 8. Identified Interview Themes Relating to ‘Characterisation’

Theme	Participants	Description	Quote
Design	10 (100%)	Comments on the design of the robot	‘I thought it was quite sweet, I think. Yeah, I think it’s the right size. I think if it was any sort of bigger, it might sort of put people off. I think I think it’s looking, it looks quite cute and it’s sort of, yeah, I think it’s probably better smaller to be honest’.
Zoomorphism	7 (70%)	Zoomorphic aspects of the robot	‘We’ve had, you know, I think some quite good successes with older people who were lonely and used to have pets and couldn’t have pets now and or couldn’t look after them. But actually, like the reassurance of having a cat around and you, you stroke it and it purrs and it, you know, I I think they’re obviously that’s pretty low level tech, but it it has a purpose’.

4.3.1 Barriers to Acceptance. This theme captures the concerns that participants had regarding the adoption and integration of SARs within assisted living environments. Identified barriers included privacy, technology literacy, confusion, negative preconceptions, perceived intrusiveness and safety concerns. One of the most frequently mentioned concerns was privacy, which was mentioned by six participants. These concerns were centred around the extra surveillance that a robot would introduce and the potential for data misuse.

‘The fact that it is watching, where’s that recorded, is it in the, you know, a secure environment?’—Interviewee 3

Many individuals may not be comfortable with the amount of monitoring that an SAR would allow, particularly as this would provide a remote-controlled camera that can move between different areas of living spaces. However, as already established, assisted living facilities regularly have these capabilities through property sensors, and many individuals choose to enable these features on their phones and smart devices. Therefore, the extra risks to privacy over conventional methods are not significant. Despite this, it is crucial to consider the impact that having a visible tracking device will have on perceived privacy.

‘We’ve all got GPS tracking because we have our phones on. But you know, like they’ve been, there’s been kit for people who’ve got dementia and go wandering. And I remember the ethical debate about is that fair to put, you know, to kind of track their movements? But if it keeps someone safe, then some people are OK with it and other people aren’t.’—Interviewee 6

They also questioned whether the technology literacy of the residents, and even the staff members, would be high enough to engage with an SAR meaningfully. Interviewees believed that the tech literacy of elderly individuals could result in situations where they do not understand the technology that is being presented to them. In these cases, they believe that it may be considered unethical to utilise some of the more privacy intrusive technologies present, such as the remote monitoring through cameras.

‘And I think as well, and again I’m sure this is a consideration, but let’s say the older generation are using this, do they understand, do you know what I mean? Because there’s a lot of technology in that. You say there’s a lot of cameras and you know. I know that they if someone had a Mylo, they would know they would be able to, you know, they they wouldn’t just take one and not know that it’s recording and you know all of that’—Interviewee 4

Ultimately, however, in many cases, these cameras are already present as requirements for living in assisted living facilities. Despite this, individuals must always be aware of the technology being used and how this could affect them.

There was the concern that the level of technology literacy may make it difficult for users to effectively interact with an SAR. Many individuals living in supported living facilities can find it difficult to utilise technology, with devices needing to be specifically designed for these users.

‘And mainly because they find it so difficult to operate and that is even sort of down to like mobile phones. So they’ve got to be really specific with the mobile phones’.—Interviewee 7

Over time, one interviewee believed that issues relating to technology literacy would become less apparent, as newer generations are exposed to technology from a younger age, therefore developing a better understanding of its capabilities and risks:

‘Anyway, so perhaps yeah, the younger generation would interact with it a lot more because they’re used to that’.—Interviewee 1

Another concern was the potential for confusion, particularly with older individuals who are more likely to suffer from various debilitating health issues, such as dementia. This can in turn change aspects that many view positively, such as the zoomorphic and caring features, into obstacles to adoption. An example of this is the idea that the user could begin to see the robot as a living being and therefore become distressed if they lose track of it:

‘Somebody with dementia likes to have something that they feel that they can care for, so whether that be like a pet or a baby or something like that, then Mylo would be that alternative. So I’m kind of thinking more that if let’s say that person with dementia happens to go into another room, Mylo starts wandering around, the person comes back, you know, they and they could actually get quite distressed not knowing where Mylo is’.—Interviewee 7

Some participants highlighted that a robot that constantly prompts the user may end up deterring usage due to the demanding nature becoming an annoyance. The worry is that, if not balanced appropriately, the desire for engagement and attention from the robot could transition from being beneficial to potentially burdensome for users:

‘I suppose it depends because if it became an inconvenience to make sure you tended to its needs, then that would be annoying because you think, Oh my God, it is actually a robot’.—Interviewee 1

4.3.2 Relationship. Interview participants frequently brought up the nature of relationships that might develop between users and the SAR, especially in terms of companionship, caring and codependency. Five of the interviewees discussed how the robot could act as a companion, particularly for users that were experiencing loneliness. A common topic that emerged from this theme was the idea that the robot could foster a sense of purpose for isolated individuals by offering opportunities for reciprocal engagement between the user and SAR.

