The Interactive Enactment of Care Technologies and its Implications for Human-Robot-Interaction in Care

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ABSTRACT

Various technical innovations for the care sector, particularly robots, are being developed to cope with demographic change and to support nursing staff. A central issue for the successful integration of such technology into gerontological care practices has not yet been appropriately addressed from an HCI perspective. Here, we draw from observation of lifting devices, used to move residents between bed and chairs. We found that this process is always moderated and facilitated by caregivers' 'interaction work': The function(ing) of care technology is inseparable from the interactive practices of care staff enacting these functions and from the emotional labor inherent to care practice. The caregivers' verbal, manual and emotional actions, and also the residents' active cooperation in the process are important factors for safe, fluid, and pleasant human-machine interaction. We propose to understand such technical care settings as a triadic interaction, and to take account of this in the future design of care technologies, in particular for robotic solutions.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in HCI studies; • **Computer systems organization** → Robotic autonomy;.

KEYWORDS

Healthcare, Collaboration, Elderly Care, Residential care, Care robotics, Social robotics, Socio-materiality, Human-robot-interaction, Ethnography

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1 INTRODUCTION

Given demographic change and resulting challenges in the elderly care sector, funding for technological innovation in elderly care has increased massively. Besides concepts for smart homes for aging in place, various projects aim to develop autonomous technology in form of care robots [4, 9, 14, 20]. For various reasons, this development has met concern. National ethics boards have discussed the potential role of robotics in elderly care [6, 52]. In the field of care work, the notion of care robots evokes strong reactions, and the importance of human care is stressed.

A key argument is that good care requires comprehensive knowledge of practices [12], thus the use of robots in care would lead to a dystopian future [39]. We also know from ethnographic studies about practices of care that care work always involves interaction work, which is situated [15] and involves emotional work [19] to support emotional wellbeing. While going through functional care tasks (lifting, undressing, transfer, washing, etc.), care staff engage in emotional and collaborative actions, and adjust their actions to the needs of the resident (e.g. talking to the person) [8, 9, 22] . Functional and emotional as well as social aspects of care are thus closely intertwined. Nevertheless, there is demand for technological support, now more than ever. While in some countries, there is a shortage of staff (partially because of low wages), in Nordic countries, such as Denmark, high wages motivate the introduction of labor-supporting technology, which not only substitutes labor, but also serves to reduce physical strain and risk of injury (reducing sick leave times and improving staff retention). Therefore, development of technological support is necessary, while there are many unknowns regarding which solutions are suited for this context,

regarding work practices, user needs, and lastly also ethical concerns for human dignity. We believe that we can learn from how current technology is utilized. Doing so provides us with insight into how the functioning of novel care technologies is ensured. In this paper, we argue that a central factor for this is the interaction work of caregivers.

Despite numerous critiques [39, 52], the underlying understanding of robots' interacting capability in human-robot interaction (HRI) is still most often that of an independently working machine. Human-robot interaction is usually conceptualized as a dyadic interaction between one robotic entity and one human user. Such a concept ignores how such machines (robots are essentially very complex machines) become embedded (or integrated) in social situations, and through this embedding are rendered functional elements of the orchestration of work [1, 2, 39, 41]. Instead, we argue for a perspective that understands how current technology is utilized and considers the already ongoing interaction work of caregivers as a starting point.

Currently, there are no care robots capable of fulfilling functional care tasks with direct contact to a human body (in contrast to transport tasks, entertainment purposes, or pet-like behaviors). Nevertheless, it is important to determine the requirements for integrating any future robotic technologies into care practices. To gain a grasp of this, it can be helpful to analyze how previous technologies have become integrated into such practices, what features have helped in this, and what adjustments and efforts are performed by the human agents in these practices to accomplish this [21, 26, 38]. To find out how machines can become integrated into functional care practices, we can look at existing machines used within such practices. In this study, we focus on a functional care task that deals directly with the residents' body, the transfer of residents (e.g. from bed to (wheel)chair), an everyday heavy workload for care staff. Given this is extremely straining and needs to be done at least twice daily for each resident, it is a promising area for robotic assistance. Currently, a range of different lifting machines and devices is utilized for this task, depending on the level of assistance needed.

In this article, we show how this seemingly functional task, in which a machine plays a central role, consists of complex interactions, involving various physical, verbal and emotional configurations of the human-machine interaction by care personnel. Our discussion is informed by an interdisciplinary ethnographic study of care practices in an elderly / gerontological care home. Our analysis aims to empirically inform a methodological discussion of the socio-technical integration of robotic technology in care work: What can we learn from the use of machines that are currently controlled by care staff and that fulfill functional tasks, about how robots could be integrated into the interactions of care practices?

