Perspectives from Unpaid Carers on Socially Assistive Robot Interactions in Older Adult Care

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Abstract. With the global population aging, there is a growing need for innovative assistive technologies to support unpaid carers in maintaining older adults' quality of life. Socially Assistive Robots (SARs) offer a potential solution by assisting with daily tasks, providing companionship, and easing the unpaid carers' burden. For successful integration, SARs must deliver personalised interactions that implicitly promote supporting the needs of both carers and older adults. We conducted a qualitative study with 15 unpaid carers who interacted with a Pepper robot to understand the perception of unpaid carers towards using SARs as an assistive tool for providing care to older adults. Thematic analysis revealed concerns about the lack of human touch, the role of SARs as assistants rather than replacements, and the potential of robots for companionship. Carers also expressed distrust in technology, lack of confidence in machine capabilities, and safety concerns. From these findings, we propose that future research studies consider the collective set of dyadic interactions as a triad between unpaid carers, older adults, and SARs in order to further investigate and design personalised care.

Keywords: Unpaid Carers · Older Adults · Socially Assistive Robots (SARs) · Triadic relation · Human Robot Interaction (HRI) · Human - Human - Robot Interaction (HHRI)

1 Introduction

The ageing demographic presents an escalating challenge globally, with the elderly population requiring increasing levels of care and support. Older adults often face a range of physical, emotional, and social challenges that necessitate personalised care to maintain their quality of life and overall well-being [1]. However, the responsibility of caring for older adults often rests on unpaid carers [2], who are typically family members or close friends [3]. These carers manage a wide array of tasks, from physical assistance to emotional support of the care recipients.

Traditionally, caregiving has been viewed through a dyadic lens, focusing on the direct interaction between the carer (i.e. unpaid carer) and the care recipient (i.e. older adult). This approach can be effective when there is a direct relationship between the carer and care recipient. However, due to advances in Human Robot Interaction (HRI), caregiving can now involve the use of Socially

Assistive Robots (SARs) [4]. Therefore, the traditional dyadic lense may not be suitable anymore in designing effective personalised interactions between the carer and the care recipient as now the relationship between the carer and care recipient is more indirect involving the provision of care through a SAR. Research indicates that SARs can play a significant role in enhancing the well-being of older adults by providing companionship, monitoring health status, and facilitating communication [5].

While SARs have the potential to improve task efficiency, there is a need to prepare this technology to address the complex dynamics between the unpaid carer, older adult, and the SAR to maximize their collective benefits [6]. We investigate the perception of unpaid carers towards using SARs as an assistive tool for providing care to older adults. To support the development of emotional and social capabilities for more effective SARs in caregiving, our work contributes to understanding the importance of addressing dyadic relationships and interactions collectively as a Human-Human-Robot Interaction (HHRI) triad. Additionally, our study unpacks the understanding of SARs as assistants in the care experience (rather than replacements), as SARs lack human-like emotional awareness that is useful in communicating with care recipients.

2 Related work

2.1 Socio-technical challenges of socially assistive robots to support unpaid carers

Generally, unpaid carers face numerous sociotechnical challenges when using assistive technologies. These challenges range from trust and acceptance issues [7], the lack of emotional capabilities in technology [8], insufficient training and technical knowledge [9], privacy and ethical concerns [10], and difficulties integrating technologies into existing care systems [8]. Similar issues are expected when unpaid carers use SARs for providing care to the elderly. For example, trust and acceptance are significant issues, as unpaid carers may be skeptical about the capabilities and reliability of SARs. Building trust requires demonstrating the robots' effectiveness in terms of short response times, error-free operation and the ability of the robot to learn from interactions and adapt to specific care situations [11].

Similarly, unpaid carers may lack the technical expertise needed to effectively use SARs, highlighting the need for comprehensive training and ongoing support [12]. The emotional bond between unpaid carers and care recipients is another critical component, as while SARs may have the technical capabilities to provide assistance, they lack the empathy and emotional connection that human carers provide [13]. Unpaid carers' acceptance and willingness to integrate SARs into their caregiving routines are influenced by their personal beliefs, experiences, and the perceived reliability and usefulness of the robots [14]. Moreover, it is essential to recognize that SARs should complement rather than replace human carers. The irreplaceable human elements of empathy, emotional support, and the ability to build meaningful relationships play a crucial role in the caregiving process [15,16]. Integrating SARs effectively requires a balanced approach where technology enhances and supports human carers, ultimately enriching the quality of care provided to the elderly [17]. However, a significant gap remains in the literature regarding how unpaid carers perceive and interact with SARs in real-world settings for elderly care [18]. Understanding these perceptions is important for developing acceptable, and effective SARs that truly meet the needs of both unpaid carers and older adults.