‘For a person who’s on their own, and then there’s a drive to have to care for it. And so you know that there’s almost putting a purpose for that person. You know if you’re on your own and you get up and you, you know, you’ve got your routine and there’s nothing more in your day other than getting up and maybe going to the shop and coming home, making myself some food, putting Mylo in your day brings a different purpose to what you need to be doing during the day. You know when and it encourages more activity and encourages interaction, and it may even encourage a person to go and expand and not be so lonely, you know, expand with other people and stuff’.—Interviewee 9

This form of mutual support can foster a sense of companionship between the user and the SAR, akin to the companionship one might experience with a pet at home. This, in turn, can alleviate feelings of loneliness and related sentiments. While also providing practical benefits such as timely medication reminders.

‘Then other people can sort of say, yeah, you know, I feel less lonely. It tells me when to take my meds’.—Interviewee 6

While they acknowledged the potential risks associated with codependency, many of those interviewed viewed it as a mutually positive interaction that would promote engagement and lead to the successful uptake of SARs.

A concern was the potential limitations in the SAR’s conversational abilities. At present, SARs are limited in the number of topics they can discuss as well as both the vocabulary they use and can respond to. Over time it was felt that this will result in repetitive interactions which may lead to disengagement from the user.

‘Maybe expanding the vocabulary a bit. You know, expanding to have a bit, maybe a bit more meaningful conversations if you have got somebody who’s lonely talking to a robot that has limited conversation in sort of firm vocabulary, it might just become a bit monotonous and they may actually go, “You know what? I don’t wanna use it anymore, cause he’s not bringing me that companionship I may want.” Obviously you can’t, you’re not gonna beat human interaction. I get that. But expanding it, that bit more, you know’.—Interviewee 6

Concerns regarding this ability to converse extends to the languages that it is able to communicate in. Assisted living needs to accommodate a diverse range of residents who will have different preferences and requirements. One of these requirements is the ability to converse in a language that they are comfortable in, either due to preference or out of necessity. Addressing this requirement involves providing built-in support for multiple languages, ensuring inclusivity and adaptability to a wide range of users.

‘Language absolutely. Different languages. I mean you have somebody from a different country and I don’t know, Poland and Mylo can’t speak Polish. You know that. That’s it. Having a Polish person having a conversation in English is not always gonna be that great, you know? So in with it that expansion, it’s expansion, not just of vocabulary, but of the different languages and stuff that you can you can have in things. So yeah, I think that would be, that would be a great addition and change’.—Interviewee 9

4.3.3 Support. This theme encompasses the ways in which SARs might provide practical support within assisted living. Identified forms of support included fall detection, reminders for medication or tasks, monitoring resident well-being, encouraging self-care, automating tasks and replacing existing technologies such as pendant alarms. In order to facilitate independence in the assisted living community, support workers need a method to monitor vulnerable individuals remotely. At present, their residencies are outfitted with cameras and other sensors. Interviewees suggested that a sufficiently capable SAR would be able to act as a less invasive method of providing this remote monitoring as it is not as explicit as a camera. A potential drawback of the SAR’s unobtrusive nature is that it may lead to individual overlooking the continuous monitoring, resulting in situations where they give away their privacy without realising it. Consistent safeguarding processes and consent procedures will be needed to ensure that the risk associated with this is minimised.

‘They may receive it really, really well and not even think about the side of you know, it’s not like somebody sticking a camera on a warning in front of you and you feel like you’re being watched all the time’.—Interviewee 10

Among the existing features integrated into Mylo, the capacity for fall detection stood out as notably valuable to interviewees, with eight participants identifying it as a crucial feature for the SAR to have.

‘Fall detection is, you know, falls are a massive driver for people being admitted into hospitals, which is a lot of our business so I think I think that’s a great feature’.—Interviewee 2

Beyond identifying instances of falls, this feature presented a means of assessing the urgency of each fall, enabling caregivers to strategically prioritise their interventions. The incorporation of fall detection within the SAR was seen as a promising means to enhance not only residents’ safety but also caregivers’ ability to allocate their attention more effectively.

‘And also, you’d very quickly establish if someone, if they did lay on the floor. If they were, you know, doing a yoga position or something like that then. It would only take one or two checks to establish that that’s not a cause for concern’.—Interviewee 6

Participants were particularly fixated on the potential for the SAR to provide passive proactive support, particularly in emergency situations. They noted that the SAR could improve on existing systems by reducing the reliance on user action. This can be particularly beneficial in situations where assistance is necessary, but individuals are unable, or unwilling, to ask for support.

‘So with the medication prompts, you’ve got medication clocks, you’ve got telecare for the full detection, but it kind of needs that person to press the button to tell someone that they fallen. And I think what’s so great about Mylo is that of course a lot, some people, and I know this, they don’t want to press that button if they feel they can get themselves up or something like that. You know, so it would just automatically then make contact with that loved one and who was registered on’.—Interviewee 7

4.3.4 Characterisation. Participants frequently commented on the robot’s appearance and personality. The two key aspects that were discussed were the design or the robot itself as well as its zoomorphic qualities. Most praised its size as a pivotal aspect of its perceived acceptability.