We discuss the relevance of our insights within the context of robotic care. We argue that for a successful deployment to be achieved, the technology needs to be embedded into the specific situational context. The context of care requires specific caution, as there is often a need for verbal, manual and trust-building adjustments between the technology and the people involved, in particular since it involves people with mental and physical disabilities. Our core argument is that these situations require a triadic structure in order to prevent breakdowns in interaction, given robots are far from dealing with the complexity of social situations alone. We therefore propose that a change of perspective within HRI is required, which anticipates a non-dyadic structure of robot deployment.

2 BACKGROUND

2.1 No Robotic Care Staff in Visible Future

Neither current technology nor technology of the near future will enable the replacement of human care staff. There are various reasons [25]: (1) No hardware yet exists that could replace human touch or human manipulation capabilities. (2) Although current technology can outperform humans on specialized visual tasks, such as face recognition [36], it still completely lacks capability for a general understanding of the social complexity of situations involving, for instance, human intentions. (3) The interaction between perception via vision, touch and audio, and actual robot action is still far too clumsy for complex situations. (4) Furthermore, most professional experts in the field of care do not wish to substitute human work in care practices, in particular if this replaces human social contact and merely maximizes efficiency [52].

Simple robot devices with some degree of autonomy are already on the market, e.g., logistic delivery robots in hospitals such as the TUG [50], but also robots that make small-scale physical contact (e.g., a spoon that counteracts Parkinson tremor [45] or a robotic seal pet that can calm people having dementia [46]). However, once large forces (as in lifting procedures) or complex decision-making processes are involved, current technology is constrained by technical limitations. Therefore, in the near future, the use of such robots will probably only take place under supervision of care staff. Thus, in the following, we put a theoretical focus on the interplay of technology and people.

Many of the robots recently discussed as 'care robots' (and usually portrayed in the media as such) – for example Pepper [11, 20, 23] – have very limited manipulation abilities and are primarily suited for social care in group and entertainment activities (directing a sing-along, quizzes, etc.). But even for these, as the next section illustrates, human intervention is essential to integrate and embed them into everyday practices.

As this overview shows, there are currently no care robots capable of fulfilling functional care tasks with direct contact to a human body (apart from small-scale tasks such as with the Parkinson spoon). An empirical observation of robotic devices for such care tasks is therefore impossible. Meanwhile, a plethora of mechanical and electrical lifting devices is regularly being used for critical care tasks such as transfer to the toilet or lifting someone out of bed. Following an understanding of HCI and HRI as embedded in social practices, we argue to start here to evaluate and develop interaction concepts for future care robots.

2.2 The Sociocultural Achievement of Robotic Behavior

In both public and scientific discourse, robots are usually imagined as acting in isolation, working independently, and replacing human work. This is despite the fact that this will not be technically feasible in the near future [25]. Robots are often portrayed in the media as skillful, autonomous and quasi-conscious entities – which does not

correspond to the current state of robotics [9, 25]. This widespread public misconception of robots' capabilities and agency often leads to illusive expectations of how robots interact with people and how they could be used.

Robotic behavior is not only performed technically. It is collectively achieved in interactions between humans and technological agents. The cultural background of discussions about care and robotics in care comes into play here, because these discourses influence perceptions as well as actions in care practice.

In discourse about care, one of the most important dichotomies is the distinction between warm and cold, where 'warm care' is often contrasted with 'cold technology' [34]. The dichotomy of warm and cold subtly combines the basic experience of temperature with the variable and fluid practices of care work, rendering them usable for a political, or even ethical evaluation of interaction in good and bad. Hochschild [19] showed that the distinction between warm and cold was used to describe newly emerging institutional forms of care as colder than traditional forms of care. But while institutional care used to be associated as emotionless and distanced, these characteristics now apply to robots – and conversely, institutional care provided by humans gains esteem again. However, recent studies show that this comparison does not correspond to empirical realities, as emotionally positive moments can also occur between technical objects, such as robots, and humans [29]. Here, we argue that this normative divide should be replaced with a more nuanced perspective on how subjects and objects blend together in concrete care practices. Referring to Mol [27], we do not cast „care and technology in contrast with each other", but „seek to rethink and reframe them together." To overcome such a dichotomy, we argue for a more processual and collaborative understanding of human-robot agency.