2.2 From HRI in care towards HHRI

In a traditional dyadic care setting, the interactions are primarily between the carer and the care recipient [19]. This dyadic interaction often focuses on the immediate tasks at hand, such as assisting with daily activities, managing medications, and monitoring health conditions [20]. According to cognitive learning literature, a dyadic context involves two individuals interacting directly with each other [21]. In the context of HRI, this dyadic interaction extends to include a robot i.e. one person and one robot interact [22]. The robot might assist with activities of daily living that aid the carer in care tasks [23]. Research in HRI and healthcare suggests that supporting caregiving tasks alone is insufficient [24] as this task-oriented approach often overlooks the emotional and social needs of the older adults and carers, which are important for preventing burnout and maintaining overall well-being [25]. According to Hornecker et al., the dyadic interaction for HRI is not enough in the care context as it fails to capture fundamental socio-technical interactions in such settings [26].

The concept of HHRI emerges from recognizing that caregiving is not an isolated activity but a complex, interconnected process [27]. Effective caregiving hinges on personalised support tailored to the unique needs of older adults, thereby fostering a sustainable caregiving environment. Failure to individualize care can compound challenges for carers, leading to increased difficulties and strain. This includes addressing their emotional, mental, and social needs. Tough et al. [28] highlight the necessity of comprehensive support systems that go beyond task management, emphasizing the importance of emotional and social support in reducing carer stress and enhancing their quality of life. Unpaid carers play an important role in shaping the care provided to older adults. Their insights and experiences are critical for tailoring care approaches that meet the unique needs of older adults [29]. By incorporating the perspectives of unpaid carers into the development and integration of assistive technologies, such as SARs, HHRI can ensure that these technologies are designed to support not only the practical tasks but also the emotional and social aspects of caregiving, to create a caregiving environment that is both comprehensive and personalised.

The existing research explores the dyadic interactions of carer and robot, older adult and robot, and, carer and older adult, but these have been done in isolation. This narrow focus fails to address the interconnected dynamics of real-world caregiving, where the interactions between all three parties significantly influence the effectiveness and quality of care. By only considering dyadic relationships, important situational aspects of the caregiving experience are overlooked. However, a triadic care interaction, involving the carer (i.e. unpaid carer), the care recipient (i.e. older adult), and assistive technology like SARs, offers a more holistic approach [23]. Triadic interactions can be further categorized into two types: open triads and closed triads. Open triads focus on two of the three possible dyadic relationships without explicitly addressing the third [30]. For instance, interactions might be analyzed between the carer and the robot, and the older adult and the robot, without directly considering the carer and the older adult relationship simultaneously. In contrast, closed triad interactions encompass all three dyadic relationships, providing a comprehensive framework, essential for the future development of robots in care [23]. Sharkey and Sharkey [31] argue that triadic care leads to improved mental health outcomes for carers, greater engagement and satisfaction for care recipients, and a more sustainable caregiving process overall. By exploring the closed triadic scope between unpaid carer, older adult, and robot, HHRI better reflects the complex, interdependent nature of real-world caregiving, offering a more comprehensive and personalised support system that enhances the quality of life for all involved.

3 Study Method

We conducted a study with unpaid carers to understand their perceptions of SARs supporting care of older adults and to identify key relevant characteristics of interactions in such settings. The unpaid carers involved in this study were well aware of the specific needs of the older adults they cared for, which adds depth to the analysis of their perceptions regarding SARs. The study was approved by the ethics committee at Cardiff University under SREC reference: COMSC/Ethics/2022/096b. Each participant was given a £20 Love2Shop voucher for the face-to-face session and a £10 Love2Shop voucher for the online interview. We used the Pepper robot to assess the impact of interacting with a SAR on an unpaid carer's trust; to identify the features of a robot that can support them in taking care of older adults. Below, we present the study design, participant details, the tools and procedures used, and data analysis methodology.