‘It wouldn’t get in the way. It wasn’t too big or anything like that. It was, I think, about the right size’.—Interviewee 2

Many interviewees emphasised that being above a specific size was crucial to prevent the device from becoming a tripping hazard:

‘It’s big enough for people to see it and not trip over’.—Interviewee 9

Or from being overlooked as just another household device on a desk:

‘Because if it’s smaller, I personally would think it will become like a, you know, like a household thing. Like, you know, you have toasters and things like that, or the Alexas or Googles. So you want it to be different from those things’.—Interviewee 1

Conversely, it was acknowledged that excessive size would be problematic, particularly in the context of smaller properties in the United Kingdom, especially within assisted living facilities with their spatial limitations.

‘I don’t think smaller would work, and I think the design itself is very good. It’s very memorable, like I can remember it, it’s very visually catching’.—Interviewee 10

A potential concern with larger robots was that they could be intimidating to residents:

‘I don’t think it should be any bigger cause if it gets too big it would potentially intimidate people more’.—Interviewee 8

‘I think people might be intimidated if it was larger’.—Interviewee 9

There was an expectation that having a character would allow users to form bonds with the SAR, thus leading to more natural and frequent interactions.

‘I can see somebody thinking because it’s got a face on. I can easily see somebody starting to identify it as it, you know, they’ll start off and calling it that thing that helps me and then they’ll probably end up giving it a name. It won’t be Mylo, but it’ll be oh, I’d just call it Bessie or I just call it like it’s real’.—Interviewee 10

Seven participants explicitly mentioned the animal-like features that the robot had. For the most part, these zoomorphic qualities contributed to a positive perception, as interviewees discussed how they believed residents would react to the SAR as a pet substitute. One interviewee had positive past experiences of implementing animal-like robots in a care setting.

‘We’ve used sort of tech cats that people can stroke. So someone who’s not able to look after a real cat can then feel like they’re looking after a, you know, an electronic cat but it could be quite calming for them’.—Interviewee 6

These findings support the idea that zoomorphism can help to create an emotional bond between the SAR and its users.

However, a specific apprehension was raised regarding the potential confusion that the animal-like appearance might pose for elderly users, especially those dealing with conditions such as dementia. Participants were concerned that the presence of a robot with an animal face might induce distress due to the potential cognitive dissonance it could evoke.

‘I come across certain people that of course, if they’ve got a fear of dogs anyway or cats, then this can be manifested and exacerbates somebody who has dementia. So of course then that fear would be, would actually be worse if they were to see a cat or dog’.—Interviewee 7

A notable suggestion that emerged from the interviews was the desire for customization options, particularly the ability to alter the robot’s face. Some interviewees proposed alternatives such as the ability to switch between a cat, a dog, or even the face of a loved one.

Two participants voiced a preference for a more mechanical and less lifelike aesthetic for the robot, akin to that of a smart home device, rather than attempting to replicate the appearance of a living being.

‘People talk to Alexa and she doesn’t have a face’.—Interviewee 4

This sentiment was driven by a desire for the robot to be perceived as a tool rather than a living entity, thus indicating that the concept of a needy SAR may not be appropriate for all. Customisation will be important to accommodate as large a range of users as possible.

5 Discussion

5.1 RQ1: What Are the Attitudes of Support Workers towards the Adoption of an Existing SAR?

Participants expressed strong interest in the potential benefits of integrating SARs as supportive tools for assisted living environments. Questionnaire responses reveal several indicators that support this sentiment:

- 18/24 agree that it would be a good idea to use the robot
- 15/24 agreed that they would use the if it were available
- 18/24 agreed that it would make the home more interesting

These findings align with other studies that have found that caregivers and residents have a generally positive opinion of assistive robots [25, 29].

The key aspects raised in the interviews and focus groups were their ability to increase the overall well-being of residents through features such as fall detection, medication reminders and passive monitoring. These additions to the current care infrastructure were considered beneficial, especially for older individuals wanting to live independently, as identified by Interviewee 2 in Section 4.3.3 and Interviewee 6 in Section 4.3.2. These align with existing research that caregivers value robots that relieve workload or enhance the quality of care provided, without increasing user or carer burden [29, 62]. These aspects were frequently mentioned in both interviews and reflected in the Perceived Usefulness construct:

- 16/23 agreed that the robot could help with many things.
- 13/23 agreed that the robot would be useful for people in the home.

— 11/23 agreed it would be useful for their own work (with 33.3% neutral).