2.2.1 Bringing Robots into Action. In the HRI literature, the perception of robots in social situations is also framed in pairs of opposites: subjects/objects [1, 41], humans/non-humans [40] or animate/inanimate beings [3]. With a special focus on power relations, feminist theory stresses the importance of dichotomous differentiation and the related labeling practices that people employ to order the world around them in a hierarchical manner [16]. But theories and methods about the relationship of humans and technology often re-produce the notion of a fundamental divide between subjects and objects. Even with the rise of Actor-Network Theory in HRI [24], which argues for a flattened ontology, such patterns re-occur in the wording of descriptions. Prominent examples include the notions of agency and affordances of interactive objects, which are treated as distinct aspects of socio-material activities. Usually, affordances are placed on the technological side, while agency is reserved for the people imagining, building, and commodifying tools and instruments.

In HRI, it has been observed how humans participate in technological agency and how robot behavior is interpreted as a part of social interactions. A striking example comes from Ala'č, Movellan, and Tanaka's [2] study of the coordination between robots and humans in a pre-school setting. They show that the assumed agency of a robot depended highly on the interactional routine and context established in a given situation. For instance, children did not engage with a robot when the experimenter seemingly ignored it. There are many examples in the HRI literature [7] where robots become 'smart' if they act within an interactional routine, and its activities are interpreted as intuitive, intelligible, and accountable within this context [15]. If the behavior of robots does not adhere to the social rules of a situation, this, for instance, gets interpreted as 'queue jumping' in a waiting situation [7] or as 'cheating' at a game of "rock, paper, scissors" [37]; the context influences how robot behavior is interpreted as well as the degree to which people attempt to understand their technological counterparts as intentional agents. Other studies [1] show that the dichotomous valuation of a robot as object or subject and associated characteristics, such as animate or inanimate, are renegotiated from case to case. Rigid categories are thereby disrupted, leading to new situational configurations between humans and quasi-subject-like technology. These findings sensitize us for a more processual and collaborative understanding of robot functionality: Instead of conceptualizing robots as task-executioners and humans as sentient interpreters, actual HRI is enacted in an interplay between such entities.

2.2.2 Interactional Enactment of Technological Agency. The affordance to interpret a robot as smart and interactive thus does not emerge from a natural situational setting, but is implicitly and explicitly framed by humans. We thus need an expanded understanding of HRI [32]. A robot's technological function cannot be separated from its interactional enactment. This is apparent even in such simple functionality such as lifting devices – analyzed in our study presented here.

Our key theoretical takeaway is that robotic behavior is collectively achieved in interactions between humans and technological agents. In the context of care robotics, the resulting interplay between caregiver, robotic devices, and patients is understood from lived practice and not through a planned process or rational calculation of technological function [40]. Hence, the agency of a robot is not the sum of functional aspects, but emerges in an ongoing interplay of people and objects [8].

In this paper, we highlight an empirical perspective on the social embedding of care technology: If affordances are enacted and based on social interactions, then our empirical focus on HRI in care should shift from mental plans and semantic representations to situated actions [40], which include collaborative accomplishment of action [17]. In particular, we need to take account of the relational triadic structure of such care situations, where care staff involve machines/objects in the care for residents. Applying this perspective, the apparently trivial example of lifting devices and machines becomes highly relevant for future interaction concepts. While these do not fulfill the criteria for robots, as they are not autonomous, the effort taken to align heterogeneous capacities for action – both from the machines and humans involved – into specific care practices illustrates such a triadic interaction.

3 OBSERVATIONS IN A CARE HOME – OUR STUDY

We build on empirical work from a two-month ethnographic study in a residential gerontological care home in Germany. This is part of ReThiCare, a project that aims to develop new ideas for technological assistance for care, in particular for alternative visions of robotic helper machinery. ReThiCare is an interdisciplinary project

involving HCI researchers, designers, sociologists, and roboticists. Through participatory observation, we could gain in-depth insights into the organization and practices of care work with a special focus on time-consuming, conflict-laden and emotionally or physically exhausting situations to identify new design spaces.

Currently, the most technical practices in German care homes involve transfer – one person is transferred from a bed into a wheelchair or reverse via a lifting device/machine. These machines are the closest to an autonomous machine we can currently find in use (apart from smaller autonomous robots such as PARO [46] and LiftSpoon [45]), being (remote) controlled at arm's length while acting on the resident's body. Moreover, this is a highly relevant scenario for care robotics. Due to the strain of manual lifting on care staff, there exist various scenarios of care robots for lifting people (e.g. [4, 47, 49]). Having seen the lifting devices in action, we wanted a better understanding of what it is like to be managed and moved around by these, and ran a session where we tried these out on ourselves. During analysis of this session, but also during the field phase, we noticed the role of care staff's verbal interactions and announcements for moderating the transfer task.

