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Placing a Robot: Exploring How Robot Autonomy is Constructed for Aged Care Within a Nursing Home Setting

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Abstract
Within the promissory discourse of care robots, claims regarding robotic autonomy have become increasingly important in scientific research and policy agendas. Autonomy, however, far from an inherent robotic attribute; is endeavoured, negotiated, and (sometimes) achieved within particular human-machine configurations. This paper delves into the assemblages that configure a care robot's autonomy within the context of aged care in a nursing home setting. Employing extensive qualitative methodology and drawing upon Science and Technology Studies (STS) literature, this study provides a thick description of the intricate dynamics that are present in the development, repair, and maintenance of a robot's autonomous capabilities. The findings shed light on the need for a redefinition of autonomy in aged care robotics and, most importantly, how the notion of place plays a key role in the interplay of spatial and social assemblages that construct robot autonomy.

Keywords Care robots · Autonomy · Gerontechnology · Older adults · Place · Science and technology studies

1 Introduction

Robots for aged care are considered a beacon of hope to the growing imbalance between the demographic rise of older adults needing care and the strain on healthcare services to provide integrated assistance. Care robots, in particular, are treated as a promising response at the intersection between industrial technology, trade policy, public science, and technology & innovation science [1]. However, even with substantial investments fueling progress in this field, research suggests significant uncertainty regarding such technology's suitability, acceptance, demand, and readiness [2–5]. Additionally, there are notable critiques of the care model that is so often embedded in care robots [6, 7] and a pressing need for participatory and user-centred design practices [8].

Amidst this nascent landscape, notwithstanding rising social exploration on gerontechnology's implications and ethics, there is still a notable empirical gap on the role that social sciences could play during robot development, implementation, and monitoring processes [7, 9]. Specifically, there is limited empirical knowledge on how care networks are transformed when robots are introduced into nursing homes [10, 11] and on how robotics could support the human times, spaces, and relationships necessary for sustainably cultivating good aged care [12]. Moreover, existing literature can often include problematic conceptualizations of ageing, methodological challenges, and an overwhelming dominance of the linear technologically determinist approach [13–15].

Conversely, Science and Technology Studies (STS) challenges the conventional understanding of care & robotics as embodied forms of semi-independent or independent technology. Instead, STS recognizes that both care relations and robots are created through complex networks of actants, where users play an active role in the development of the technology [16].

Adopting STS's understanding of care as an assemblage, the introduction of new actors triggers a transformation in the practices and values of care, as well as in both robot and care heterogeneity [17]. Robots, thus, cannot be interpreted as isolated artefacts with a set of functionalities that enter interactions with individuals [8]. Instead, the aim to weave technology and social theory into an integrated whole [18].

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Taking from this idea of heterogeneity, the robot is a technology that gains significance when it is integrated into a network of care relationships, emphasising the relational and contextual nature of the robot [17].

This study examines how robot autonomy is configured within the assemblage of aged care in a nursing home. Embracing autonomy as a relational and distributed property among various agents in an interdependent network, the following sections explore how it is constructed when a care robot is introduced into an aged care nursing home.

Autonomy holds particular significance in the field of robotics. It is the capacity to exhibit a certain level of autonomous behaviour that sets robots apart from other technological artifacts. Claims about robotic autonomy are not only prevalent in science fiction and popular media, but have become increasingly important to the promissory discourse in scientific research and policy agendas [19]. Nevertheless, the intricate dynamics and extensive human efforts involved in enabling a robot to demonstrate some degree of self-sufficiency often go understudied and overlooked.

Moreover, the discussion regarding autonomy revolves around two opposing viewpoints. On the one hand, in the context of robotics, autonomy is generally understood as the capability of robots to make decisions and execute actions without continuous human intervention [20]. On the other hand, in the field of bioethics, relational theory offers an alternative to the traditional notion of autonomy centred on self-governance and self-sufficiency, proposing a relational account of autonomy [21], putting forward a fundamental critique of the ideal of independence in human life.

Using a perspective that highlights that receiving and providing care aimed at supporting the health and wellbeing of older adults as an experience in which forces, capabilities or vibrancies flow through human bodies, thoughts and places [22], this article examines how a care robot's autonomy is resolved within the context of an aged care facility. In particular, this paper focuses on a care robot named Temi and takes place when it is introduced in an aged care facility located in the metropolitan area of Barcelona. By a combination of qualitative methodology – extensive participant observation followed by semi-structured and open-ended interviews with residents – the aim is to delve into the struggles and shifts encountered in constructing, repairing, and maintaining the care robot's ability for autonomous interaction. Moreover, addressing: How is a care robot's autonomy configured within the heterogeneous network of a nursing home? Additionally, what phenomena participate in the assemblages that configure robot autonomy?

This research reveals how the placement of a robot plays a pivotal role in the endeavour for robot autonomy. Understanding place as the 'intertwined knot of spatiality and sociality' [23], this study argues for an understanding of place as an additional element within the assemblage of the robot and broader care system relationships. In order to comprehensively discuss how place participates in the configuration of robot autonomy, two fundamental phenomena are examined: (I) the spatial focus involved in installation and maintenance, and (II) the social dynamics of human-robot relations.

Interestingly, there is still much to explore regarding the notion of place in the domain of care robotics and contextually situated research in STS. Notwithstanding, exploring robot placement addresses a crucial practical concern in robotics — ensuring and anticipating that technology responds appropriately to user interactions [24]. In this manner, this study brings forth a nuanced discussion in this field and hopefully provide insight for the design, development, and implementation of future robotic systems in aged care.

This paper is structured in five sections. First, a short overview of how autonomy is framed in social robotics and STS. Next, in the third section, the empirical case and methods of the study. Section four offers a discussion on the study's findings, and finally, the concluding section highlights key findings and directions for future research.