Interviewees highly appreciated the robot's automated fall detection and proactive alerts, features that directly tackle significant and well-established issues within the care of the elderly:

'Properties or schemes would benefit from that across the country with this sort of ageing population and people having stumbles and falls within their property'.—Interviewee 2

Importantly, the questionnaire results regarding the Trust construct reveal that support workers have confidence in the robot's ability to perform these functions consistently:

- 23/24 agreed that they would trust the robot to provide timely notifications
- 19/24 agreed that they would trust the robot to detect falls

The potential of the SAR extends to supplementing or enhancing existing solutions [46, 47]. It was suggested that SARs could serve as a viable substitute for many existing systems. Care homes already employ an array of sensors and cameras to monitor the well-being of residents. Adequately equipped SARs could potentially assume some of these functions, providing a technologically sophisticated alternative to enhance resident safety and overall quality of life. A perceived benefit was the ability to eliminate intermediaries by enabling immediate communication with a designated contact person if the user experienced a fall or a similar event:

'I suppose there is technology out there that already covers those things it had, like when you wear pendants and things like that. So I'm aware of technology that's around. So I wouldn't say that there's a massive gap in the market, but if it was unique to you and it was not through like a call center and stuff like that and you could interact straight away with somebody that is your family member or your career or somebody that's a nominated person'.—Interviewee 3

Despite positive feedback, the questionnaire revealed concerns regarding implementation readiness. Specifically, the Facilitating Conditions questions suggested that while the attitudes of support workers are positive towards the concept of an SAR and what it could bring to assisted living, successful implementation would require significant training and familiarisation:

- 2/24 agreed that they knew enough to make good use of the robot
- 19/24 were neutral or disagreed about having what they needed to use it effectively

Support workers also expressed concern in the questionnaire results regarding residents' ability to operate the robot, suggesting that familiarisation efforts needs to include residents as well. Misunderstandings from elderly users are a consistent source of difficulty for implementing robots, even in monitored studies [48].

— Only 7/23 agreed that people at the home would be able to use the robot

This gap between the participants high trust in the robot and their lack of perceived knowledge of how to operate the robot indicates that participants see the potential of integrating a robot in assisted living, but are not currently confident in how to use it successfully. It is also important to note that trust may have been positively influenced by the demonstration provided during the focus groups, as an expert was available to ensure that the robot was able to operate effectively. This setting likely reduced the number of observable errors for participants. Future research should assess independent usage of the robot, with minimal support from experts beyond initial training, to observe whether this gap between trust and facilitating conditions changes.

Given the high level of trust, manufactures have a responsibility to ensure that the capabilities, limitations and functionalities of robots are understandable to potential users. This importance is

heightened by the current lack of perceived knowledge of how to use robots within an assisted living setting. Failure to make this information transparent to users could result in inflated expectations and a higher risk of robot misuse.

The cost of the device presents yet another barrier. Historically, SARs and other assistive technologies have been perceived as prohibitively expensive for widespread deployment [52]. Our participants from the NHS shared their prior experience of effectively employing Paro, the robotic seal, with elderly individuals. Unfortunately, this success proved fleeting as the device remained unused following the testing period. Worries were voiced in the focus group that a similar scenario could unfold with a new SAR or other unproven technology in general. Budget limitations could present a challenge in demonstrating the necessity of adopting these technologies. Given the current economic landscape of rising inflation and a cost-of-living crisis impacting essential services, experimental technologies, such as SARs, must provide a compelling justification for their costs. They must demonstrate tangible value for money to garner broader acceptance and facilitate their integration into assisted living environments.

Support workers show significant enthusiasm for adopting SAR, especially when robots offer practical and unobtrusive assistance that fits into their current work processes, as evidenced by the strong agreement between interview feedback and questionnaire results. Successful implementation in real-world settings, however, requires attention to staff preparedness, knowledge and environmental obstacles to guarantee a seamless integration into everyday use.

5.2 RQ2: What Are Support Workers’ Opinions and Apprehensions Regarding the Concept of a *Needy* SAR?

The concept of a neediness in this context was met with a mix of enthusiasm and caution from support workers. Most of the participants saw potential in how a needy SAR could help to increase engagement, support mental well-being and give residents a renewed sense of purpose. Simply having someone to talk to, even if this is a robot, can help to reduce loneliness [22].

Caring for the SAR resonated particularly well with caregivers, especially among those tending to dementia patients who already find solace in ‘doll therapy’ as a means of comfort and soothing [53]. In particular they noted how a needy SAR could help to provide companionship to residents, thereby alleviating loneliness and social isolation:

‘And just to be able to have that companionship and feel useful again, because I guess that’s the thing with a lot of people when they no longer work anymore, and if they are housebound, to have that’.—Interviewee 2

‘I’ve got someone to talk to even if it is a cat faced robot’.—Interviewee 7

While a small degree of neediness, such as subtle cues or infrequent prompts, might be appreciated, our participants believed that residents may react negatively to constant requests for attention. This notion was partly evident in the Social Presence construct questionnaire results:

—4/24 agreed they could imagine the robot as a living creature

—16/24 disagreed, indicating that anthropomorphism had limited resonance with the staff.

Despite the perceived benefits, some participants expressed concerns about the threshold at which a robot’s expressions of neediness would become burdensome. It was proposed that the level and frequency of demands should be customised by the user:

‘As long as you could kind of tailor it. So if it was annoying and you thought, oh, this is too much. And you could just kind of find a good balance then’.—Interviewee 3

The cat-like characterisation garnered especially favourable feedback. Study participants not only appreciated the design but also lauded the device's expressive nature. The appearance of SARs is critical in influencing user acceptance and perception. Research shows that the visual aesthetics of a robot impacts users' first impressions, trustworthiness and overall desirability [45]. The impact of cultural and contextual factors on user expectations and perceptions of SARs is significant [44]; the design of robots for diverse user populations necessitates consideration of these influences.

