The Penguin – On the Boundary Between Pet and Machine. An Ecological Perspective on the Design of Assistive Robots for Elderly Care

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Abstract. Following current demographical trends, the aging population has emerged as a main target group for the development of assistive robots [16]. In current studies, assistive robots are seen as assistants, butlers or companion pets [2, 5]. These roles seem to assume an anthropomorphic or zoomorphic metaphor for the role of robots, acknowledging them intelligence and independence in performing daily tasks. In this paper we wish to reflect on the roles that assistive robots could play in elderly care, building on results gathered from a research through design investigation that we conducted as part of the SMOOTH (Seamless huMan-robot interactiOn fOr THe support of elderly people: www.smooth-robot.dk (Last seen 15/02/2019)) project. Our results suggest that the participants to our study seemed divided between understanding our robot as a tool but also as an intelligent being capable of social interaction. Therefore, we propose that assistive robots might be playing an ambiguous, evolving role in between that of a tool with a specific purpose and an intelligent being, like a pet, not equal and unthreatening to their human counterparts.

Keywords: Assistive robots · Elderly care · Ecology · Anthropomorphism

1 Introduction

In this paper we explore the role of assistive robots within elderly care. Taking an ecological perspective [13, 15] we analyze elderly care as a network of artefacts and human actors participating in a set of practices, aimed at securing conditions for successful aging [11] for elderly individuals. By successful aging we mean a positive understanding of aging within elderly care centers, in which residents and caregivers

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daily engage in practices aimed at securing the residents' well-being and individual dignity.

In current literature assistive robots are seen as assistants or companions [2, 3, 16], translated in future visions of human or pet-like robots replacing living beings in our lives. We aimed at challenging such visions through a research through design inquiry [22], in which we designed and tested a low-fidelity prototype to explore the role of assistive robots in future elderly care. This inquiry was part of the SMOOTH project, which was conducted in cooperation with Ølby elderly care center, located in Køge (Denmark). Our design process started with an ethnographic user study, continuing with a co-design workshop and a formative evaluation of a low-fidelity prototype, which we call the Penguin and more specifically "Casper[1]", as the famous character "Casper, the friendly ghost", but also a common male name in Denmark. Currently a high-fidelity prototype is under development.

During the making of the prototype we targeted three main scenarios, defined together with caregivers, in which our robot would: transport dirty and clean laundry, collect the garbage, and guide the residents to common areas for meals or social events. These scenarios (as in [19]) provided meaningful grounding for explore and challenge what could be accepted regarding cultural values, future functionalities, affordances, and interactions with the Penguin in elderly care ecology.

In the following Sect. (2) we present a literature review and the theoretical framework of our study, the methods adopted in the study are discussed in Sect. 3, while Sects. 4 and 5 respectively present results from the evaluation and conclusions.

2 On Role of Assistive Robots in the Ecology of Elderly Care. A Literature Review

In this section we present a literature review grounded on an ecological understanding of elderly care, to identify knowledge gaps and inspirations for our case study. In the first sub-section we discuss the theoretical foundation of our study (Sect. 2.1), in the second we reflect on the definition of assistive robots in relation to the needs of the aging population as it is discussed in literature (Sect. 2.2); in the third we reflect on the role of robots and the use of metaphor in design (Sect. 2.3).

2.1 An Ecological Perspective on Assistive Robots

Based on current literature and preliminary data gathering, we approach elderly care as an ecology [13], a complex set of practices taking place within elderly care centers, such as: medical care, meals, physical exercise and leisure activities like boardgames or movies.

The notion of ecology in the study of technologies is not new and it is intended as a biological metaphor aimed at evoking a complex organic whole composed of relationships among people, their practices, and the artefacts involved. Ecologies have

[1] https://en.wikipedia.org/wiki/Casper_the_Friendly_Ghost (Last seen 15/02/2019).

been defined as systems [13], assemblages [10], and networks [6, 15]. We find that these terms are in general equivalent yet embodying subtle differences in meaning. The term assemblages is extensively used by Latour [6, 10], and seems to evoke a messier and more dynamic unit than a system or a network. In his book *Reassembling the Social (2005)*, Latour argues that he aims at analyzing the "social" element in sociological studies as a moving target, an ever-changing element, which needs to be constantly analyzed and explained. System and networks seem to evoke respectively a more technological understanding of ecologies, as in [13]. From our side, we aim at exploring how caregivers and residents of elderly care centers perceive the role of assistive robots, as a human or pet companion, within their ecology, in relation to their values and the different practices they engage in.

According to Nardi and O'Day [13] an ecology is always placed within an environment, composed of artefacts an embodying values and expectations pertaining the practices taking place in it. In this sense, the environment is seen as participating in the relationships and practices in which each species (humans and non-humans) engage in. Regarding our study, we refer specifically to the practices taking place within a Danish elderly care center, which provides a significantly different context for elderly care than private home, as in [11]. For instance, according to the caregivers, in Denmark people retire to the care center when physical or cognitive frailty occurs. Therefore, our study addresses a specific segment of the elderly population, including people who in most cases cannot take care of themselves. Our robot has to act inside the care center, hence the physical layout of the center will set requirements regarding the physical features, as our robot should be able to walk through the corridors together with residents without taking too much space, pass smoothly through doors, and interact with available artefacts such as laundry and garbage bins.