In our analysis, we focus on routines and expectations associated within a specific care situation, that shape how a machine/device is perceived and addressed as an interlocutor. In particular, we pay attention to seemingly inconspicuous communicative actions in care situations, such as explicit instructions, implicit deictic gestures, or interjections, like "Mhm" and other sounds, and how these actions structure the situation. Our analysis focuses on the interplay of multimodal forms of interaction between the caregivers, ourselves and the lifting equipment. Linguistic and ethnomethodological research found that such mundane activity is crucial for turn-taking in human conversation and should be expanded to integrate technological agents in everyday situations [34, 42].

3.1 Our Ethnography in the Care Context

Four members of our project team engaged in ethnographic participant observation in our partner care home, the Diakonie Sophienhaus, Weimar. One did a 2-month internship, where she quickly became entrusted with all daily work tasks (with very few exceptions, such as portioning and delivering medication). Three researchers did participant observation, one for six days and two doing this for two days. The three were quickly asked to assist the caregivers, in particular, when this would speed up tasks or avoided waiting for another staff member. A shift works on one floor of the residency home, with 2 (sometimes 3) trained care staff (plus often an intern or trainee) taking care of 18 to 22 residents on a floor.

To ensure the study was done in an ethical manner, we took a number of steps. We followed established practices for ethnographic work [13, 31]. The procedure was discussed with and approved as appropriate by the official management of the care home. Care staff were informed about the project, introduced to the researchers, and made aware of our role. Residents were (where feasible, depending on their mental capabilities) informed about our affiliation with the university and that we were here as part of our research. Since the specific environment of a care facility involves the cautious practice of ethnographic research, we handled this situational according to the position of the researcher as well as the resident. Given the sensitive nature of the context and inhabitants, any form of recording was out of question. All researchers wrote extensive field notes and finalized these in a diary that was shared between the research team, with names of inhabitants pseudonymized.

Our ethnographic observations, in particular by the researcher who in her 2-month internship became treated as a normal staff member, reveal the ordinary, everyday practices and patterns of behaviors. They confirm that the behaviors observed during our experience session are habituated. They further provide us with a background understanding of what role these practices have and why they are useful.

3.2 Experience Session

Having seen the lifting machines in action multiple times, we had come to wonder what it is like to be lifted around by these. From an outside observer perspective, a human being is here surrendered to a machine-like structure and hoisted at a meters' height over a distance, as if they were a package carried by a crane (compare figure 1). We requested to try them out, with ourselves in the position that residents would normally be in. In doing so, we were influenced by the notions of 'experience prototyping' and 'bodystorming' [10, 30] and of empathy tools [18], where the research team takes the role of the user in the interaction with a prototype to gain first-hand experience. Note that we are fully aware that we can only ever have a limited understanding of residents' actual experience [5].

Four researchers (three are authors here) participated. Two care workers spent around 90 minutes with us, operating the machinery / devices, which we were not allowed to operate. During breaks in the activity, we asked questions, and often the care staff offered their experience on their own accord. We were allowed to use a standard resident room during lunch break (staff would only have to cater for emergencies and thus had time for us). Personal items were moved out of the working area and bedding removed. The session was video recorded (with two cameras from different angles) with explicit permission from the two staff involved. Given we cannot video record actual care practice involving 'real' residents, this recording was essential in allowing an analysis of minute action (micro-ethnography, see [15, 43]). All researchers furthermore recorded personal notes after the session.

The first machine was the battery-powered passive sling lift 'MaxiMove' from Arjo [48], a lifting machine for transferring immobile, bed-ridden residents out of bed via a net that is attached to the machine (figure 1). This machine is used for residents who have little to no ability to move themselves. The resident is rolled into the net and then hoisted within the net into a wheelchair or reclining chair, and can later be hoisted back into bed (the net is not removed from the chair).

The electric standing and raising aid/device (by Beka Hospitec) (figure 2) is used to transfer people who are able to stand for a short time, if supported, from one seated position to another. The seated resident places their feet on a foot plate and leans against knee pads. The legs are then fastened with safety belts. They hold on to a padded handle. A lifting belt, attached at the handles, goes behind the resident's back. The handles and the belt are raised electrically, raising the resident slowly to the full vertical load of the legs. The

Figure 1: The procedure for the passive sling lift 'Maxi- Move' from 2 perspectives, from front and side. The top row shows the procedure from being rolled onto the net until being lowered into the chair. The bottom row shows it from being lifted off the bed until being seated.

standing aid can then be moved by nursing staff and the carrier frame spread out (e.g. to position a wheelchair etc.).

The stand-up device (by Etac) [51] supports residents who lack the strength for standing up and the motor control for turning, but for whom electric-motor assistance is not necessary. This is simply a footrest with a handlebar to hold onto, which care staff swivel around, using their body as a counterweight (figure 3). The resident needs to still have enough muscle tension and strength to help during the procedure, for example to hold onto (and hang) onto the handlebar and to pull themselves up. Note that this last device was less relevant for our analysis, but is included for completeness here.