From the questionnaires, it was clear that many participants had some doubts about their preparedness to use or support to robot:

- 2/24 felt they had everything needed to make good use of it
- 20/24 were neutral or disagreed with the statement that they knew enough to use it effectively
- 16/23 were neutral or disagreed that people in the home could easily use it

A prominent concern was the technology literacy of the expected users, primarily as they would be from an older generation who may not have been exposed to recent advancements in technology. There is always the risk that users would not understand the technology being used and would choose to reject it, either out of an inability to utilise it effectively or due to a fear of the unknown. Significant training will be required for support workers to ensure that they can effectively implement the SAR. Residents must receive a clear and thorough introduction to the SAR to prevent confusion and ensure understanding of the key features. Despite these concerns, it is clear that many elderly individuals are open to the idea of new technology, whether they have prior experience or not [24].

Misunderstandings may occur where individuals incorrectly perceive the robot as a sentient entity. While the support workers indicated that they were unlikely to perceive the SAR as a living entity, individuals with dementia, or similar conditions, are especially susceptible to being misled in this manner. As highlighted by a dementia advisor who took part in our study:

'We have to remember that for somebody with dementia, their reality is very different to someone who doesn't have dementia, so in effect that Mylo could be a very real person to them, you know, a very real person. And that could be a negative because of course, Mylo isn't a real person'—Interviewee 10

This also raises issues around consent, particularly when it comes to directly monitoring individuals. Residents may struggle to grasp the implications of allowing SARs into their homes due to a limited understanding of how these technologies function. However, some of the participants believed that this would not be a problem, as similar technologies with potentially privacy intrusive features are already employed in assisted living facilities through different means. While they might not use SARs equipped with cameras, many facilities already have sensors and other monitoring systems in place. Constant surveillance is considered a normal aspect of life for residents in these circumstances.

'I'm using in terms of what do you know what I mean then I actually I think it's down to individual preference and individual choice and to be honest for somebody to have a Mylo I think would be open to that surveillance anyway'.—Interviewee 7

Support workers generally respond positively to displays of neediness that foster emotional bonds, especially when linked to companionship and self-care. Encouraging users to 'care for' the robot was viewed favourably when it facilitated the creation of meaning and directly benefited the user. However, feedback from both interviews and questionnaires emphasised the importance of moderation, to prevent the robot from becoming mentally taxing. Robot behaviours should be

relatable without causing an unnecessary burden and must be carefully designed not to deceive individuals.

5.3 RQ3: To What Extent Do the Perspectives of Support Workers on SARs Align with the SARNY Framework for *Needy Robot Design*?

Our previous work on the SARNY framework [41] identified core characteristics that are necessary for the implementation of a positive needy robot. This study’s findings from the focus groups, questionnaires and interviews are consistent with the previously described beneficial characteristics and can be broadly aligned with the established categories.

5.3.1 Character. Many of the participants enjoyed the characterisation of Mylo, reacting positively to the ‘cat’ face and natural animal-like reactions. These factors served as a beneficial way of endearing the robot to users. There was also an expectation that having a character would allow users to form bonds with the SAR, thus leading to more natural and frequent interactions as has been seen in other studies [72]. The focus groups highlighted a significant issue with the voice, which some participants felt did not align with the characterisation. This highlighted the importance of maintaining a consistent character for the SAR.

This enthusiasm for the robot’s sociability was reflected in the questionnaire results:

- 18/23 agreed that they and others would find the robot pleasant to interact with.
- 15/24 indicated they would enjoy using the robot themselves.

Individual user preferences emerged as a point of divergence, with some users questioning whether the specific cat portrayal in this instance would be suitable for all residents. Interviewees pointed out that different users will have different preferences when it comes to their preferred characteristics. Allowing this to be customisable would help to alleviate this concern to some degree. The potential to provide a character similar to a family member was also viewed positively by several interviewees; however, this does raise concerns surrounding misleading and confusing individuals.

5.3.2 Expression. Mylo reacts by emoting when touched, stroked or talked to. These zoomorphic expressions were popular, and many participants in the focus groups chose to interact with it of their own accord during the demonstration. Natural reactions such as these have proven useful for endearing the robot towards users [60, 63], which in turn makes them more likely to use it. These interactions and rewards through expressions evidence a reciprocity loop which is key to our concept of a needy SAR. This also aligns with the positive experiences of one of our participants who had previously implemented an animal-like robot to support older people and found that the action of stroking it had a beneficial effect for them:

‘We’ve had, you know, I think some quite good successes with older people who were lonely and used to have pets and couldn’t have pets now and or couldn’t look after them. But actually, like the reassurance of having a cat around, and you stroke it and it purrs and it, you know, I think that’s obviously, that’s pretty low level tech, but it has a purpose’.—Interviewee 6