3.1 Participants

15 participants with experience as unpaid carers of parents, parents in law, and grandparents took part in the study (Female=10, Male=5). All participants were recruited from a local community in the UK and were between the ages of 18 and 44 (M= 30.5; SD = 8.44). The study's inclusion criteria required participants to be over 18 years old, have no formal training for the care of older adults, and have no prior experience with robots. Participants completed a questionnaire to assess their understanding of robots and technology. Out of the 15 participants, 13 had experience in taking care of older adults in a home setting, while 2 had volunteering experience in a care home. None of the 15 participants in the study had any prior experience interacting with robots and were unfamiliar with how a

SAR works. As participants had no prior experience of interacting with a robot, we provided a familiarisation stage to showcase robot diverse communication modalities. First, using the tablet interface, participants could input information, and also interact by voice with the robot.

3.2 Study Design

A two-hour in-person session was conducted in a lab with participants and the robot, followed by a 1-hour online semi-structured interview after the lab session. During the in-person session, participants first received a brief demonstration ex-

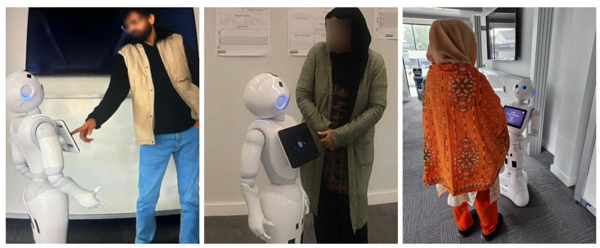

Fig. 1. Participants interacting with the Pepper robot

plaining the study's importance, the problem statement, and the key stakeholders involved. Afterward, participants were asked to provide their consent, with the understanding that they could withdraw at any time if they felt uncomfortable. Following consent, demographic data was collected from the participants. The interaction with the Pepper robot was explained to all 15 participants. The Pepper robot was programmed to interact autonomously with participants, and the sessions were both audio and video recorded.

The researcher used the Robot Operating System (ROS) to enable voice communication with Pepper, while a web-based application through Choregraphe was utilized for the tablet interface. The Pepper's hand, head movements, eye tracking and overall motion were automated because of inbuilt autonomous abilities. Each participant interacted with the Pepper robot individually for five minutes (See Figure 1). These interactions involved using both the tablet interface and voice communication. During the interaction, participants were asked six questions related to the emotional well-being of carers from the Zarit Burden Inventory (ZBI), an instrument used to assess caregiving burden in clinical and research settings. The robot interaction flow included greeting the user, providing instructions about the test questions and the option to quit the test, asking the questions, and waiting for replies. The interaction concluded after six questions with a thank you message displayed on the robot's screen. After the session, an online interview was conducted to get their perceptions and understand what kind of personalised support may help them in taking care of older adults.

3.3 Analysis

To analyze the data collected from the interviews, we used inductive thematic analysis [32]. The process involved several steps: first, the transcripts of the online semi-structured interviews were recorded and transcribed. We then read through the transcripts multiple times to gain a comprehensive understanding of the data and coding the qualitative data (e.g., interview transcripts) line-by-line to identify recurring themes and patterns. Once the codes were generated, we grouped them into broader themes to identify patterns and relationships within the data. The first and last authors independently created their codes and subsequently discussed them to decide on the final themes. This collaborative approach ensured the reliability and validity of the identified themes.

4 Results

4.1 The impact on the human-human care relationship

From the analysis of the interviews, we identified unpaid carers' perception of the potential impact of integrating robots on the human-human care relationship, highlighting both the opportunities and challenges this technological intervention brings to the orchestration of unpaid-care work. Despite advanced technology, robots still can't match the emotional understanding and physical sensitivity of humans. As participant P11 stated, *"I won't be happy talking to a robot in my stress time as they're not like people. Humans not only listen but also solve your problems. And also, how would I be sure that the robot's answer in my stress time is good or not?"* Some participants expressed concerns that robots cannot replicate the human touch and emotional connection integral to caregiving. For example, participant P1 said, *"I personally can't imagine a world where they're a complete replacement for humans and how efficient they can be. They're not a complete alternative to human care. They can be used as assisting technology along with human care."* Similarly, unpaid carers emphasized that SARs should serve as assistants to human carers rather than replacements. The importance of maintaining the human element in caregiving was highlighted, ensuring that the emotional and relational aspects of care are preserved.