2 Assembling autonomy

Autonomy has long been discussed as a cornerstone of good care. In active ageing policies, autonomy has become the driving force behind most services and technologies within a context of increasing long-term care needs [25]. Against this backdrop, care robots are presented as innovations that could strengthen the autonomy of older adults living in nursing homes. Accounts of robots interacting effortlessly with older people and supporting their caregivers are not only present in popular media but also in scientific research and policy agendas [19].

This portrayal of care robots as "autonomous technology" echoes the notion of robotic autonomy in practice, which holds that, once programmed, robots should be able to operate with minimal human intervention [26]. More precisely, in human-robot interaction (HRI), autonomy is understood as 'the extent to which a robot can sense the environment, plan based on that environment, and act upon that environment, with the intent of reaching some goal (either given to or created by the robot) without external control' [27].

In this context, the societal objective for robots and older adults appears to center on achieving autonomy. However, the 'ideal of autonomy'— both in older care and robotics — has been contested at several levels. Care ethics puts forward a relational account of autonomy, emphasizing that individuals' actions are inevitably connected to multiple interconnected factors, including the social relationships,

personal characteristics, and the chances and restrictions of the agent's environment [28]. Likewise, robotic technology also requires broader socio-material arrangements [25]. From the STS perspective, robot autonomy is approached as a fragile and precarious phenomenon that needs to be maintained and repaired, not only through technical interventions but also in a conversational sense with the users [19].

Autonomy, as an emergent attribute that is materially heterogeneous and distributed, requires constant testing and attuning [25]. Apparently seamless human-robot interactions are sustained by invisible backstage work. The staging, mediation, and performance of the interaction depend crucially on the detailed material and technological arrangements in place [29]. For this reason, robots do not always lead to less work overall for the individuals expected to benefit from such technological advancements, but rather, there can be newly added human labour from automation [30]. As these efforts are often hidden, it is by observing real-world practices that it is possible to unpack the adjustments by which humans (and robots) accommodate each other's specificities.

3 Case and methods

This paper presents an ethnographic study conducted during the introduction and testing of a care robot in a nursing home for older adults. As part of a broader one-year initiative, the study focuses on the initial phase of testing—encompassing the preparatory design work and the first seven weeks of deployment. From mid-April to early June 2023, the robot, named Temi, was installed at a nursing home situated in the metropolitan area of Barcelona and used by residents and care workers without on-site intervention from the roboticists.

The project was developed by an interdisciplinary team comprising partners from academia, industry, healthcare, and residents from the nursing home. It brings together actors from four key areas: a third sector entity responsible for coordinating involved parties; a company specializing in assistive robotics, providing technological services and software development; a nursing home, where caregivers and residents carried out testing; and the Barcelona Science and Technology Studies Group, focusing on the impacts of such technology. The study's authors are part of the latter group, with the first author conducting ethnographic research.

Grounded in a Science and Technology Studies (STS) perspective and guided by an ethics of care approach, this study recognizes that knowledge is situated and shaped by the researcher's positionality. The ethnographer's role was not only observational but participatory, often acting as a mediator between the robot, care workers, and residents. This involvement blurred the boundaries between researcher and actor in the field, affording a deeply embedded perspective on the ongoing negotiation of robot autonomy.

Being a university-affiliated researcher without formal training in robotics or caregiving, the ethnographer's outsider status simultaneously enabled open-ended dialogue with participants and required careful negotiation of trust in a context marked by professional hierarchies and age-related experiential divides. Importantly, this work was informed by a commitment to relational ethics, valuing different forms of knowledge and expertise, particularly those often marginalised in technological development processes. To become acquainted with the nursing home community, the ethnographer went on different occasions to the nursing home before the robot's arrival.

Moreover, prior to the robots' deployment, all members of the project's interdisciplinary team participated in several meetings to collaboratively discuss procedures for obtaining consent, how to present the project to residents and their families, as well as the robots' functionalities and the overarching objectives of the study. However, once the robot was installed, not everyone involved in the project was present during the robot's day-to-day use. Only on two occasions did the roboticists come back to conduct onsite re-programming of technical glitches. Daily interactions with the robot involved the six care workers, who rotated depending on their shifts, the nurse assigned to the project and responsible for monitoring the robot's functioning, the social worker who visited for weekly sessions, the residents, and the ethnographer.

The robot, Temi, is an *autonomous* mobile device that can assist and interact with individuals in various environments (see Fig. 1). Equipped with speech recognition, natural language processing, computer vision, facial recognition, and mobility, they are designed to navigate spaces and interact with users *autonomously*. In the context of aged care, Temi robots can be used to provide companionship, medication reminders, vital sign monitoring, emergency assistance, cognitive stimulation, and social engagement.

While Temi robots have been explored in various aged care contexts, including efforts to reduce loneliness in geriatric care [31], minimize health risks in assisted living [32], and understand care workers' experiences with robots [33], its use in Spain has so far been limited to in-home private elder care. For this reason, there is little research on the challenges that emerge when adapting the robot for institutional care settings.

Figure 2 shows a detailed map of the dining hall. Each blue block indicates a table, seating six residents in assigned positions. At one end of the room, there is a careworker's desk equipped with a computer, allowing staff to perform tasks while monitoring the area. The bathroom section,