5.3.3 Personalisation. Personalisation is one of the key traits mentioned in our focus groups and interviews. It was considered important for both functional and non-functional aspects of the SAR. As identified in the character section, while most participants in this study liked the chosen characterisation of Mylo, there was an acknowledgment that this opinion would not be shared by all of the residents. Participants also expressed similar concerns regarding the robot’s level of engagement. They emphasised that a one-size-fits-all approach would be unsuitable, as the degree of attention and interaction that some individuals find endearing could be perceived as intrusive or

irritating by others. SARs must be able to adapt to the needs, routines and socio-cultural context of their users [23]. These findings highlight the importance of allowing for personalisation and adjustable interaction settings to better accommodate diverse preferences among users. These results indicate that in a needy robot the level of neediness displayed must be personalised, so that bids for attention feel supportive for users, without becoming burdensome for others.

5.3.4 Understanding. One of the most significant concerns raised was the issue of technology literacy among older individuals. Support workers worried that many residents might struggle to understand or engage with the technology integrated into the robot. This potential barrier could hinder the robot's effectiveness and acceptance, particularly among those who have had limited exposure to modern digital devices. Addressing this challenge will require careful design choices that prioritize simplicity, intuitive interaction and clear user guidance.

Needy SARs rely on the potential for users to form social connections and expectations with the robot through an emulation of specific personality traits. Examples of these traits include expressions of distress, such as appearing sad when ignored. While this can be useful for acceptance, it may also lead to users making decisions based on a sense of obligation or guilt rather than based on their preferences. This will be further complicated in elderly, vulnerable or otherwise technology illiterate users who may struggle to differentiate between programmed responses and a genuine emotional need from a living being [3, 26, 68].

Language emerged as a consistent concern across the focus groups. Several support workers expressed apprehension that the robot might struggle to understand residents, particularly older individuals who may not speak English fluently or at all. This challenge highlights the critical need for the robot to be adaptable to a range of languages and dialects. Ensuring robust multilingual capabilities will be essential for promoting acceptance and effective communication within diverse resident populations.

5.3.5 Restraint. A key principle of a needy SARs is that the user must continually interact with it to maintain its well-being. Although designed to promote healthy habits like social interaction and cognitive engagement, this feature can foster unhealthy dependencies. Users may feel obligated to interact with the SAR if it implies that not interacting with it will have negative consequences. This sense of obligation may override the user's consideration of the potential benefits of interacting with the SAR [3].

Constant demands from the SAR can result in decision fatigue leading to a decline in the quality of decisions made over time. Persistent reminders and requests may end up pressuring the user into compliance, reducing autonomy by effectively taking decision making out of the hands of the user. A prominent theme that emerged was the need for SARs to regulate their behaviour when interacting with users to respect boundaries. Engagement needs to be subdued or responsive to fluctuations in user engagement to avoid overwhelming and frustrating users [71]. Several study participants expressed concern that frequent prompting could result in a situation where the user decides to disengage entirely:

'You can only be so needy, can't you, before somebody turns around and goes, I ain't listening to that thing, and turn it off'.—Interviewee 6

5.3.6 Honesty. While the participants of the study showed a fondness for the design and characterisation of the robot, they were wary of the potential for anthropomorphic deception. While recent work indicates the ethical risks related to anthropomorphic deception from SARs is not significant [79], this work has been carried out with non-vulnerable individuals, and may not be equally applied to the vulnerable older individuals typically seen in assisted living.

Unlike cameras and other more direct methods of monitoring individuals, users may be unaware of the amount of data that is being gathered by SARs. This may lead to users unknowingly sharing personal information. As needy SARs will be designed to interact in socially engaging ways, users may feel inclined to treat them as a trusted friend and might disclose personal information that would otherwise be reserved for caregivers or close companions [26, 68]. It is vital to establish boundaries that make the nature of the SAR clear to potential users, particularly in the case of a needy SAR that acts as a companion, as the risk of deception is high.

6 Conclusion

This study sought to illuminate the attitudes of support workers towards an existing SAR, both positive and negative, as well as to identify whether their opinions of so-called ‘needy’ traits match our previous research. The invaluable perspectives of support workers and healthcare professionals will play a pivotal role in shaping the design of SARs tailored to the unique needs of individuals within assisted living facilities. Their first-hand experiences provide crucial insights, shedding light on aspects that may not always be apparent to the eventual users of the technology. We found that support workers in assisted living broadly welcomed SARs that provided meaningful support, particularly those that offered fall detection, reminders and companionship. Nevertheless, they voiced worries about several aspects, including emotional burden, confusion and confidentiality.

Many of the support workers who took part in the study expressed enthusiasm about the incorporation of zoomorphic features and the defined character. They emphasised the importance of personalisation in ensuring that SAR designs cater to the diverse needs of users. Interviewees highlighted the potential of this type of SAR to offer companionship and instil a sense of independence among residents. Thus, allowing them a level of freedom that may not currently be available to these vulnerable individuals.

Interviewees expressed apprehensions about the technology literacy of the core demographic, fearing it might not be sufficient to comprehend the implications of the technology. This was especially pertinent in terms of privacy concerns and potential confusion arising from the emulation of a living being. In light of these concerns, they emphasised the importance of presenting the technology transparently and honestly, ensuring that users are well informed about its functionalities and potential impacts.