Finally, referring to Trasmundi [19] and Enquist [6] we see our robot as a distributed system relying on affordances, interbodily dynamics, wordings and other artefacts present in the environment, such as doors, laundry and garbage bins, and other objects with which it will have to interact. All these functionalities will act as *perceived affordances* [6], which will be interpreted by different users in personal ways. This aspect becomes central when dealing with elderly, in relation to technological acceptance [2] and cognitive challenges caused by conditions like dementia. Critical questions emerge, therefore, in terms of sensibly framing the design process, to support key values in successful aging such as well-being, safety and life quality.

2.2 Assistive Robots and Their Users

Assistive robots are generally defined as "technologies directed to assist the elder population in a variety of tasks" [8, p. 28]. Two main types of robots are typically identified: service type robots targeting practical tasks [3] and social assistive robots playing an affective role as companions in the life of their users [3, 5]. Service type robots are aimed at supporting an independent life style, while social assistive have also been designed to support physical rehabilitation, however, both are expected to have an emotional impact in the life of their users [3]. Social assistive robots are expected to communicate in a natural and intuitive way with people, eliciting positive feelings

[5, 11]. Other studies [2, 11, 16] do not provide a specific definition of assistive robots, nonetheless they provide a value-based perspective, arguing that assistive robots should enable their users to have an independent life style and to keep their dignity as human beings.

Similarly to Forlizzi et al. [8], our study is framed within an ecology of elderly care, specifically localized within the walls of elderly care centers as in [2]. These care centers share distinctive characteristics that are different from personal homes. First of all, the residents are in close and constant contact with specialized caregivers and conduct a less independent and dangerous life style than if they were alone in their home. Second housing and medical facilities are explicitly designed for the care of elderly, meaning that doors and rooms are wide enough to enable them to move freely with rollators and wheelchairs. Third, building on [10, 13] we find that elderly center are dynamic ecologies, welcoming people with different stories and sociocultural backgrounds, including different experiences with technologies. At the same time, caregivers are bringing their own experiences too, having passed through ever changing trainings with old and new technologies. As a result, new practices and sociocultural values are challenging old ones, creating dynamic tensions and eventually leading to new practices.

Current research has tried to analyze the experience of aging, to identify requirements for the design of assistive robots and to justify the need of creating such robots. At the very start of their study Forlizzi et al. [8] claim that elderly people are rapidly increasing in the USA and that it is has been estimated that "there will be about 12 million people over age 85 in 2040" [8, p. 26]. Similarly, Broekens et al. [3] and Broadbent et al. [2] argue that as the elderly population is increasing in the world, so is the need for advanced technologies that could provide them with assistance, compensating for the insufficient number of professional caregivers. According to both studies [3, 8], people appear to live more meaningful lives in their homes than in elderly care centers, therefore, assistive robots should be designed to enable people to live in their homes for a longer time. On the other hand, Broadbent et al. [2] argue that in general elderly people living in care centers are generally positive towards a future with assistive robots. However, lack of knowledge might generate feelings of embarrassment and mistrust, leading towards a rejection of assistive robots. Lee and Riek argue that the products designed for the elderly embody negative stereotypes of aging, hence leading people to refuse otherwise valuable aids, disregarding that aging means that "people are living longer, active lives" [11, p. 1]. In alternative, Lee and Riek propose a "successful aging" perspective, in which the design of assistive robots should be grounded on a holistic and positive approach to aging emphasizing the interrelation between "physical functions, social engagement and self-confidence" [11, p. 2]. The perspective of successful aging seems to give a more concrete foundation to the claims of Broadbent et al. [2] and Forlizzi et al. [8], who argue for human dignity as a target value for the design of assistive technologies; so defined successful aging provides a main target for our study.

2.3 The Role of Assistive Robots in Elderly Care Ecology

Different metaphors have been used in reflecting on the role of new technologies, such as those of tools, texts and systems [6, 13]. From our perspective we wish to include in this discussion, anthropomorphic and zoomorphic perspectives, which have been applied specifically to assistive robots [3]. These metaphors provide straightforward perspectives, to analyze the role of new technologies within the ecologies they were designed for [13]. However, metaphors can limit our understanding of technologies within the ever-changing social dynamics internal to ecologies of practice [10, 13], so that metaphors can provide only a starting point for our analysis.

The tool metaphor represents an obvious way to look at technologies, intended as artefacts designed to achieve a certain goal [13]. Tools are associated also with "tactics" and selection [13, p. 29], this means that a tool is accurately chosen for a task and users must learn how to master them. Hence the tool metaphor embodies meanings of specialization, skills, and learning [6, 13]. From the perspective of design practice, looking at technologies as tools enables designers to go beyond pure aesthetics and forces them to focus concretely on their target users and practices, hence fitting well an ecological framework on practices and technologies. In the case of elderly care, the tool metaphor can enable designers to consider how their newly designed technology can fit the goals, values, and skills of the users, in relation to professional caregivers and elderly residents. However, as in [6] the tool metaphor can anchor the designers to consider only one specific function, predetermined and unchangeable [10], forgetting users' roles in determining the use of tools, a critique often addressed to the design of assistive robots [8, 11].