Fig. 1 Robot Temi (right) and residents in the dining hall. Source: local TV

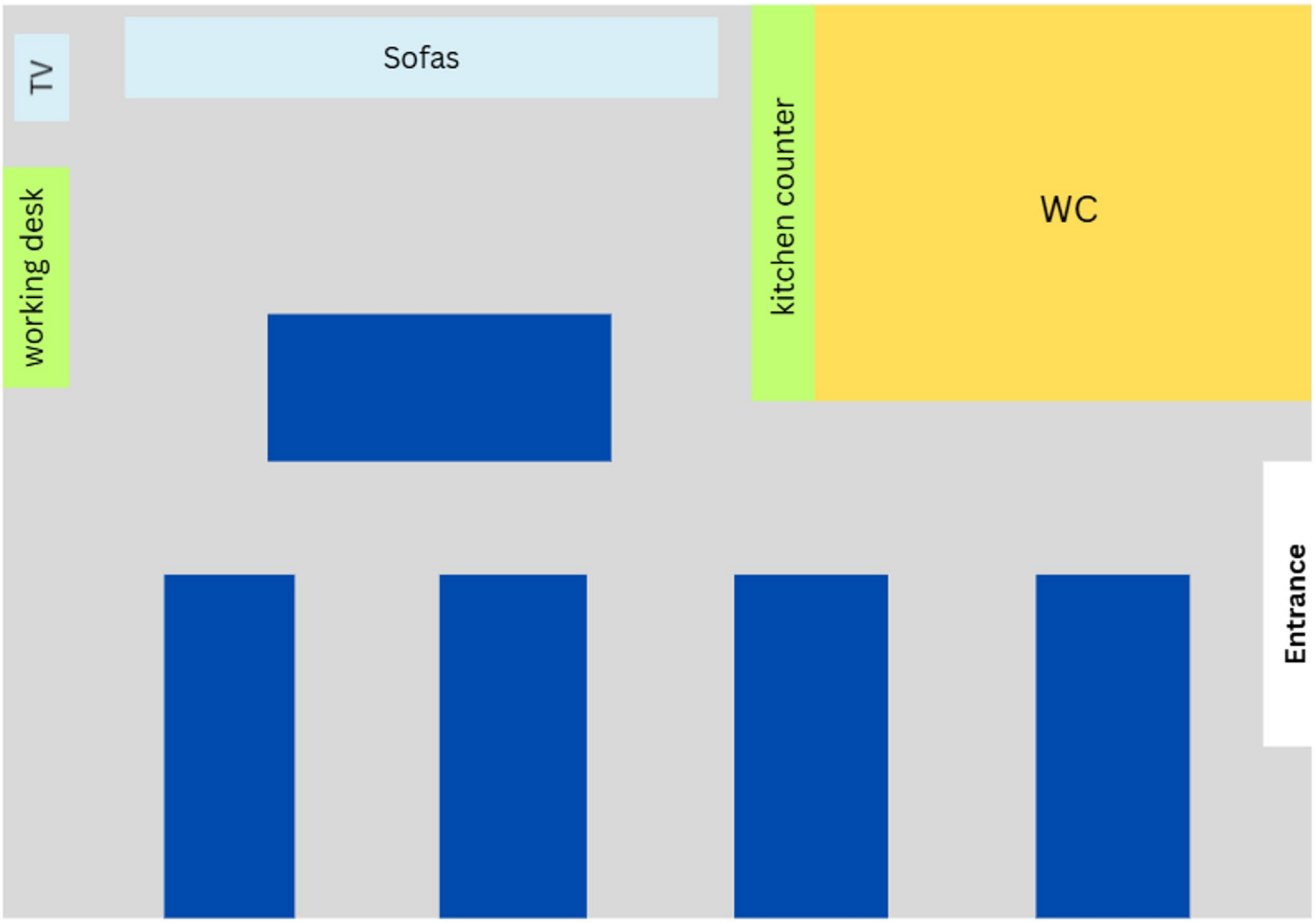

Fig. 2 General organization and map of the dining hall. Source: local TV

highlighted in yellow, is a private and restricted space containing multiple rooms designated for different tasks of hygienes.

At the nursing home, the robot was thought out to participate in different ways. It was programmed to provide reminders and schedules surrounding meal times, enhance the group music session, maintain a conversation, and offer information such as news and weather forecasts (see Fig. 3). These features were pre-established within the robot's software, and their incorporation was agreed upon during the initial team meetings.

Decisions regarding the testing space and resident participation were led by professionals from the nursing home. The selection criteria of participants was based on prioritising residents with better health. Participant selection prioritized residents in better health, and because the facility is organized into sections according to health status, independence, and care needs, the robot was deployed in the areas of residents with greater autonomy. As a result, thirty female residents—reflecting the demographic composition of those particular sections— participated in the study. Interaction with the robot was completely voluntary, and residents could freely decide whether or not to engage with it.

Once this had been agreed, the robot was installed in the main dining area of the nursing home. This space serves as a central hub where residents not only have their meals but also spend their free time, socialise and participate in programmed activities such as the music or bingo session.

The study was approved by the University's ethics committee. The principal ethical challenge of people with cognitive impairments is that they may have difficulty understanding the nature, purpose, or implications of a research study. To mitigate this risk, before the robot arrived, care workers organised a session with residents, providing a detailed explanation of the project and addressing any questions or concerns. Apart from being informed verbally, participants and their families received a plain language statement on the aims and procedures of the research to sign. Likewise, participants who were interviewed signed a consent form that explained the objectives of the interviews, as well as the measures in place to ensure confidentiality and anonymity of their data. All interviews were recorded and transcribed.

Fig. 3 Resident interacting with Temi. Source: Local TV

Adopting an inductive or 'bottom-up' approach, extensive participant observation was conducted, followed by semi-structured and open-ended interviews with residents. Specifically, seven ethnographic interviews were conducted, that is, in-depth, informal, conversations designed to understand a participant's perspective. In addition to this, formal interviews were conducted with the two residents who had interacted most with the robot: one who had used the robot to videocall family members and the other had mostly used it for conversation.

Ethnographic research consisted of an average of two days per week, averaging five hours per day. During this time, the ethnographer observed interactions between the robot and residents, spoke with individuals at the nursing home about their impressions of the robot and technology more broadly, and closely followed the daily practices of care within the facility. On many occasions, the ethnographer was also expected to assist with the robot and took on a mediator role during robot-resident interactions, providing support when necessary.