The research offers support for the key positive traits that make up the SARNY framework, a model intended for the creation of ‘needy’ SARs. This framework aims to facilitate the design of SARs that evoke emotions in users effectively, without inducing feelings of being burdened or overwhelmed. Each of the key characteristics were reflected in the responses from our participants.

Character: Likeable, consistent personas helps users to connect with the robot.

Expression: Subtle zoomorphic reactions are an effective method to increase engagement.

Personalisation: Different users require different levels of emotional engagement, sociability and design.

Understanding: SARs must be equipped to interpret the users context accurately.

Restraint: Prioritise user autonomy; excessive requests and prompts risk being seen as annoying.

Honesty: Transparency in the robot’s capabilities and identity is essential to ethical and comfortable interaction.

Together, these insights contribute to a more nuanced understanding of how needy traits in SARs can be leveraged to foster engagement and support, while also setting clear boundaries to preserve user autonomy and emotional safety. While this study does not yet provide a full empirical test of a needy robot, the results indicate the value of these traits in isolation and warrant further study that

directly tests them in practice. Importantly, this work has identified the key aspects that support workers value as well as their perspectives on how these traits should be integrated into an SAR.

6.1 Next Steps

Based on this papers' findings, the next step for this research will be the design and prototyping of SARs that incorporate the needy traits of the SARNY framework directly. Support workers, assisted living residents and other key stakeholders should be involved in a collaborative effort to integrate practical design parameters. On-site studies within assisted living facilities will be crucial for an accurate assessment of how the integration of a robot with needy traits impacts sustained engagement, emotional health and routines. Ultimately, these steps aim to inform the development of SARs that are attuned to the needs and lived realities of those that they are intended to support.

6.2 Limitations

We note the constraints of the study here. There were 6 months between the initial demonstrations and subsequent interviews. There is a potential benefit to this delay as this may have permitted the participants to reflect on their experience and the potential novelty factor of the new technology may have worn off. The first two participant groups also did not have the opportunity to directly experience the fall detection feature during their demonstrations due to time constraints, which might have influenced their insights and impressions. Instead, this feature was explained before the interviews took place. While this was not a key aspect of our study, as it does not particularly pertain to neediness, this was a feature that many participants in the third and fourth groups described as useful after witnessing its effectiveness.

This study was limited to support workers and professionals from Gloucester in England. Their views and requirements may not be representative of other support workers across the world, or even the rest of the United Kingdom. Comparisons between the requirements of different demographics are needed to identify the differences in needs and preferences between them. This must expand to the individuals who will be directly impacted by the implementation of SARs.

A notable absence in our study was the direct participation of elderly individuals in assisted living facilities. Their insights and perspectives would have provided invaluable first-hand experiences, enhancing the robustness and applicability of our findings to the intended user group. This would provide an opportunity to address their concerns, such as privacy, and cater to their specific needs more directly.

The 'needy' characteristics we aimed to assess were not physically demonstrated, instead participants relied on verbal explanations to grasp these attributes. Future studies will be needed to ascertain whether these opinions remain the same after witnessing a direct implementation of these traits and suggested features. Conducting additional assessments of SARs in real-world environments, as opposed to controlled lab settings, constitutes a crucial next step. This is especially pertinent in validating the feedback we received from interviewees regarding the design and dimensions of the device.

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Appendix

A Questionnaire Results

Table A1. Responses for Anxiety (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
If I should use the robot, I would be afraid to make mistakes with it	0 (0.0%)	5 (20.83%)	3 (12.5%)	15 (62.5%)	1 (4.17%)
I find the robot intimidating	0 (0.0%)	0 (0.0%)	2 (8.33%)	16 (66.67%)	6 (25%)
I find the robot unpleasant	0 (0.0%)	1 (4.17%)	0 (0.0%)	15 (62.5%)	8 (33.33%)

Table A2. Responses for Attitude (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think it would be a good idea to use the robot	0 (0.0%)	18 (75.0%)	5 (20.83%)	1 (4.17%)	0 (0.0%)
The robot would make my job more interesting	1 (4.17%)	11 (45.83%)	11 (45.83%)	1 (4.17%)	0 (0.0%)
The robot would make the home more interesting	2 (8.33%)	16 (66.67%)	4 (16.67%)	2 (8.33%)	0 (0.0%)

Table A3. Responses for Facilitating Conditions (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I have everything I need to make good use of the robot	0 (0.0%)	0 (0.0%)	15 (62.5%)	9 (37.5%)	0 (0.0%)
I know enough about the robot to make good use of it	0 (0.0%)	2 (8.33%)	9 (37.5%)	11 (45.83%)	2 (8.33%)
I feel confident that I could successfully use the robot	0 (0.0%)	9 (37.5%)	9 (37.5%)	5 (20.83%)	1 (4.17%)
The robot will be accepted by the people where I work	0 (0.0%)	9 (37.5%)	12 (50.0%)	3 (12.5%)	0 (0.0%)