Each of us (researchers) took the role of to-be-moved-person, once for each device, in one direction of transfer. For the MaxiMove, one of us lay on the bed, was rolled into the net, lifted and transferred into the wheelchair. Then we swapped, and another of us sat in the wheelchair and was transferred into the bed. A similar procedure was adopted for the other two devices/machines. Thus, all four researchers experienced each of the devices/machines once for one transfer direction.

3.3 Interactive Enactment of Lifting Functionalities

In the following analysis, we highlight three dimensions of interactive enactment of lifting functionalities in care settings: the verbal enactment of lifting procedures, manual adjustments within the procedures and the management of trust before, within, and after the situation. A key observation was that the lifting devices rely on different degrees of participation to function properly. For example, even being held in the 'net' of the lifting machine requires relaxation and calm behavior. The other two machines demand even more active collaboration by the person being lifted and moved. To accomplish this participation (but also to make the process more predictable and pleasurable for the person being lifted), we experienced that caregivers routinely coordinated the interaction between them, the device, and us through verbal, manual, and emotion-management practices.

3.3.1 Verbal Enactment of Lifting Procedures. Having previously done shadowing in care work and also working with the care staff, we could immediately recognize the pattern of care-talk engaged

Figure 2: Procedure with an electric standing and raising device, from two angles, from standing up from the bed (top left) to being seated in a wheelchair (bottom middle and right).

Figure 3: The stand-up device has the resident stand up, gripping the handles. The caregiver swivels the device around, so the resident can lower themselves into the wheelchair.

in while the staff were lifting and moving us. They engaged in these clearly habitually, the tone of voice and wording identical to that we had heard in actual care work with residents. We here first report on our observations from the experience session, and then expand on this based on our ethnographic observation and field note diaries.

Once one of us was put onto the net of the lifting machine and before pushing the buttons to lift the net, the care staff always said: "*So! – Now going up*" (all quotes translated from German). She did this for all four of us, always in the same tone of voice. There were small variations in phrasing, but it was always initiated with "*So!*" (with a quick stop, attracting attention and indicating an announcement is coming) and concluded with "*goes/going up*", all in a decisive tone. From the tone of voice, this is a habituated, almost automatic phrase. Similar phrasing was used with the electronic stand-up machine ("*so now – it goes up*" – "*good, now going up*"). When the net was lowered down to lay us into the bed or chair, this was also announced with "*Sooo*" (but more rarely extended to "*now down*". Having observed and participated in regular care work, we recognized this tone of voice for announcements, even if we had previously not realized how standardized the phrasing is. Another sign of how habituated this is, was that it was interjected into ongoing conversation, as both care workers would throughout the process explain how this is usually done and how we behaved differently from residents (they might be stiffer, more limp, or the net was too big for us). This 'configuration task' (of configuring the resident to the lifting machine) is thus competently embedded into and interleaved into ongoing talk.

One of the care staff managing the machine in the session explained to us that the lifting transfer machine with the net often agitated a person living with dementia, who then would scream and cry. On some days, when that person was a bit more responsive, it would be possible to calm her down by explaining every step up-front. Such announcements appear to be important whenever transitions between states are prone to be abrupt, such as being lifted off the bed (with the MaxiMove). In our try-out session, one of the researchers was moved into the wheelchair via the electric standing and raising aid/device (figure 2). When at one point they were moved backwards, it made them feel a bit nauseous. At this point, there is a shift between standing up, where one can see where one is moved to and has at least partial control, to being turned around and moved backwards into the wheelchair, where one cannot see anymore. Here, an explanation of what happens next (e.g. "*I drive/turn you to your wheelchair*") prepares the resident mentally and fosters trust in the situation, providing an advance warning.

The experience of everyday care work gained through our fieldwork in the same institution reveals the pervasiveness and important role of this kind of 'facilitating talk'. During our participant observation and internship, we found ourselves very quickly taking over these practices, partially as they instinctively made sense, and partially from imitating actions of care staff.