Literature suggests that ethnography is the most suitable approach for exploring the unfolding impacts of robots in nursing homes, due to its potential to elucidate people's interaction in a real context with in-depth observation of their behaviour as well as reasoning [34]. In particular, the research draws on focused ethnography, an increasingly popular form of ethnography characterised by relatively short-term field visits and data intensity. Data intensity refers to the fact that in focused ethnography larger amounts of data are collected within a shorter time frame compared to long-term ethnographies. This approach has proven its utility in examining the development of specific technological systems, providing insight into the rapid changes, such as shifts in work practices to meet the new technology's requirements [35].

Qualitative studies have been shown to be powerful tools to explore HRI that differ from hypothesis-driven experimental approaches; they capture holistic, multi-factorial and emergent data in a way that is nonetheless formal, rigorous and systematic [36]. Following this tradition, this study does not aim to generalize the findings to other robots or establish a comparison with other robots. As ethnographies rely on data tied closely to a specific context, applying findings to other types of robots does not fit with the purpose or methods of this study. Instead, the aim is to explore, explain, and describe the integration of a particular robot within a nursing home setting.

Regarding data collection, both observations and interviews were taken in the form of fieldnotes by the ethnographer. All interactions were documented, including not only

those between residents and the robot, but also the practices and engagements of roboticists, care workers, and residents. All personal identifiers were removed from transcripts, notes, and other research materials.

Fieldnotes are a long-established method of data collection that provides direct experiential and observational access to the insider's 'world of meaning' [37]. The interviews and fieldnotes were transcribed to explore in detail the dynamics of interaction during conversations and pinpoint the nuances that offer insight into what the residents found meaningful during interaction with the robot [34].

This study draws on interview transcripts and fieldnotes gathered through participant observation. The analysis was conducted manually by the ethnographer and overseen by senior researchers involved in the project. Employing reflexive thematic analysis, themes—understood as patterns of shared meaning shaped by a central organizing concept [38]—were identified inductively from the data. This means that the themes are developed directly from the data, rather than being driven by theoretical interests. Instead, analysis is data-driven, as patterns are strongly linked to the field notes. This involves identifying key themes in the data, for example, instances of people talking about invisible human work vs. reducing workflow with the robot.

The topic of autonomy was not a pre-existing research focus; rather, it evolved organically during analysis, particularly as invisible work and high expectations on robot autonomy were recurring themes in the fieldnotes. Nevertheless, it is important to acknowledge that researchers are not detached from their theoretical and epistemological beliefs. This is what Braun & Clarke (2019) highlight with *reflexive* thematic analysis, that is, they recognise the researcher's role in knowledge production and are aware of the need to question assumptions made when interpreting and coding the data [38].

The overall goal of the analysis is to create a 'thick description' of the fieldwork, in other words, to provide a densely textured description of the social phenomena, shedding light on the layers of cultural significance underlying themlayers of cultural significance underlying themlayers of cultural significance underlying them [39]. Thus, incorporating 'thick descriptions', means delving into the intricate details and nuances of care heterogeneity, enabling a deeper understanding of the meanings and interpretations associated with the introduction of the robot in the nursing home.

4 Robot abandonment

This section provides an examination of the key findings from the ethnographic observation and interviews conducted during the first seven weeks of testing the robot Temi in a nursing home setting.

Upon initiating testing at the care facility, the robot became intricately entangled between two different logics regarding its functionalities. On one hand, during initial interactions, it became apparent that the technology fell short of the residents' and caregivers' expectations for an independent and self-sufficient device. In dissonance with the imagined robot companion, the robotic system required extensive onsite adjustments to navigate the premises, engage in conversation, and schedule reminders. Moreover, its functionalities consistently encountered issues, requiring significant time and effort from a third party, often a caregiver at the nursing home.

On the other hand, this did not come as a surprise to roboticists. It is common that scientists struggle to align their day-to-day work with the promissory discourses concerning the prospective impact and meaning of technoscientific projects [19]. Interestingly, the robot's lengthy installation process and recurrent need for adjustments were not interpreted as a problem, but rather as a testament to the fact that robotics is still in its early stages of development.

As the testing process advanced, the friction between the user's envisioned robot autonomy and its actual demonstration intensified. This disparity led to a sense of uncertainty among caregivers and residents about how to effectively make use of the technology. Over time, the robot ended up on the major part left turned off and in the back of the room, seemingly 'abandoned'.

Drawing on Latour's detailed analysis of Aramis (1996), the significance of exploring the failure to construct robot autonomy in the fieldwork lies in the understanding that it is precisely when an artefact breaks down that we gain access to its underlying design. Far from an object, it is a lash-up, an association of humans and non-humans, an institution, parts of which are delegated to pieces of machinery, parts of which are delegated to collective persons, and parts of which are delegated to humans [40].

In the forthcoming sections, an overview is provided of the assemblages that intertwine in the configuration of robot autonomy, outlining the two key dynamics and interactions that have shaped the robot's state of autonomy, namely: (I) the spatial mapping of the nursing home, and (II) frictions in human-robot interaction.

4.1 Spatial mapping of care

Similar to typical robotic testing processes, the care robot required regular efforts of maintenance and repair to function properly. In the specific setting of the study, the presence of roboticists on-site at the nursing home was limited to the initial installation phase and two occasions when specific spatial issues required their in-person intervention. Consequently, the majority of the robot's technical challenges were attended to by a caregiver at the nursing home, leading to a consistent three-way interaction between the resident, caregiver, and robot. This dynamic is what Hornecker et al. (2020) named the triadic interaction scheme (HHRI), which implies that successful integration of robotic care technology still needs to rely on the interaction between residents, caregivers, and the technology itself [41].

On the day robot Temi was introduced at the nursing home, all involved parties – roboticists, residents, caregivers, and academic researchers – eagerly gathered to witness the robot's arrival. In a short time, the discrepancy between vision and demonstration of care with robots became apparent [19]. On the one hand, the two roboticists silently embarked on the lengthy installation process, which took nearly the whole afternoon. On the other hand, the rest of us probably were expecting to see the robot quickly navigate spaces and start interacting. In fact, when the robot arrived, a resident went up to it and requested it to "sing something for her" or "dance a little", followed by a care worker's explanation that such actions weren't part of the robot's programming. Quoting Benjamin Lipp's work [19], this aligns with the idea that care robots become real in two largely disconnected ways.