On the contrary, the text metaphor emphasizes the communication aspect of design practice and it has been adopted by theorists like Latour [10] in analyzing the active role to users in the process of constructing meaning by engaging with artefacts. This metaphor also acknowledges how the affordances offered by an artefact are not immutable, but subjectively determined by each user, a notion defined as *perceived affordances* [6].

Analyzing technology as a system provides "the richest, most troubling, and most mind-altering perspectives" [13, p. 33], in connection to provocative perspectives of the pervasive influence of technology on human life. Adopting this metaphor, technologies are seen as something independent from people, yet deeply affecting people by reframing systems of values in the name of efficiency. The system metaphor is often associated with negative feelings and skepticism towards technologies [6]. In relation to assistive robots, a system perspective might emphasize the downside of having robots instead of caregivers interacting with residents, subtracting human touch and empathy from a sensitive user group. However, in [13] it is suggested that local perspective on ecologies might suggest more constructive views on technologies, inspiring to investigate how skilled and knowledgeable professionals, like caregivers in elderly care ecologies, can ethically and empathically reframe technologies according to the needs of the elderly.

Assistive robots have been investigated as assistants, mediating between caregivers and residents [2]. Broekens et al. [3] discuss the role of robots as companions, exploring a zoomorphic metaphor for pet-like robots such as Aibo. The terms assistant and companion implicitly embody anthropomorphic and zoomorphic metaphors, suggesting functional and relational values. Following this notion [7, 18] it is argued that people tend to interact with their technologies based on tacit expectations originated by the way in which they interact with each other. Moreover, it has become a common belief that people would prefer to interact with a robot resembling a person or a pet, in looks and interactive capabilities, providing a more intuitive and emotionally appealing interaction style [4, 20]. In this sense, anthropomorphism and zoomorphism have been discussed also as strategies to increase acceptance of assistive robots among the elderly [7].

Disturbing concerns emerge from the anthropomorphic perspective, envisioning robots as "autonomous machines" with the ability of assisting or replacing human beings in specific tasks [20, p. 8]. In [2] it is argued that caregivers from an elderly care center expressed worries regarding the safety of their own jobs, fearing to be replaced by assistive robots in the near future. Furthermore, it has been found that the more human a robot looks like, the more disturbing or scary it might be perceived by users, a phenomenon called the *uncanny valley* [2, 5]. In this regard, studies like Wu et al. [20] claim that no matter how pleasant a robot can be, people are sensitive to the fact that robots are not truly sentient or emotional and are not positive towards the scenario of entirely substituting humans or pets with robots. Hence, Wu et al. warn us against adopting a functional approach to companionship, interpreting it as simply an interaction with something.

Taking these insights into account, we aim at reflecting on the role of assistive robots acting as assistants and companions in elderly care centers. We refer to anthropomorphism and zoomorphism as metaphors, enabling us to analyze concretely functional and ethical aspects of future scenarios for the use of assistive robots in elderly care.

3 Methodology – Design Process and Data Gathering

In this study, which is connected to the SMOOTH project, we followed a research through design approach [22], so that we conducted our scientific inquiry through a participatory design process, involving our target group of users and stakeholders as co-designers [1]. Being a scientific inquiry, the output or our design process takes the form of artefacts, embodying our understanding and acting as exemplars of a reflective solution for the problem investigated [21]. The testing of our prototype was undertaken as a scientific experiment, to validate the researchers' theoretical results from the study.

We adopted a qualitative approach, leveraging on ethnography, interviews and video analysis, with the goal of exploring needs and values related to the future use of assistive robots in the ecology of elderly care. We aimed also at giving a voice to users and stakeholders regarding their own future, in line with [1].

Our process was scenario-based as it was grounded on a series of scenarios for the use of our robot, which we defined together with the care center and the municipality of Køge early in the process. We formulated 3 main scenarios: transportation of dirty and clean laundry, transportation of garbage, and guiding guests to common areas for meals and social events. An additional scenario was also tested and discussed, in which the robot was supposed to serve drinks to the residents during meals and social arrangements. These scenarios provided a main source of inspiration through the process to design functionalities, features, and interaction abilities for the robot. As in Trasmundi [19], the three scenarios provided a concrete framework to explore possible roles for the robots, regarding how it will fit within the cultural values embodied in elderly care ecology, also challenging what could be accepted regarding functionalities, affordances, and interactions. The scenarios were literally used as resources for an embodied dialogue, which culminated during our evaluation, when residents and caregivers were invited to enact the scenarios, exploring how they imagined interacting with our prototype, which was controlled by one of the researchers.