The researcher doing the 2-month internship reports that the MaxiMove lifting machine was used daily. With a bed-ridden resident who was mentally able, but needed the lifting device due to a stroke, announcements were used for all upcoming actions. She was asked daily if she would like to be put in her electric wheelchair or stay in bed. If she wanted the wheelchair, use of the lifting device was initiated with "*we now put the net under you*". The resident was already familiar with the procedure and helped in repositioning her body, making it easier to put the net underneath. The relocations were further announced with "*we now turn you over to me* [caregiver]" or "*now we turn you to L.* [researcher]". Once the lifting net was under the resident, the lifting device was moved to the bed and the net attached. This was not described because the resident knew the process and could observe everything. The start of (electric) lifting was always preceded by the caregiver announcing the action with "*Sooo, Mrs. XY, now it goes up*", to avoid the moment of fright when the body suddenly takes off. Sometimes, small jokes were made, making the inhabitant laugh, such as, "*only flying is better*", to humanize and lighten the mood of the procedure, which was accompanied by the electrical noises of the lifting machine. While not all residents were able to assist with the process and some who are at an advanced stage of dementia cannot understand what is going on, such announcements for upcoming action were always made to calm down the resident.

Such actions aimed at calming and re-assuring residents pertain care practice, not only when using the lifting machines. One of the authors in her fieldnote diary describes how she was asked by the caregiver she shadowed to assist with tilting an immobile resident with dementia (who still reacted when approached by others and appeared calm) onto the side as part of the morning washing routine. The carer began to tilt the woman up, and the researcher had to place her hands onto shoulder and hips, keeping her upright, so the carer could have her hands free to replace diapers and wash. The woman remained calm, but at some point, started to mutter. The researcher instinctively reacted by moving the hand on her shoulder in a slight stroking gesture and talking to her, and the woman relaxed again.

3.3.2 Manual Adjustments. Reviewing the video, we also noticed several small adjustment actions done habitually and almost in passing, to ensure comfortable positioning (figure 4). The care staff would continuously monitor whether we were being laid down onto the bed in a posture that would be comfortable, or whether we would be lifted into the wheelchair accurately, so we would then sit solidly (and not too far at the front or not centrally). When the machine would lay us onto the bed, the carers always put their arms under our feet, lifting them, so the legs would be free to slide (and not get stuck with the knees up, which would be the natural position one ends up when laid down in the net – apparently it is difficult for the elderly to release their legs once they are propped up). For being lifted into the wheelchair, the carers always lifted our feet a bit up to the fore, so that legs and feet would hang loosely and not get stuck at the footrest. These precise but small adjustments, executed very fluidly and soft, were not verbally announced but made to appear incidental; yet they are important for comfortable positioning of the resident and thus for the successful functionality of the lifting device.

3.3.3 Establishing and Sustaining Trust. Part of handling the devices and interacting with residents is to demonstrate that one knows what one is doing, as well as calming people down and getting their collaboration in the procedure. The act of care is highly social and involves tuning in with residents, projecting the feeling of being 'safe and cared for'. Discussion with the two care workers in our session of trying out the machines brought this up, and one of them mentioned: "*if it is evident that we know how to deploy these* [lifting devices], *then this creates trust*". We were told that residents do feel when a care worker is insecure in how to handle the devices, and that this makes them feel more anxious as well. There is thus an element of emotional contagion. We were further told that people living with dementia appear to have a very good sense of how the other person feels and how well they are equipped to deal with a situation (or a device).

For residents with a high degree of dementia, the researcher doing the 2-months ethnography observed that confusion and fear were triggered by the lifting device on some ('bad') days, especially at the moment of lift-off from the bed. For residents in the later stages of dementia, any sudden change is alarming and aggravating. In addition to announcements such as "*Mrs. YZ, now it goes up*", the caregivers managed the trust and well-being of residents verbally. The carer would attempt to calm the resident down: "*Don't be afraid, Mrs. YZ, nothing can happen to you. You'll be right back down*". Establishing trust also involved physical touch by care staff – for example by touching residents or taking them by the hand. One researcher reported in her diary that she intuitively put her hand on the shoulder of a resident and reassured her by saying, "*It's all right, Mrs. YZ. We'll just lift you into your nest*", or "*Don't worry, it'll be over soon*". Going through our field diaries, we found various instances of such verbal and nonverbal acts of ensuring and calming nature, in particular during any care tasks (in direct bodily contact) regarding residents with advanced stages of dementia.

Figure 4: Carers' subtle manual adjustments. While somebody is being laid onto the bed, both carers lift the person's feet. Right: The hand on the right lifts a foot so it hangs loosely and won't get stuck at an uncomfortable angle once being seated.

3.4 Care as a Collaborative Task

Moving a resident is often rendered easier and more comfortable (both for the resident and the care staff) if staff manage to enlist the residents' collaboration, even if this just means a relaxed body. Furthermore, many devices are supporting devices for those people who can still move and do things, but not do so completely on their own. It is important for the elderly to stay active to prevent further decline, thus care staff prefer it when residents are not disengaged, but contribute to the task (even if this may slow things down). Care staff and those cared for thus usually have to collaborate, as one of the staff explicitly explained during our 'experience session': "*It always depends on, how well 'he' [*the resident*] still participates in the action, there's no recipe – it depends on the care worker and the inhabitant and on how they get along – there is no – how it is correct – well, there is, but that's [*the difference between*] theory and practice*".