Table A4. Responses for Intention to Use (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I would use the robot if it was available	1 (4.17%)	14 (58.33%)	7 (29.17%)	2 (8.33%)	0 (0.0%)
I think the people at the home would use the robot if it was available	2 (8.33%)	7 (29.17%)	12 (50.0%)	3 (12.5%)	0 (0.0%)

Table A5. Responses for Perceived Adaptability (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think the robot can be adapted to my needs	0 (0.0%)	16 (66.67%)	7 (29.17%)	1 (4.17%)	0 (0.0%)
I think the robot can be adapted to the needs of people at the home	0 (0.0%)	21 (87.5%)	3 (12.5%)	0 (0.0%)	0 (0.0%)

Table A6. Responses for Perceived Enjoyment (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think I will enjoy using the robot	2 (8.33%)	13 (54.17%)	7 (29.17%)	2 (8.33%)	0 (0.0%)
I think that people at the home would enjoy using the robot	2 (8.33%)	16 (66.67%)	3 (12.5%)	2 (8.33%)	1 (4.17%)

Table A7. Responses for Perceived Ease of Use (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think I will know quickly how to use the robot	0 (0.0%)	14 (60.87%)	8 (34.78%)	1 (4.35%)	0 (0.0%)
I think I will be able to use the robot without extra help	0 (0.0%)	6 (26.09%)	11 (47.83%)	6 (26.09%)	0 (0.0%)
I think I could use the robot with someone there to support me	3 (13.64%)	13 (59.09%)	6 (27.27%)	0 (0.0%)	0 (0.0%)
I think I could use the robot with a manual or guide	1 (4.35%)	20 (86.69%)	1 (4.35%)	1 (4.35%)	0 (0.0%)
I think people at the home would be able to use the robot	0 (0.0%)	7 (30.43%)	13 (56.52%)	3 (13.04%)	0 (0.0%)
I think that I could tell others how to use the robot	0 (0.0%)	10 (43.48%)	7 (30.43%)	6 (26.09%)	0 (0.0%)

Table A8. Responses for Perceived Sociability (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think I will find the robot pleasant to interact with	0 (0.0%)	18 (78.26%)	3 (13.04%)	2 (8.70%)	0 (0.0%)
I think people at the home will find the robot pleasant to interact with	0 (0.0%)	18 (78.26%)	4 (17.39%)	1 (4.35%)	0 (0.0%)

Table A9. Responses for Perceived Usefulness (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think the robot will be useful to me	0 (0.0%)	9 (39.13%)	8 (34.78%)	5 (21.74%)	1 (4.35%)
I think the robot will be useful for my work	0 (0.0%)	11 (47.83%)	8 (34.78%)	3 (13.04%)	1 (4.35%)
I think the robot can help with many things	0 (0.0%)	16 (69.57%)	6 (26.09%)	0 (0.0%)	1 (4.35%)
I feel like the robot will be useful for people staying in the home	1 (4.35%)	13 (56.52%)	8 (34.78%)	0 (0.0%)	1 (4.35%)

Table A10. Responses for Social Influence (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I think it would give a good impression if I used the robot	0 (0.0%)	6 (25.0%)	17 (70.83%)	1 (4.17%)	0 (0.0%)
I think it would reflect well on the home if we used the robot	1 (4.17%)	9 (37.5%)	13 (54.17%)	1 (4.17%)	0 (0.0%)
I think that the home should be utilising more technology	0 (0.0%)	18 (75.0%)	6 (25.0%)	0 (0.0%)	0 (0.0%)

Table A11. Responses for Social Presence (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can imagine the robot to be a living creature	0 (0.0%)	4 (16.67%)	4 (16.67%)	13 (54.17%)	3 (12.5%)
I think it is good to have a robot around	0 (0.0%)	11 (45.83%)	11 (45.83%)	2 (8.33%)	0 (0.0%)

Table A12. Responses for Trust (Counts and Percentage Distributions)

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I would trust the robot to provide notifications on time	1 (4.17%)	21 (87.5%)	2 (8.33%)	0 (0.0%)	0 (0.0%)
I would trust the robot to work consistently	1 (4.17%)	16 (66.7%)	5 (20.83%)	2 (8.33%)	0 (0.0%)
I would trust the robot not to impede me or my work	0 (0.0%)	17 (70.83%)	5 (20.83%)	2 (8.33%)	0 (0.0%)
I would trust the robot not to impede people living at the home	0 (0.0%)	18 (75.0%)	4 (16.67%)	2 (8.33%)	0 (0.0%)
I would trust the robot to detect falls	2 (8.33%)	17 (70.83%)	5 (20.83%)	0 (0.0%)	0 (0.0%)

Table A13. I Would Trust the Robot to Detect Falls, by Group (Counts and Percentage Distributions)

Group	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Internal (n=14)	1 (7.14%)	9 (64.29%)	4 (28.57%)	0 (0.0%)	0 (0.0%)
External (n=10)	1 (10%)	8 (80%)	1 (10%)	0 (0.0%)	0 (0.0%)

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