Our process started with an ethnographic user study, supported by video recordings of interviews and observations with caregivers and residents. Our goal was to make sense of the practices going on at the center. We also conducted a series of three workshops with the project consortium, which included representatives from the research team, from the companies involved in the project, from the caregivers and stakeholders like the administration of the center and the municipality of Køge. During these workshops, we shared our findings from the observations we conducted at the center and we discussed the design of the robot, with the goal of integrating our findings on user needs with the technical expertise provided by the companies.

In the end, we held a formative evaluation with a low-fidelity prototype [14], a simple polystyrene representation of the robot. Two male residents and three employees (2 caregiver and 1 administrator) participated to the evaluation. Our evaluation aimed at exploring how our prototype could fit within the three scenarios and to gather new requirements to design the final prototype. More details are discussed in Sect. 4.

3.1 The Design of Casper, the Penguin

The making of the prototype included three main stages:

1. A participatory design workshop at the elderly care center,
2. A sketching phase combined with two workshops within the consortium,
3. The making of a low-fidelity prototype, a simple mock-up make of polystyrene, which we used in a formative evaluation at the center.

The participatory workshop was held in June 2017, at Ølby elderly care center, it was conducted early in the project, to gain meaningful requirements for the design of the robot from aesthetic and functional perspectives, and also to increase the users' excitement about the future robot.

We started the workshop with an informal interview with caregivers and residents about developing specific ideas, hopes, needs, and fears regarding the implementation and design of our robot. After the interview, we engaged in a collaborative prototyping session. We divided the participants into three groups and we provided each of the groups with designing materials like: cardboard, paper, scissors, tape, plastic crumbs, straws, rulers, egg trays, Lego bricks and more. The groups were encouraged to reflect on central aspects for the development such as: preferred behaviors and interactions with the robot, its appearance, and what kind of verbal and physical feedback the robot should provide to human input. Since we could not gather permission from all the participants, we did not videorecorded this session, but we took pictures of the final prototypes to gain relevant documentation and inspiration.

At the end of the co-design workshop the groups presented their prototypes, as visible in Figs. 1, 2 and 3. The first two robots (Figs. 1 and 2) were focused on empathy and serving. They both have trays on the front and anthropomorphic features, showing an expressive face to elicit an intuitive interaction and communicate on an emotional level with the residents. The lively colors of the second prototype (Fig. 2), seem aimed at enhancing its expressive value. The third prototype (Fig. 3) is instead designed to look like a machine with arms aimed at solving practical tasks. Almost no effort was made to create an anthropomorphic appearance, there are no anatomical features, like the expressive faces displayed by the first two. Interestingly the first and third prototypes are mainly constructed in cardboard, in the first markers are used to draw specific features, like the face and buttons, and plastic glasses were used to represent the feet. In the third, plastic rulers and forks were used to create the arms.

Fig. 1. Serving robot made of cardboard with expressive face and front platform.

Fig. 2. Robot made of Lego bricks with expressive face, front platform and wheels.

Fig. 3. Robot made in cardboard, designed for practical tasks with arms but without face or anthropomorphic features.

The second prototype (Fig. 2) was entirely made of Lego Bricks, the body is shaped in a parallelepipedal, geometric form, but head and eyes are round, maybe to suggest a softer, human-like appearance. In particular, its large eyes seem to suggest a need for expressivity. Wheels were attached to the base of this prototype, suggesting that the designers explored options for the movement of the robot.

The workshop ended with a plenum discussion, during which we identified three emerging themes on the features of the robot, such as:

- Social interaction: Polite voice, human-like voice;
- Technical constraints: Global call system, be safe around humans, collect garbage and laundry one room at the time, lift outside garbage container lids, wheels for fluid movement;
- Appearance: Appealing design, no sharp edges, hygienic, friendly shape and look.

As we discussed in a previous study [9], the following design process was based on the outcome from this workshop. However, since our final prototype had to be marketable, functional, affordable, and safe, we had to rely on the off-the-shelf technologies provided by the partner companies. We, therefore, tried to combine user's needs and technical constraints in a creative way, to enrich the users' experience, our main priority. Because of technical constraints we had to re-elaborate the prototypes made through the workshops, the front platform present in the first two prototypes had to be replaced with a back platform. The use of the front platform would have required extra sensors to enable the robot to sense people while carrying stuff, causing safety issues as well as higher costs. The arms of the third prototype had to be eliminated, as the companies claimed that for legal and safety issues they cannot design robots with movable arms for healthcare facilities. We, therefore, conceptualized the back platform capable of lifting things to compensate for the loss of arms. Moreover, to guarantee stability, the robot had to move on a wide tricycle base, resembling the wheels attached to the second prototype.

As we were told during the workshop that the robot had to be cute and nice to interact with, we experimented with the concept of the robot as an assistant trying to create a funny looking character. According to the caregivers, the main role of the robot would be to "help with practical tasks", leaving the caregivers free to dedicate more time to the residents. Therefore, we approached the robot as a future mediator [10], acting in between residents and caregivers.