Participants also acknowledged the potential of SARs to engage with older adults and provide companionship. They noted that such interactions could help reduce feelings of loneliness among the elderly, ease the burden of unpaid carers, and enhance their quality of life. Participant P13 remarked, *"The patients could be vulnerable and very lonely, and it will be a sense of giving them company. Obviously, they would know that it's not a human interacting with them, but it will be some kind of response and it wouldn't make them feel as lonely. It would help their morale and prevent them from feeling insane, which happens to a lot of people who are lonely."*

Furthermore, participant P14 emphasized the need for robots to be good listeners to ease their burden, sharing, *"My mom is old and she loves Hindi dramas. She loves talking about it all the time. But as I am busy with my own* *kids, I can't give her full time to listen to her stories, and this makes her unhappy and very irritated. So if a robot just listened to her and gave her the impression that it is very interesting, I would be happy to have this kind of robot, and it would be a very big help."* These insights underscore the necessity of integrating robots thoughtfully into caregiving to enhance support for both carers and care recipients.

4.2 Functional sensitiveness

Participants' responses revealed several key themes related to the technical aspects of using SARs in eldercare. Many participants expressed a general distrust or discomfort with technology. This apprehension stemmed from a lack of familiarity and confidence in the ability of robots to perform caregiving tasks reliably. As participant (P5) said *"How much we will trust a robot depends on capabilities of robot. So trust in robot is meant to be attached with functionality of the robot. if functionally is not fit then I don't see it working in health care sector."*

Participants frequently highlighted their doubts about the capabilities of robots in providing effective care. They questioned whether SARs could understand and respond appropriately to the complex and nuanced needs of older adults, which are often best addressed through human intuition and empathy. Participant P1 said *"Robot has implications for your physical or mental health. So for me personally, I would not rely on a machine to sort out what medications I have to take."* Similarly, a significant number of participants indicated a limited understanding of how robots function and behave. This lack of knowledge contributed to their hesitation in embracing SARs as a viable support tool. Participant P1 said *"I'm biased towards using technology in general at the moment, just it has to do with the lack of my knowledge of that technology and how and in what situation robot can be used."* Participants felt that without a clear understanding of what robots can and cannot do, it was challenging to trust them in caregiving roles. This was highlighted by participant P6 by saying *"I think it depends on the robot. You know we have different kind of robots, different sizes of robot, different robots who are programmed very differently. So it depends right who is making the robot and how it operates or what are the things that robot is able to do. So, if it is like up to that mark, you know, let's say I have tested it myself first and if the robot is able to the basic requirement that is actually not my requirement but my let's say my elder's requirement, if it's meeting them let's say they give them water, food, medicine and they help them get out of their bed. In that case I would be satisfied to use that robot."*

Similarly there was a prevalent fear among participants that robots might malfunction or make errors while performing caregiving tasks. Such malfunctions could potentially lead to dangerous situations or inadequate care, thereby increasing the carers' burden rather than alleviating it. As participant P3 said *"I wont be comfortable getting robot invasive task. Robot can malfuntion and might result in more bad emergency situation."*

Safety was also a major concern, with participants worried about the physical and emotional safety of older adults when interacting with robots. The potential for robots to cause harm, whether through mechanical failure or inappropriate responses, was a significant barrier to their acceptance. This was echoed by participant P11, stating *"As robot is a machine and I am not confident in the use of robot in health care setting because of safety reasons. It only takes one serious or fatal incident involving a robot, to lose complete trust."* These insights into the technical concerns of unpaid carers highlight the necessity for clear communication and transparent demonstrations of SAR functionalities to foster trust and confidence in these technologies.

5 Discussion

5.1 Addressing emotional and social needs

Participants expressed a clear preference for SARs to assist rather than replace human carers, highlighting the irreplaceable value of human touch and emotional connection in caregiving. According to a study by Abdi et al. [33], SARs are most effective when they complement rather than replace human carers, enhancing the quality of care without diminishing the essential human touch. Another study by Dembovsk at al. [13] underscores the importance of maintaining human elements in care to ensure emotional and relational needs are met, which SARs alone cannot fulfil.

Participants also recognised the potential of SARs to engage with older adults, providing companionship and reducing loneliness. This aspect of SARs can significantly enhance the quality of life for care recipients, like older adults. The study conducted by Chen at al. [34] also found that social robot interventions hold significant potential for reducing depression in older adults. However, understanding that the unpaid carer's primary expectation for the robot is to provide companionship and alleviate loneliness in the older adult can be challenging for the machine like robot. This understanding can only be ensured if the unpaid carer's perceptions and expectations about the robot are clearly communicated and integrated into the robot's operation. It requires the robot to have technical capabilities customized according to the personalised care needs of the older adult. Implementing a closed triadic interaction can be beneficial for designing interaction between SARs and older adults under the care of unpaid carer. The closed triadic interaction means that the dyadic interactions and relationships between the unpaid carer, the older adult, and the SAR are considered together.