During the installation process, much like cartographers, two roboticists methodically mapped out the physical space where the robot would move around, meticulously programming key reference points and identifying potential obstacles. Sitting in the middle of the room while residents, care workers, and social scientists watched attentively, they started working on the robot's program from their computers. The program gradually depicted two different colours to indicate the areas where it could move freely and the positions of objects (see Fig. 4). Additionally, they designated a specific location where the robot would stay and recharge when not in use. This spot was located at the back of the room, slightly behind the caregiver's desk.

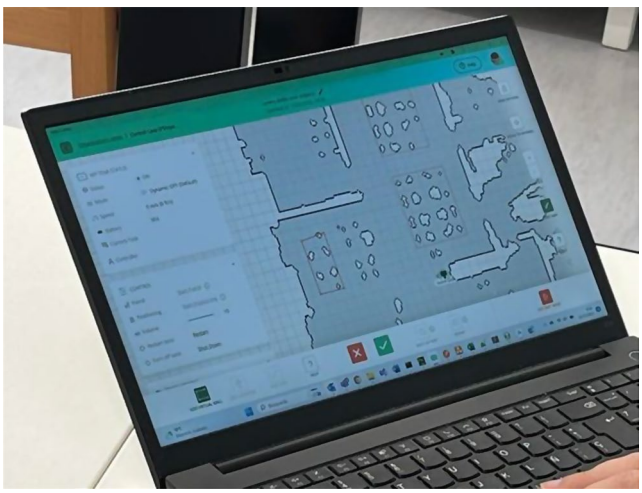

Fig. 4 Resulting map from the installation process

To preserve this differentiation, it was necessary to ensure that obstacles like tables and chairs remained in their designated positions during the following months of testing. Even minor changes in the furniture layout could disrupt the robot's ability to navigate around the room. Additionally, there was uncertainty regarding whether the robot would recognize wheelchairs as obstacles and how this would impact its movement. Fortunately, this was not a problem, and maintaining the accuracy of the robot's 'map' was relatively uncomplicated due to the regimented nature of daily life in the nursing home, which includes assigned seating positions and fixed schedules.

Figure 5 shows the dining room after the robot's installation. At one end of the room, adjacent to the careworker desk, the robot's charging area is highlighted in red. The remaining seven spatial reference points are marked with an 'X,' and were distributed throughout the room.

Certainly, "nothing comes without its world" [42] and the robot's capacity to move around in an 'autonomous manner' is the product of hours of tailored and scrupulous human effort. This phenomenon echoes what is discussed within STS as the invisible worker or invisible infrastructures [24]. Quoting Latour, behind the solidity, robustness, beauty, and originality of science and technology, there are their artisans, factories, human and non-human allies [40].

Once the roboticists completed the successful installation and left, it soon became evident that the robot's functionality depended on active involvement and behind-the-scenes effort. Consequently, a caregiver undertook a wide range of tasks to achieve, at most, glimpses of autonomous behaviour. These activities included programming real-time dialogues from a distance, addressing frequent technical glitches, encouraging resident interaction with the robot, as well as guiding and rephrasing questions directed at the robot. However, when caregivers were occupied with their responsibilities, this resulted in long periods where apparently 'nothing happened' with the robot.

On one particular morning, the caregiver who had been in charge of programming the robot made a spontaneous decision to 'let the robot lose'. Curious to see what would happen without her intervention, she turned on the robot and left the room to continue her work in another area of the facility. It was only a few minutes later that she received a