Early versions of the robot included the "Dyno", (Fig. 4) a name which emerged from the shape of robot which included the basic features established with the companies: a wide tricycle base and back platform for lifting and carrying stuff. The Dyno was a very simple prototype to foster discussion and it was presented at a consortium workshop. It was criticized for not being cute enough and elicited comments on the functional features. The Dyno inspired us to explore an animal theme through simple 2-D digital drawings and 3-D models, playing with different sizes and shapes.

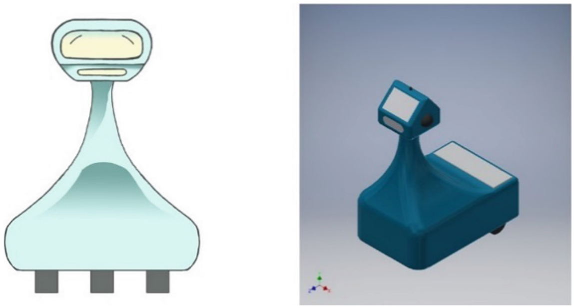

Fig. 4. Early design, the "Dyno". 3D model courtesy of Frederik Haarslev.

After the workshop we went on to design the "Butler", which provided a meaningful anthropomorphic metaphor, suggesting a serving-mediating role, in which caregivers would be in charge and the butler would mediate between them and the residents. The Butler was re-elaborated further in an elongated and a shorter version, which were called the "Swan" and the "Penguin" (Fig. 5) [12]. The Swan was a slightly taller design, whose head was supposed to reach the shoulder of an average person, with arms-like wings to grab things but less dangerous and mobile than arms. The elongated version was also re-elaborated in a few colors and into a different robot named the Giraffe. The Penguin emerged as a chubbier character, inspired by pop-culture analogy between a penguin and the black-and-white clothed butlers[2]. A smaller robot was also designed, called the Mouse, which was directly made into a 3D model. These smaller robots were supposed to be less intimidating and modular than the taller ones. These sketches were exchanged by email across the participants to the consortium, initially the Swan, the Mouse, and the Penguin were chosen [12].

[2] https://disney.fandom.com/wiki/Penguin_Waiters (last seen 15/02/2019).

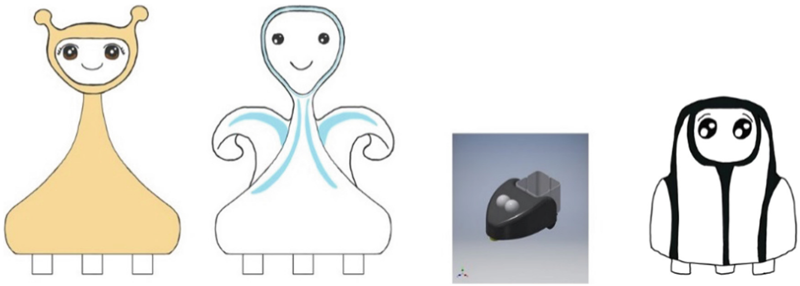

Fig. 5. Different sketches of our robot, from left: Giraffe, Swan, Mouse and the Penguin. 3D model of the Mouse courtesy of Frederik Haarslev.

In the end the Penguin was selected as a basis for developing the prototype to test at Ølby [9]. The Swan appeared a bit bulky and being taller it might also become more unstable, unless it had a larger base, which might not fit well corridors and narrow spaces in the center. The little size of the mouse was potentially dangerous, eventually causing people to trip on it as it might be difficult to see it at a close distance. Finally, the notion of the Penguin elicited some funny remarks, appearing as a funny, cozy character, the Penguin provided the main inspiration for the low-fidelity prototype.

4 Evaluation and Discussions

Based on the design of the Penguin, we made a physical low-fidelity mock-up [14], a simple and cheap prototype which was named Casper (see Fig. 6), which was tested during a formative evaluation at the elderly care center, three caregivers and 2 residents participated in the test. Our test aimed at gathering feedback and inspiration on our prototype to be used in our new design iteration, regarding: functionalities, aesthetics and experience, and emerging challenges.

The evaluation started with an informal conversation accompanied by coffee and tea, during which we presented the plan for the test, which all together took about two hours.

After the conversation we proceeded with enacting the scenarios, the first scenario to be tested was the guiding scenario, also the only one in which the residents are supposed to directly interact with Casper. The residents were invited to walk along the corridor to the dining area together with the mock-up pretending it was a finished robot. Our mock-up was placed on an office chair, so that it could be pushed around by one of the researchers, to give the illusion that the robot was moving on its own. Afterwards we tested the garbage and laundry scenarios, which require the caregivers to interact with Casper. We also tried a fourth scenario, in which the robot had to serve drinks in the dining area. At the end of the test, we had another informal conversation sharing a cake, during which we presented a series of videos representing how we imagined the scenarios in the start, to foster comparisons and reflections with the experience from the test. The video scenarios, which were edited with a combination of video footage and digital drawings, showed the robot in action in the center, engaging with imaginary residents and artefacts, like the bins for collecting garbage and laundry.

Fig. 6. Mock-up of Casper during testing.