Furthermore, in our shadowing and participant observation we noticed a constant negotiation and checking back with residents: "*is this comfortable*", "*what do you want to wear*", "*do you want to do this yourself today or shall we help*", and so on. This has multiple functions, from making sure that residents are comfortable, that they feel they have (at least some) agency, to the provision of human attention.

Moreover, as the examples given so far show and as mentioned by the staff itself, care-staff rely on the cooperation of residents. Many tasks are far easier if the resident complies and assists – in whatever small ways they are able to. Therefore, calming down and making residents feel safe and sheltered is important not just from a humane point of view, but also in order to smooth processes.

4 DISCUSSION & IMPLICATIONS

The various actors (subjects and objects) of the triadic structure of care staff, resident, and care technologies are in an asymmetric relationship with regard to their gradual agency. While this asymmetry is likely to decrease in the future due to technological advancements, robots in care will not be able to act completely on their own in the near and medium-term future [8]. Thus, for the integration of robots into care interactions to succeed, we can learn from a closer look at how current care technology, caregivers', and residents' practices and actions are intertwined in situ.

The lifting devices that we focused upon in our study are not robots (and do not act autonomously) but technological support systems used in existing care scenarios. As we have argued at the start of this paper, we nevertheless can learn from how these become integrated into care practices, to understand how human-robot interaction is being ensured in such an intimate and vulnerable setting as that of physical application on a human body. As in-depth analysis of how humans react to and interact with robots [1, 2, 7, 11] has shown, the technical functionality of a robot cannot be separated from its interactional enactment, from how the significant human agents in the situation (in our case: care staff and residents) frame and orient towards the robot. We interpret these devices from a practice-theory-led perspective – influenced by the research team's background in STS, Actor-Network Theory, and ethnographic workplace studies/CSCW – focusing on the interactive elements that are needed to make the machines as well as their interplay with both caregivers and patients work. We have shown how the use of these machines requires activity from both sides as well as collaboration between caregivers and people to be lifted. None of the lifting devices can function without such collaboration – and be it for the resident to remain motionless while hanging in the net. Our analysis has shown that the communicative and emotional practices performed by caregivers are just as crucial in enabling lifting functionality as the manual tasks. From an HRI perspective, the caregivers – although not primary users of the devices – are an essential factor for a safe, fluid and pleasant interaction.

This raises the question of what would happen if we take care staff out of the equation, with only an autonomous robot in the room with the resident? Our empirical analysis indicates that this would be problematic, since many of the subtle interactions and the affective engagement cannot be substituted easily (even if some of these in the foreseeable future might need to be conducted at some physical distance and through face-shields). We argue here, that the instances we observed can be understood as human-human-machine interaction, and this successful interaction pattern could inform future research work in HRI.

Next, we discuss several implications of these findings for robots in care. First, we argue to rethink the understanding of interaction in HRI in care. Second, we give insight and an outlook on the conceptualization of robots in care settings.

4.1 Rethinking Care Robotics

Our findings reveal that it is necessary to rethink the concept of HRI in care. The enactment of lifting functionalities through caregivers' activities is just a small example for the role of mundane and subtle practices in daily care routine that carry a lot more implicit functionality than acknowledged in the field of HRI, especially in care robotics. Such practices, as the casual laying on of hands, addressing, or verbal preparation of a procedure, are at the core of emotional and subjective care work as pointed out by gerontology and care science. Experts argue that care work always involves interaction work, which is situated, involves emotion and subjective action [22]. Due to its situated nature, these rather mundane practices have been overlooked for a long time, even in the field of care.

Today's care robots – especially those who should act directly on a resident's body – are not robust and safe enough to act autonomously and therefore need an active organization of the interplay of subjects and objects involved in the situation. As we pointed out in the background section, this very likely will also be the case in the near future [9, 25]. Moreover, our observations have highlighted the important role of human care staff in adjusting and configuring people to the machine while caring for their emotional and physical wellbeing. Also, empirical studies outside of care contexts show very clearly that the behavior of experimenters or bystanders, i.e. intentional or unintentional observers of an HRI, has a significant influence on how the robot is perceived, reacted to and treated [2]. Nevertheless, the understanding of HRI in care is often still based on a dyadic perspective where one person and one robot interact (e.g. [14, 44]. This perspective puts the robot, the elderly, or at least the dyadic relationship between them in the center of analysis, but often excludes the crucial role of care staff. Some studies suggest that care staff is crucial to facilitate acceptance and use of robots in care settings [11, 33]. The results presented here support this perspective, but also provide further differentiation in how technological functions become enacted through interactive practices.