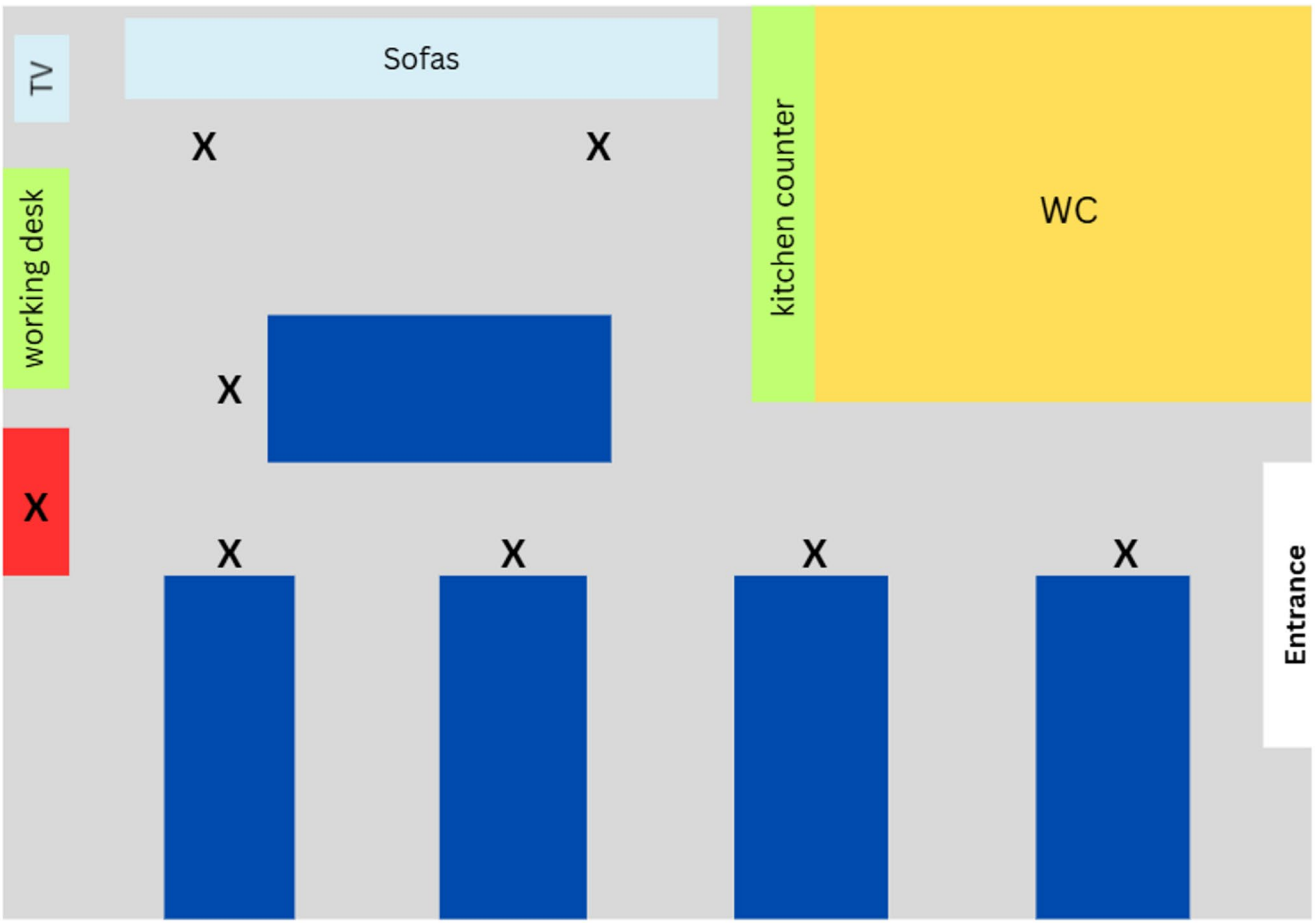

Fig. 5 Robot installation in the dining hall

call on her work walkie-talkie from another worker, requesting her to go and turn off the robot "because it had gone mad". As she later recalled with a touch of humour, the robot had started following someone around the room and was unresponsive to commands.

This anecdote highlights an intriguing aspect regarding the concept of a robot's 'ideal' autonomy. 'Full autonomy'—wherein a robot that moves around without any human involvement—is not only unwanted but also completely impractical. Instead, a desire for a relational account of autonomy is developed, one that is tailored to the nursing home's physical and social requirements. Indeed, successful autonomous systems are those that effectively establish a level of human-machine collaboration, where responsibilities and decision-making authority are distributed between humans and machines [43].

By challenging both the feasibility and desirability of achieving 'full autonomy' within the domain of care robotics, it becomes apparent that there is a need to redefine robot autonomy. Even though care robots are designed and imagined to reduce human involvement and automate tasks, they are dependent on extensive human preparations and ongoing efforts to operate effectively. This isn't new to the care perspective, where autonomy is conceived as a relational property and the possibility of a self-sufficient self is rejected. In contrast, it is argued that to understand the value of care itself, it is necessary to rethink the human condition as interdependent [21]. Thus, we point towards the need for a redefinition of autonomy in care robotics, one which conceives autonomy as enacted within particular spatial and social assemblages.

4.2 Spatialising human-robot interaction

Throughout the exploration of interactions in the nursing home environment, the enactment of certain distances were observed when the robot was introduced. In line with construal-level theory, the individual's self in the here and now is treated as the reference point for assessing distance [44]. The concept of distance is relevant to understanding robot autonomy because the farther the technology is removed, whether physically or subjectively, from an individual's experience of self, the poorer interactions become.

As the accumulation of distancing circumstances compromises the efforts of maintenance and installation, it also hinders the achievement of robot autonomy. Building upon this, three distinct ways in which the robot is detached from the self in the present moment are identified: physically, symbolically, and emotionally.

4.2.1 Physical distance

As the most fundamental form of contact, social touch is commonly used to build a sense of togetherness [45]. In the field of aged care, recent studies point to the benefits of touch interaction in robot therapy, leading to the growing development of robots that focus specifically on touch interaction [46].

In the context of the nursing home, touch plays a particularly intriguing role. On one hand, despite residents always sitting together, they generally do not engage in any form of physical contact. Even when conversing about disheartening subjects like overwhelming feelings of loneliness or contemplating one's death, a twenty to thirty-centimeter gap between individuals remains intact. However, in caregiver and resident interactions, physical proximity and contact are indispensable. Caregivers recognize the significance of close interaction by actively crouching down to maintain eye level with the residents, placing their hands on their shoulders, and providing comforting gestures such as caressing their faces and offering a reassuring pat on the back. In fact, one of the caregivers shared that one of the first things that struck her about the care robot was that it didn't have hands.

In social robotics, physical embodiment and tactile interaction have been explored as key factors in human-agent interaction [47]. However, unlike social robots designed for touch, this particular human-robot interaction is characterised by a lack of physical contact. Temi robots, equipped with speech recognition and natural language processing, do not need physical interaction to carry out their tasks and engage with individuals. Instead of hands, the robots rely on their built-in touchscreen display as the primary interface for user interaction.

This leads us to understand that when it comes to providing care, the robot's interaction pattern does not align with the particular caregiver and older adult interaction. This disparity poses a challenge when integrating the robot into existing practices, as simply incorporating it into nursing home activities proves ineffective.

Indeed, physical touch holds a central role within the heterogeneous network of care in the environment this study explores. Specifically, holding hands serves as a powerful way for caregivers to express care toward residents. This became notably apparent when observing the weekly guided music session. During the session, the organiser requested residents to form a circle and repeatedly held and moved their hands to the rhythm of the music. In the final song of the session, she asked participants to hold hands. As they joined hands, the dining hall seemed to be permeated with a tangible expression of connection, trust, and intimacy.

When the robot was incorporated into the music session, the robot interfered with the contact between caregivers and residents. The organiser was no longer able to hold the participants' hands, as she had to stay close to the robot to operate and control it. Understandably, this shift in dynamics led to the decision to remove the robot's involvement in the session.