On a general level both residents and caregivers welcomed us with a positive attitude and the prototype was commented positively. As for functionalities, one of the caregivers asked why the robot had no arms. We explained about the companies' legal restrictions for safety and its accepted to rely on the back platform for transportation tasks. The lack of arms was found limiting especially while enacting the fourth scenario (drinks serving), as it showed that the robot had to be loaded by caregivers, unless it could rely on specifically designed artefacts. For instance, for the laundry and garbage scenario, it was discussed that the center should adopt trash and laundry bins with wheels to be pushed by Casper along the corridors of the center. These changes were found a doable and valuable investment to support caregivers and residents. Movable carts could be made available to enable the robot to transport different items around the center. Practical and ethical issues emerged enacting the drinking scenario, as in elderly care ecology center drinks have medical meaning. All the residents have some medical condition, such as diabetes or hypertension and they are given individual juices containing medicines and supplements. Moreover, residents affected by dementia need constant help by the caregivers as they tend to forget to eat or drink, or might refuse their drink preferring another one, potentially endangering themselves if taking the wrong drink. Although a simple assistive task, which could be easily performed by a robot in other contexts, serving drinks becomes dangerous within elderly care ecology, posing ethical questions in relation to the role of Casper in case residents would opt for another drink or refusing to drink at all. It was suggested that in this scenario, the robot could act as a self-moving cart, carrying the glasses for the caregivers, who will be in charge of distributing the right drink to the right resident. It was instead suggested that the robot could remind the residents to take their medicines or call them out for social events. Finally, one of the caregivers asked if the robot could lift a wheelchair, a typical scenario for future assistive robots [16]. However, we did not work with that scenario in mind, because we were told during consortium workshops that the residents should be able to move on their own for physical exercise. Moreover, it would require a more expensive technology to secure the safety of the residents, but it is an interesting scenario that will be considered as future work.

Moving towards the aesthetic and experience aspects, it was decided since the start that the robot would interact mainly vocally. During the evaluation, the participants talked to the prototype in a natural way, calling it by name: “Casper!” It was proposed that the robot could respond: “I am coming!”, informing the users that the call was heard by the robot. The physical movement of the robot generated safety concerns, it was proposed that it should keep a safety distance from the residents while moving around in the corridors, eventually producing a beeping sound while approaching, to alert residents and avoid accidents. The aesthetic of the penguin, a chubby robot shorter than humans, called Casper was found amusing. However, critical feedback was provided in relation to the face, especially regarding the perceptual capabilities of residents with advanced dementia. A caregiver said pointing at her own face: “They do not know what they see, they need eyes, nose, a face!” The physical prototype had two round big eyes and a sketched mouth (Fig. 6). We were wondering if the face should have been physical or represented in a small screen, enabling for slightly dynamic facial expressions, like smiles. The caregivers instead emphasized the need for a static smiling face, with large expressive eyes and a nose. Dynamically changing facial expressions had to be avoided, as these might be perceived unsettling, hence the caregivers suggested us to check Ruben’s dolls[3] (Fig. 7), which are successfully used in the center for the therapy of residents affected by dementia.

Fig. 7. A Ruben’s doll used at Ølby center.

[3] https://www.rubensbarn.com/ (last seen 15/02/2019).

Caregivers and residents also advised us to use neutral colors, like grey or pastels, as strong colors, like black or red, cause distress in the residents affected by dementia.

Regarding the look of the penguin as a type of assistive robot, a resident said with decision: “It has to look like a machine!” and caregivers nodded agreeing with him. The robot had to be clearly a tool for a practical purpose, a robot imitating a human or zoomorphic shape would be perceived as confusing, unsettling, and even threatening for the residents affected by dementia; nonetheless it might feel like disrespectful for the others, who are not interested in a machine pretending to be a living being, as in [5, 20]. Interestingly this resident said to be fond of science-fiction and to have read Asimov’s robots stories, in which in fact robots might have anthropomorphic features, to interact comfortably in human-made environments, however, Asimov’s robots are not imitation of humans, their intelligence is different and do not have emotions. He argued that being fond of science-fiction, he is readier than others to embrace assistive robots in his future, saying: “Making a robot is a technical problem, but many old people might not want them!” an issue acknowledged in current research [2].

Interestingly, as it was stated that Casper had to look like a machine, we found a slightly contradiction as during the enactment of the guiding scenario, the residents addressed our prototype politely, engaging in small talk with the researcher controlling the prototype (Fig. 8).