HRI in care settings involves not only interaction with the robot – where the robot is handled as a quasi-subject – but also interaction around it, where the robot becomes an object, as something to be handled in the specific situation, to be talked about and adjusted to the needs of residents. This has also been found to be the case for voice user interfaces, such as Alexa, becoming part of and embedded in dinner conversations [35]. Within such a triadic structure, the robot also becomes a reference point for emotional work, especially in the context of elderly people and people with dementia, as these – as in the case of lifting devices – are used close to the body of humans and can therefore evoke negative feelings. This does not imply suspending an understanding of HRI as something happening between a single human and a robot, but enlarges this perspective. Robots in care must be understood as actively contextualized, socially embedded in the situation and this embedding enables or neglects the functions and behaviors by a robot.

4.2 From HRI to HHRI

As we have argued, at least in the field of care one should draw the pragmatic conclusion that robotic systems should not be developed with regard to dyadic interaction schemes but should take account of (at least) triadic interaction structures. This goes beyond the mainstream of studies conducted in the field of HRI, which are based on a two-sided understanding of interaction and therefore have an analytical focus on dyadic forms of interaction. Most previous HRI work informed by an ethnomethodological perspective that equips robots with the ability to read and provide social cues – e.g. using eye gaze as indicator of human awareness and readiness to be approached or preparatory movements of the robot as an indicator of direction [28, 43] – do not look at Human-Human Robot Interaction. But in the care context, there are different roles, for example a human enlists the robot to perform a service for the resident, while the behavior or actions of the robot have to be announced or the resident is enlisted to collaborate. As explained in the background section, there is a great opportunity to disrupt existing dichotomies, such as subject/object, human/nonhuman and associated characteristics, such as warm care and cold machines, through the careful and contextualized development and use of robotic technologies. This could not only contribute to a physical reduction of the caregiver's workload but also to an emotional enrichment for the residents.

But also, without such a progressive intention, an active embedding of such robotic technologies would be necessary for successful use so that this would be positively evaluated from an emotional perspective of residents. Thus, for the future development of robots in care, we should consider a triadic interaction structure of the concrete application area. The basic description of a generic situation with a robot in care should no longer be the Human-Robot Interaction but the Human-Human-Robot Interaction.

5 CONCLUSION

We have discussed insights for the integration of robots into care practices gained from an interdisciplinary ethnographic and micro-ethnographic study of technologically supported care practices in a gerontological care home. We observed that devices and machinery utilized in direct care tasks – a number of lifting devices – were not operated in a purely functional manner. Their use was always moderated, facilitated, and socially embedded by communicative actions into the context to make the situation a success for all actors involved. Instrumental care work (e.g. lifting people, washing them) and emotion-related work, such as comforting them, are always intertwined. Moreover, use of lifting devices frequently relied on active collaboration from the residents, who contributed to easing the task as well as making it more comfortable for themselves. Care staff enlisted residents' collaboration, where 'active collaboration' includes being passive and relaxed.

To create fluent robot interactions for care settings, we need to adapt this perspective to our understanding of human-robot interaction: The function of a care robot cannot be separated from

the interactive practices of care workers enacting its functions and from the emotional work inherent to care practice. This stance implies a shift towards a practice-oriented approach, that recognizes and centers on such practices.

Following the thinking of scholars from (feminist) STS, we have argued that the empirical use of robots in social situations strongly depends on the way the robot is framed, introduced and treated by knowledgeable people in a situation. The concrete interaction between a robot and humans therefore is always achieved collectively and the object itself also has a gradual agency in doing so. We asked what we can learn from the practices around the use of current care technology, such as lifting devices. Based on data from a session of trying out these devices by ourselves we unfolded the practices that come into play when technological objects for care, the residents cared for, and the caregivers are intertwined in situ. In line with our theoretical background section, we found that the use of partly autonomous machines relies on the cooperation of different entities that each bring in their specific capabilities. It is obvious that robotic technical support is necessary to improve the daily routine of caregivers and protect their health. As autonomous care robots are not yet in sight, the limited interaction scheme of dyadic HRI is currently of limited use, even if it dominates the field.

For the use of robots with vulnerable groups, we conclude that the dominant dyadic interaction scheme of a HRI should be replaced by a triadic interaction scheme (HHRI). This is based on the insight that a successful integration of robotic care technology will in the near future still need to rely on the interaction between residents, caregivers and the technology itself.

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