4.2.2 Symbolic distance

After completing six weeks of ethnographic research, interviews with the residents were initiated. Initially, it was believed that it would be relatively easy to find participants who were interested in being interviewed. Unlike other fields of research, the residents have ample free time and have already engaged in conversations that span a broad spectrum of topics. Surprisingly, however, the response was different from what was expected. Residents didn't want to talk about the robot because "it had nothing to do with them" and they were scared of being caught "saying something ignorant about it".

It was only after reiterating my genuine interest in their perspectives that two residents eventually agreed to participate in the interviews. However, they imposed certain conditions for their involvement. They requested that the interviews were not audio recorded, that they would be allowed to review my notes, and granted the freedom to remove any elements they deemed necessary.

As they expressed, the reasoning behind this initial hesitation stemmed not from their lack of interest but rather from their belief that robotic technologies have little relevance or connection to older adults. Particularly, "older adults who hadn't received formal education". One resident mentioned that her grandson, an engineering student, would likely find it fascinating. Another commented that, in her view, robots were more suited for "connoisseurs." Moreover, this last resident added:

> When I [the resident] look at it [the robot], it's as if I weren't seeing anything because I can't understand it… It's a curious thing [the robot], but a curious thing for them [the engineers] because we don't understand anything. (Interview with resident)

This sense of perplexity can be understood by the fact that emerging technologies are not simply tools that expand what we can do; they engender new forms of life. Technological

innovation, far from a unilinear progression, is of a multicentered and complex nature [48]. An effect of this phenomenon is shared situations of confusion regarding the role or use of the technological development. Even when we grasp an understanding of how to use such devices, most technology is described solely in terms of their outputs and inputs, leaving us to not understand anything about what goes inside such black boxes. Even if we might know how to drive a car, we probably won't know how to fix it.

In this context, the resident's perspective adds a layer of complexity. Not only does the robot create confusion regarding its use and working, but it also configures a 'we' and a 'them'. This perceived division between engineers and users refers to what is known in social sciences as the expert divide. This divide represents a disparity in knowledge, understanding, and access to information between academic professionals and the general public. In this case, the accounts of the expert-resident dissonance shed light on another node of the heterogeneous network of the robot's network: symbolic distance.

4.2.3 Emotional distance

Temi robots are designed to engage in various types of conversations with users. In this study, the robot's scripted dialogues included reminding older adults about medication schedules, alerting emergency services or family members, and offering weather forecasts and current breaking news stories. Far from establishing a natural or casual style of conversation, its language is characterised by being formal and concise.

During testing, it became apparent that the predefined conversation areas and language style programmed into Temi's software did not accurately mirror the topics and interests prevalent in real-life conversations among the residents. Residents were encouraged to ask questions to the robot, but their questions were nearly always unanswered. Examples of these unanswered questions included:

> 'When will I be able to go back home?' 'Why don't you work?

> 'Can you sing something for me?' 'Give me some good news'

> 'Tell me about whatever you want' 'Do you know I care about you?'

This mismatch between robot conversation patterns and the residents' natural communication highlights the emotional distance between envisioned and tested interactions. Quoting an interviewed resident:

> Yes, I have tried to speak to it [the robot] but we don't get along very well. It doesn't chat, it doesn't have time for chit-chat (Interview with resident)

Though a formal language could be ideal in other contexts, the ability to establish chit-chat is extremely important in nursing homes. Research suggests that the most popular activity among residents is talking, and the most common conversations centre on their feelings about living in the facility [49]. In contrast, the design of the robot in aged care focuses on providing medical care and emergency assistance and isn't designed for fostering emotional support or natural social interaction. This conversational mismatch sometimes led to confusion among residents, as sometimes when they attempted to casually interact with the robot, it would respond as if they were requesting medical or emergency assistance.

This dissimilarity can partly be explained by the fact that studies indicate that design practices can often be tainted by a distorted and prejudiced conceptualization of aging, partly due to the process of user integration or participation in developing products [50]. Simply put, older people have not been present in the design, and their concerns are not identified; instead, they are ascribed to general needs resulting from healthcare demands and demographic shifts [31]. In this context, it is worth noting the substantial body of STS that advocates for the implementation of participatory design within robot manufacturing, involving users right from the inception of the design process [51].

5 Placing robot autonomy

Approaching autonomy as inseparable from particular human-machine configurations [52], the findings offer insights into the processes by which a care robot strives to achieve autonomy through spatial and relational practices. The dynamics of the more-than-human assemblage, which strives for stabilisation, comprise two main phenomena: installation & maintenance, and relationality.

On one hand, the installation process emphasises the significance of a fixed arrangement of objects, furniture, and people in enabling the robot to move and perform tasks with a sense of autonomy. Indeed, the positioning of the robot within the room has a direct impact on its ability to interact effectively with individuals. This leads us to reiterate the importance of spatial dimensions in configuring and sustaining robot autonomy within the context of aged care.

Adhering to geography's dominant view of space as deeply relational, the findings align with the idea that spatiality cannot be taken any longer, especially for practical purposes, as referring to points 'in' a causally inert, geometrical uniform manner [53]. Instead, space acts as a swirl of flows, networks, and trajectories, as a chaotic ordering that locates and dislocates, and as an effect of social process that is itself spatially dispersed and distributed [6].

Much like Certeau's take on pedestrian spatial practices [54], while the spatial order of the residence organises an ensemble of possibilities and interdictions, the robot's introduction actualizes these possibilities, transforming each spatial signifier into something else. To perform a certain degree of robotic autonomy, paths must be cleared and furniture mustn't be moved.

As a result, this study rejects the notion that robots simply adapt to their spatial environments, instead, the research points to a co-adaptation of both the environment and the technology to accommodate the robots' place in the care practices. Much like any other technology, robots are stabilised if and only if the heterogeneous network of relations in which they are involved reach some kind of accommodation.