5.2 Addressing functional sensitiveness

Participants' responses highlighted several key themes regarding the technical aspects of using SARs in eldercare. A common sentiment was distrust or discomfort with technology, primarily due to a lack of familiarity and confidence in robots' ability to perform caregiving tasks reliably [35]. Many participants doubted whether SAR could effectively understand and respond to the needs of older adults, which are often best addressed through human intuition and empathy.

Vandemeulebroucke et al. [36] found that while robots might be accepted for certain tasks, there were concerns about their ability to provide personalised care and emotional support. Moreover, there was a limited understanding among participants about how robots function and behave, contributing to their hesitation in adopting SARs as a support tool. This uncertainty made it challenging for carers to trust robots in caregiving roles. Concerns were also raised about the potential for robots to malfunction or make errors, which could lead to dangerous situations or inadequate care, thereby increasing the carers' burden rather than alleviating it. A study conducted by Hebesberger et al. [37] evaluated a long-term autonomous robot in a care facility for older adults, focusing on social acceptance and user experience and found that the robot's utility is tied to tasks and functioning, with ambivalent social acceptance among staff, who view robot integration in eldercare as inevitable. Safety was a significant concern, with worries about the physical and emotional well-being of older adults when interacting with robots. The potential for harm, whether through mechanical failure or inappropriate responses, was a notable barrier to the acceptance of SARs [38]. These insights into the technical concerns of unpaid carers underscore the need for clear communication and transparent demonstrations of SAR functionalities to foster trust and confidence in these technologies.

5.3 Towards a Triadic Relationship Framework in HHRI

We conducted a study to understand unpaid carer's perception towards using SARs as an assistive tool for providing care to older adults. From our results, it is clear that every unpaid carer has different perceptions about robots and these perceptions are based on the specific needs of the older adults they care for. Recognizing that no single rule can apply to all care recipients, we need tools (i.e., a design framework) that researchers can use for designing SAR interactions that address the diverse and specific needs of older adults in care. To capture these nuanced perspectives and interconnected needs, it is essential to study triadic interactions rather than isolated dyadic ones in order to fully understand the complex dynamics and feedback from all involved parties.

Existing studies on SARs and caregiving predominantly focus on dyadic interactions, addressing interactions between robot-unpaid carer [33], robot-older adult [34], or unpaid carer-older adult [19] but not all three simultaneously. These studies, while valuable, tend to focus on the immediate, task-oriented interactions and often overlook the broader, interconnected dynamics of caregiving that involve both human and robotic participants. Some research attempts to bridge two of these dyadic relationships, implicitly forming an open triad. For example, [37] evaluate the long-term social acceptance and user experience of autonomous robots in care facilities, considering the perspectives of both carers and older adults. However, comprehensive studies that integrate all three edges of the triadic framework i.e. robot-unpaid carer, robot-older adult, and unpaid carer-older adult interactions, are notably absent in the current literature and opportunity exists to explore each of these in tandem. This leads to the proposal of a design framework as a step toward HHRI interactions to address the complex needs of caregiving environments that involves interactions between the SAR and the older adult in the care of an unpaid carer. The design framework, which we term U-CARE (Unpaid Carer, socially Assistive Robots, and oldEr adults) is based on the concept introduced by Hornecker et al. [23]. The aim of this design framework is to enhance HHRI through collaborative human insights, adaptive support, and personalised interactions in a continuous, cyclical process, ultimately improving the quality of life for older adults while easing the burden on unpaid carers.

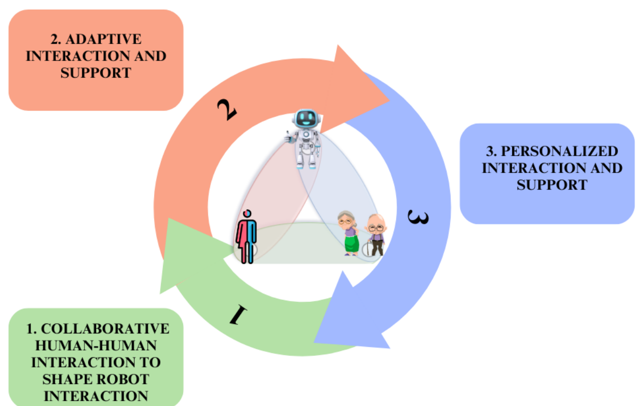

Fig. 2. U-CARE a step towards a triadic relation framework (HHRI)

Figure 2 represents the U-CARE triadic framework. At the center of the framework diagram, a Venn diagram is formed representing dyadic relationships between unpaid carer, older adult and a robot. The overlapping sections of the Venn diagram illustrate interdependence of the three aspects of dyadic relations within a triadic framework for older adult care. The interactions and connection between the study's findings and the development of the HHRI model between these dyadic interactions are represented in three stages.