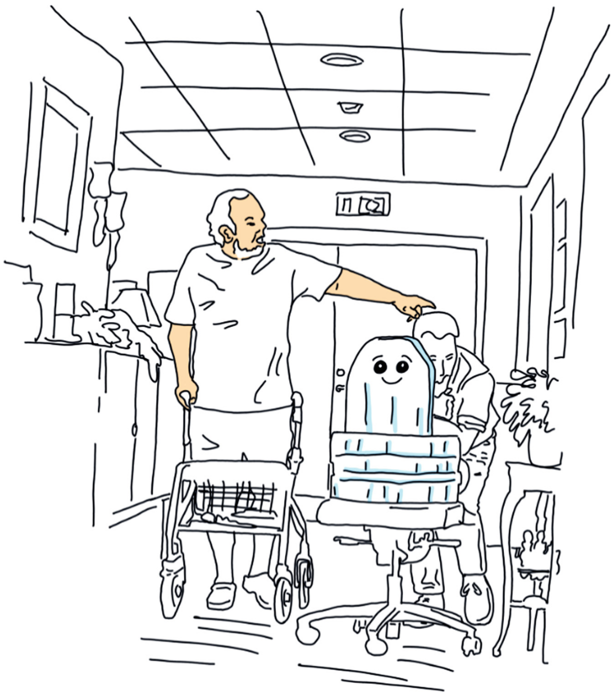

Fig. 8. Sketch taken from our videorecordings, representing a resident chatting with our prototype, Casper, pointing outside at cigarette buds in the garden.

Here is an excerpt of a conversation:

Resident:"Good morning, how are you?"
Researcher:"Good morning, fine thank you, how are you?"
Resident:"Fine, thanks!"
Researcher:"Have you slept well?"
Resident:"Yes, thank you!"
Researcher:"Should you have anything for lunch today?"
Resident:"Yes, I would like that. But look at there!"
Pointing a finger and gazing at the large window on their left
"They are throwing cigarette buds there! Isn't it bad!"
Researcher:"Sure, ahhh …. that's really bad!"

Residents and researcher-Casper chatted in a friendly way until they reached the seat of the residents in the dining area.

While enacting the laundry scenario, the caregivers called aloud "Caaaasper!" while giggling. They seemed amused by this role-play activity and were calling the robot with an intention that is typically associated to calling a small child or an animal, not certainly an adult or a colleague. A need for a cheerful, human-like interaction also emerged while enacting the drinking scenario. It was suggested that after having delivered all the drinks, Casper could say: "Cheers!", as the caregivers usually do to elicit a feeling of conviviality in relation to a medical care practice. It was also suggested by the residents that the robot could engage in small talk, acting as a mascot, during meals. At the same time, the caregivers claimed that the robot should only be in the common areas and never access the residents' rooms on its own, for safety and hygiene reasons. While not being active, the robot should stay in a service area, isolated enough not to be a bother, but still accessible enough to be called, always available as a butler.

4.1 Which Role for Caper?

Our data from the evaluation suggest that assistive robots are perceived as an ambiguous, mediating species within the ecology of elderly care, placed in between a tool and a pet. Regarding the metaphors used in the study of the technologies, we find that observations and interviews seem to point towards different directions.

The tool metaphor [6, 13] clearly emerged through interviews, which suggest that on a conscious level residents and caregivers like to look at Casper as a tool, a "machine" with a practical purpose. In line with [20] it seems that the users of assistive robots want to keep a clear separation in their mind regarding the living and non-living beings they encounter. A robot imitating a living being could also be perceived as a disrespectful deception towards the residents, especially those affected by cognitive impairments, hence going against the principles of successful aging and dignity [8, 11] that we want to follow in our study.

The text metaphor emerged in our final conversation when the caregivers discussed how residents, especially those affected by dementia, might "read" Casper, eventually projecting malevolent intentions. According to the caregivers, Casper must communicate that being a tool it does not have feelings and that it cannot have the will of causing arm. The caregivers argued that a robotic face able of reproducing dynamically changing feelings, for instance shifting from a neutral to a smiling face, could be interpreted as unpredictable or provoking, as if the robot might shift from having good or bad intentions towards the residents. Therefore, the caregivers insisted on Casper showing an immutable, serene facial expression.

However, during the enactment of the guiding scenario the participants showed a desire for interacting socially with the prototype. Casper was expected to show a certain degree of intelligence: being able to move around in the center, being aware of where to go and of the people in the room, being able to intelligently respond to calls and to perform specific tasks without direct supervision. On the other hand, Casper is not supposed to enter the private rooms of the residents and to initiate a conversation. Casper is also supposed to keep a safety distance from the people moving in the center and to signal its presence to avoid incidents. In this respect, Casper is supposed to act as a sensing being, able to intelligently sense the world through its body and act accordingly [17, 19]. Casper is also envisioned as capable of relying on affordances, wordings and interbodily dynamics with humans and available artefacts, to act as expected by the human actors according to the present circumstances. The interaction with the robot is characterized as bodily dialogue, in which the robot approaches physically when called, turns its gaze towards their interlocutors or at the direction indicated by their interlocutors, as it was enacted by the resident during the guiding scenario (Fig. 8). In this sense, Casper was expected to pay attention and to display empathy, answering politely to the residents' attempts to engage in dialogue. At the same time, Casper had to be kept under control, as if it was a child or helping pet, potentially causing troubles. Interestingly the caregivers called Casper with a loud and amused tone of voice, prolonging the "a" in Casper, as if addressing an intelligent being with a sort of affection, but considered as non-equal in intelligence and status, someone like a child or a pet. According to the caregivers the robot could interact with the residents eliciting a positive mood for the coming activity, for instance discussing the daily menu while guiding them to their meals. However, the caregivers should decide which residents should be guided by the robot, according to their physical and mental condition. These limitations were clearly showed during the drinks-serving scenario, Casper cannot perform this task as an autonomous, responsible being, as functionally Casper cannot identify a specific drink and associate it with the intended resident. But even if Casper was functionally capable to associate a drink and its intended resident, it was too awkward to discuss what would be an acceptable behavior for Casper in case of conflicts, when for instance a resident would refuse his-her destined drink to get another one or nothing at all. The caregivers were not ready to delegate this responsibility to an assistive robot, expressing concerns for the residents' safety and dignity saying: "It would be a disaster if a resident gets the wrong drink…" and "It cannot do it!".