Moreover, when inquiring about the robot's place, it is also important to ask about what kind of place the nursing home itself is. Ethnographic observation allowed familiarisation with the spatial and social structured nature of the facility and how daily life is governed by numerous set schedules, encompassing activities such as meals, medication administration, personal care and hygiene, therapy and rehabilitation, family visits, and group activities. Upon closer examination, it becomes apparent that the place in question possesses highly striatiated properties as described by Deleuze & Guattari [55]. Striation entails the establishment of strict boundaries, identities, and spatial practices that are stabilised in strictly bounded territories with choreographed spatial practices and socially controlled identities [56].

In contrast, testing processes usually happen in spaces that grant roboticists almost complete control over the conditions of tests [19]. In the context of this care robot, Temi requires its structuring of the space. By mapping out an area, making it possible to move, it is also conducting its own striation of its surroundings. When the facility's particular striation clashes with the robot's specific striation, it creates further challenges in the assemblage's struggle to meet the robot's autonomy needs.

This leads us to discuss another crucial element in configuring robot autonomy: social relationality. Firstly, caregiver involvement is essential to the maintenance of the robot's ability to exhibit some degree of autonomous behaviour. This dependency resonates with a common critique of robot experiments, which is that they primarily focus on human-human interaction mediated through a robot rather than examining human-robot interaction [19]. This goes to show how care robot functionality is inseparable from the practices of care workers and how, ultimately, robots display agency through interaction embedded in heterogeneous networks of humans and non-human actors [51]. Viewing interactions between humans and robots as collective achievements highlights the need for a practice-oriented approach—one that recognizes and prioritizes everyday care practices [41].

In this manner, an important consideration regarding participants' involvement is the framing of the study as a pilot project. Awareness of the experimental context may have influenced positive appraisals and their interest in the pilot 'being successful' — a phenomenon known as the Hawthorne effect. This effect has been shown to influence outcomes in robot pilot tests, indicating that additional dimensions and relations should be integrated into the analysis to explain robot autonomy from a relational perspective [57].

In summary, autonomy is a precarious achievement, assembled within the relational nexus of spatiality and sociality. This leads us to identify a new element within the assemblage that enables robot autonomy: the notion of place. In the context of this case study, as testing went on, the robot often found itself left turned off and placed in the back of the room, giving the impression of being 'abandoned' for the most part. The robot's place illustrates the network's struggle to meet the autonomy demands of the robot.

Interestingly, the notion of place remains profoundly unexplored in the domain of care robotics. Historically, the status of place has been simplified either as an objective entity or a subjective sentiment or experience. However, more recent literature challenges both object and subjectivist reductionism, adhering to "staying with the trouble" that comes with the entangled ontological complexity of the phenomenon of place [23].

Effectively, the robot's placement diminishes its need to entangle itself within the network. Anecdotally, during ethnographic inquiries about the robot's place, on one occasion a resident responded that she thought that 'the robot had been lost'. Indeed, autonomy—the attribute that characterises and differentiates robots from other technological artefact—is a precarious achievement which can be easily lost.

Lastly, the robot's abandonment is particularly interesting as fear and feelings of abandonment by families are a recurrent theme in conversations between people residing in the nursing home. Thus, highlighting the uniqueness of an abandoned robot within what is perceived to be 'a place of abandonment'. The intention of this study is not to argue that residents and the robot hold a similar place within the

network; rather, it aims to call attention to this common connection which is the dialogue between feelings of abandonment and the robots & residents.

6 Conclusions

Challenging the idea that robot autonomy is separate from its particular human-machine configurations, this paper has examined the processes by which an assemblage endeavours to construct and stabilise care robot autonomy in a nursing home. Drawing on care ethics' relational account of autonomy [21], this study puts forward the argument for a redefinition of autonomy in care robotics.

Through in-depth participant observation and interviews with users, the findings show that robotic autonomous behaviour, at most, is a precarious achievement that depends upon the larger assemblage. In this manner, it is not the robot that is autonomous, but rather the entire assemblage.

In the struggle for autonomy, place—that is the knot between the spatial and social dynamics—holds an important role. In other words, the achievement of autonomy depends upon granting the robot a *place*. A robot that achieves an adequate place, occupies an adequate space at an adequate moment in time is seen as 'autonomous'.

In this case study, the robot's 'abandonment' illustrates how the notion of place participates as another actant within the heterogeneous robot's network and system of care relationships. Furthermore, throughout the descriptive analysis, this research explores the demands of robotic autonomy and the associated difficulties with transforming an environment to enable the emergence of robot autonomy. Though the nuances of place are yet to be investigated in STS research, this analysis hopes to offer a practical example of how place is not only congruent with, but directly supports STS's empirical approach to heterogeneous networks.

In this manner, this article encourages further investigations on robot autonomy to focus on identifying how robot placement is practised, and what places facilitate the establishment of a higher degree of autonomy in care robots. Note that in the context of this study, it seemed that the robot temporarily held a less marginal place when engaging in video calls with family members rather than attempting to integrate into pre-existing activities. This leads us to consider that assigning robots to new tasks rather than replacing or enhancing existing aged care dynamics is a mitigation factor for situations of 'robot abandonment'.

Future research could examine how the physical placement of care robots within facilities (in communal areas, private rooms, or transitional spaces) influences the acceptance and assemblage of 'robot autonomy'. It would also be valuable to study its integration into daily routines, that is, which specific settings or contexts—such as facilitating video calls—enable robots to assume more central roles without disrupting established care practices.

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Declarations

Ethics Approval and Data Availability The research was approved by the Research Ethics Committee of the Universitat Autònoma de Barcelona (CERec). The datasets generated during the current study are available in the institutional repository of the Universitat Autonoma of Barcelona. Any additional data that support the findings of this study are available from the corresponding author upon reasonable request.

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