1. Collaborative Human-Human Interaction: The study revealed that the interaction between unpaid carers and older adults forms the foundation of effective caregiving. The importance of maintaining the emotional and relational aspects of care that only human carers can provide. From our results, it became clear that the success of any robotic intervention hinges on first understanding and defining these human-human interactions. This realization guided us to position the unpaid carer and older adult relationship as the starting point of the framework, ensuring that the robot's role is built upon a thorough understanding of these dynamics. So, in the framework at the base of the triangle, the interaction between the unpaid carer and the older adult is highlighted. This interaction is foundational and involves sharing insights, understanding emotional and social needs, and providing direct care and support. The collaborative efforts between the carer and the older adult are important in shaping how the robot will interact with both parties.

2. Adaptive Interaction and Support: We found that unpaid carers highlighted the importance of having the ability to guide the robot's actions based on their intimate knowledge of the care recipient's needs and preferences. This finding led to the development of the model's second component, which focuses on the carer-robot interaction, ensuring that SARs can adapt their behavior in real-time according to the carer's input, thereby building trust and enhancing the caregiving process. The carer provides the robot with insights and instructions based on their understanding of the older adult's needs. The robot adapts its behavior and support mechanisms according to the carer's guidance, ensuring that it can provide relevant and effective assistance.

3. Personalised Interaction and Support: The final stage of the HHRI model emphasizes the personalized interaction between the SAR and the older adult.

The robot uses the information and instructions received from the carer to offer personalised support and interaction to the older adult. This personalisation helps in addressing the specific emotional and social needs of the older adult, enhancing their overall well-being.

Feedback Loop: An important finding from our study was the need for a continuous feedback loop between the older adult, the carer, and the SAR. Participants expressed concerns about the reliability and safety of SARs, emphasizing that their trust in the technology would increase if the robot could adapt its behavior based on ongoing feedback from both the carer and the care recipient. The circular arrows indicate a continuous feedback loop. The older adult's responses and changing needs are communicated back to the carer, who then updates the robot's instructions accordingly. This ongoing loop ensures that the robot's interactions and support are always aligned with the evolving needs of the older adult, providing dynamic and responsive care.

5.4 Recommendations

Our study recommends a methodological approach that integrates an in-depth contextual understanding of the interactions between unpaid carers, older adults and SARs, emphasizing that effective SAR deployment for care purposes in care settings should be informed by feedback from both carers and older adults. The U-CARE triadic framework can be potentially applied as part of the IEEE P7007 Standard for Ethically Driven Robotics and Automation Systems. By using triadic approach of U-CARE framework, developers can align with the standard's principles such as "well-being" and "affective computing", which are important for addressing the emotional and social needs highlighted in our results, such as providing companionship and reducing loneliness in older adults. This combined approach ensures that SARs are not only ethically designed but also responsive to the real-world needs of caregiving, enhancing the overall quality of care and support in these environments. Future research should aim to increase the sample size and extend the interaction duration in the wild, while also exploring the relationship between the robot, older adults, and unpaid carers from the perspective of the older adults.

6 Conclusion

This study highlights the importance of understanding unpaid carers' perceptions of SARs in eldercare. By conducting semi-structured interviews with 15 participants, we identified several key themes: the lack of human touch and feelings in robots, the role of robots as assistants rather than replacements, and the potential of SARs to provide companionship and minimize loneliness among older adults. Additionally, technical concerns such as trust in technology, understanding robot functionality, and safety were emphasized. The findings underscore the need to understand the collective interactions between unpaid carers, older adults, and robots as a triad relationship to provide adaptive and personalised support that is harmonious to the needs of both unpaid carers and older adults together. Such approach will ensure that SARs complement human care, address the specific needs of both the older adults and their carers, and mitigate the caregiving burden. From these findings, we propose that future research studies consider the triadic interactions between unpaid carers, older adults, and SARs in the design of personalised care.

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