These insights show that caregivers and residents do not want assistive robots to play an actual anthropomorphic role as human assistants, which would be capable of taking responsibilities and ideally equal to human actors. Casper should be hierarchically inferior, being told what to do and act accordingly. This controlling attitude towards assistive robots is confirmed by the need expressed by the caregivers to restrain the future robot socially and physically in ways, which would not be not acceptable for human assistants.

Taking all these insights into consideration, a robot replacing the caregivers would not be acceptable, as this would generate a scenario in which the robot would be in control of the well-being of the residents for better or worse, a dystopian scenario typically embodied in the system metaphor [13], in which technologies are perceived as out of human control and potentially threatening.

Our data suggest instead that the participants would like a robot playing an ambiguous or dynamic role, placed in a dynamic balance between a machine and an intelligent being: unthreatening and non-equal to humans, unable to take responsibility, and easily disposable, but gifted of a certain intelligence, likable, and capable of social interaction. Therefore, we propose that assistive robots, acting in ecologies of elderly care, are envisioned by potential users as playing a role in between that of a machine and a pet. This does not imply the imitation of a pet, as it was explored for robot-companions like Aibo [3], we propose instead the notion of a dynamic machine-pet role, defined as a moving target within a spectrum, confirming the notion that the social interactions in information ecology are in continuous co-evolution, being dynamically negotiated by the participating species [10]. In our scenario, the role of assistive robots would have to be dynamically placed in between a tool and a pet, according to the evolving needs of the users, who will be deciding each time the degree of autonomy and social participation granted to the robot according to the given circumstances. We depict here a complex picture in need for further clarification, for instance on how to concretely explore this spectrum through forms of sociomaterial and playful interactions.

5 Conclusion

Different metaphors have been applied to discuss the role of assistive robots in supporting elderly care practices, such as classical metaphors of tool, text and system, but also anthropomorphic and zoomorphic metaphors. Anthropomorphic metaphors are based on the assumption that people interact with technologies, based on the way they interact with each other [18]. In this way, anthropomorphism has been presented as a strategy to increase the acceptance of assistive robots by elderly people, who are typically seen as reluctant to adopt new technologies [2, 20]. These metaphors are applied as sharp images suggesting aesthetic and functional features of assistive robots.

As part of the SMOOTH project [9], we explore the role of future assistive robots within the ecology of elderly care, seen as a set of individuals (mainly residents and caregivers), tools and practices placed within elderly care centers [6, 10, 13].

Empirical data were gathered through a participatory design process supported by ethnographic methods, in collaboration with Ølby center in Køge (Denmark) and local robotics companies. Our design process was based on three pre-established scenarios in which our robot was supposed to transport laundry, collect garbage, and guide residents to the dining area. An additional scenario was also discussed, in which the robot was supposed to serve drinks to the residents. A low-fidelity prototype was evaluated with caregivers and residents in the center, revealing a complex picture in which our participants claim to want a tool that could support specific tasks. However, during observations we noticed a need for a more intelligent being, able to communicate socially and empathically, but non-equal to the human actors around.

The role played by our robot emerged as that of a sophisticated distributed system [19], able to engage in a bodily dialogue with users, relying on wording and interbodily dynamics to perform practical tasks and to act as a social being. However, the participants to our study are not willing to approach assistive robots as equal anthropomorphic beings capable of taking responsibilities and to tell humans what to do, for instance in case a resident would refuse to take his-her drink. This scenario would be perceived as potentially humiliating and going against the principles of successful aging and human dignity that we want to follow in our study [11].

We propose, therefore, that assistive robots might play a role in between that of a machine and a pet combining a need for functionality and social interaction. An anthropomorphic role, as often implied by current literature discussing the role of assistive robots as assistants or companions [5], eventually replacing specialized caregivers [2], would not be desirable. At the same time, assistive robots imitating humans or pets are seen as a deception, going against the need of people distinguish between the living and non-living beings they encounter [20].

We, therefore, define the role of assistive robots as a dynamic role between a pet and a tool. As in [10], we see the role of assistive robots as a moving target within a spectrum, in which users will decide according to circumstances how much autonomy and social participation to grant to the robot, hence seeing it more as a tool or a pet. The role of assistive robots in elderly care ecology is configured here as the result of a continuous co-evolution among the actors involved [10, 13].

In this respect, open questions emerge in relation to sociomaterial and eventually playful forms of interactions which could be explored in the elderly care center, which we will explore as future works.

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