A Design Space Exploration of Creative Concepts for Care Robots - Questioning the Differentiation of Social and Physical Assistance

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ABSTRACT

In an interdisciplinary project, creative concepts for care robotics were developed. To explore the design space that these open up, we discussed them along the common differentiation of physical (effective) and social-emotional assistance. Trying to rate concepts on these dimensions frequently raised questions regarding the relation between the social-emotional and the physical, and highlighted gaps and a lack of conceptual clarity. We here present our design concepts, report on our discussion, and summarize our insights; in particular we suggest that the social and the physical dimension of care technologies should always be thought of and designed as interrelated.

Author Keywords

care robotics; socio-technical; speculative design; Assistive technology;

INTRODUCTION

Our project ReThiCare aims to break with dominant visions [17, 18, 19] in the field of care HRI, and adopts a design-led, creative approach in order to explore alternative concepts for care robotics. In an open-ended process, an interdisciplinary team of HCI-researchers, sociologists, designers, and robotics researchers developed concepts, with ideas inspired both from in-situ observation and conceptual discussions (including ideas of deviant design [2]). These concepts cover a broad range from the speculative to the solutionist (problem-solving). With these, we hope to open up a design space for care robotics beyond sci-fi tropes [3, 4, 25], ubiquitous 'butler robot' scenarios or the political promise of a salvation of the care crisis [17, 24, 19].

To better understand the design space that our concepts might reveal, we began to discuss these in light of the assistive robot, that is often referred to in the literature to categorize assistive and care robots. In an iterative differentiation between social (affective) and physically mapping process, every team member first placed each idea, then those results were comparatively discussed and aligned in a subsequent group meeting.

This not only helped us to clarify purposes and design aspects of our robot concepts, but also resulted in a critical reflection of this differentiation. We here report on our discussion, where our set of concepts provoked questions about the notion of the 'social' in social robotics and the interrelation between the physical and the social aspects.

Our contribution with this pictorial consists in presenting nine concepts with which we hope to inspire a creative rethinking of care robotics, and that serve as a lens for discussing and critiquing this common classifications of robots in the context of care, raising a number of questions for the community to resolve.

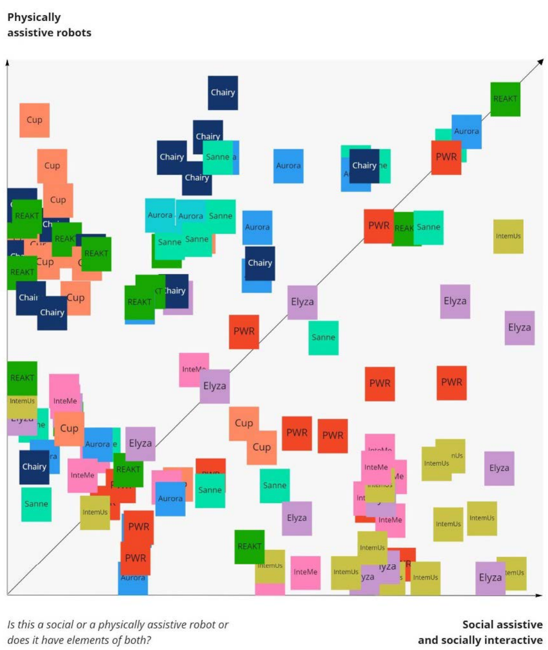
THE AXIS

A common distinction in the literature [1, 15, 19] roughly divides assistive robots into:
(1) physical assistive (effective) robots and
(2) social assistive robots, often framed as companions.

Physically assistive robots execute utilitarian functional physical tasks. Examples for such effective designs aimed for fulfilling basic needs [1] include: floor wiping, interactive wheelchairs, carrying and fetching objects, help for lifting (bodies or objects), all usually intended to relieve staff from repetitive, time-consuming or bodily straining tasks.

Socially assistive robots (affective strategies [1]) aim at emotional and cognitive well-being of their target group, e.g. interactive pet-robots [22]), or entertain or amuse aging individuals (e.g. Pepper, see [6]). They can act as companion robots that engage in social and playful physical interaction or promote physical and intellectual activity.

For instance, a laundry transport robot (as used in hospitals) is seen and categorized as purely physically assistive. On the other hand, socially assistive robots (e.g. pet robots) are intended for entertainment and companionship and therefore rated higher on the socially assistive dimension. These dimensions or categories do not exclude each other, in fact many care robots combine them (much could be discussed on how this distinction is too simplistic).



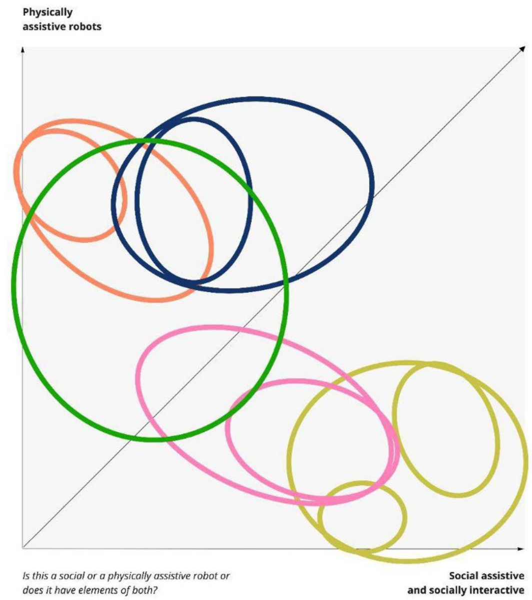
The initial outcome from all team members overlaid, before discussion

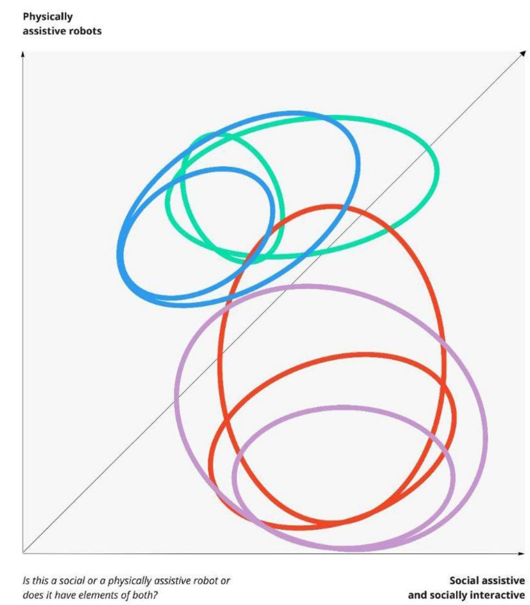
Nevertheless, we decided to use this as a starting point to discuss our own robot concepts, imagining this as a design space of degrees of physically and social/emotional assistance, visualized as a matrix with two dimensions, or axes. A matrix enables us to say that one robot concept combines properties of both dimensions, or is weaker on one dimension than the other.

For our following discussion, while there may be unintended aspects that emerge during use (e.g. if the floor cleaning robot Roomba gets treated as a sort of social being [26]) we focused on the intended associations a robot evokes as it was depicted in early video prototypes.

After our discussion (see next page on the process) we find that our nine robotic concepts take up different areas within the dimensions of social and physical assistance that span up a design space.

Here, on the right, this is split into two graphs (or plots) for better overview. Each robotic concept is represented in a different colour and all but one cluster contain focal areas represented by a second circle in the same colour (the ‘center’ or majority of votes lies in the inner circle, and group consensus was on the outer circle).



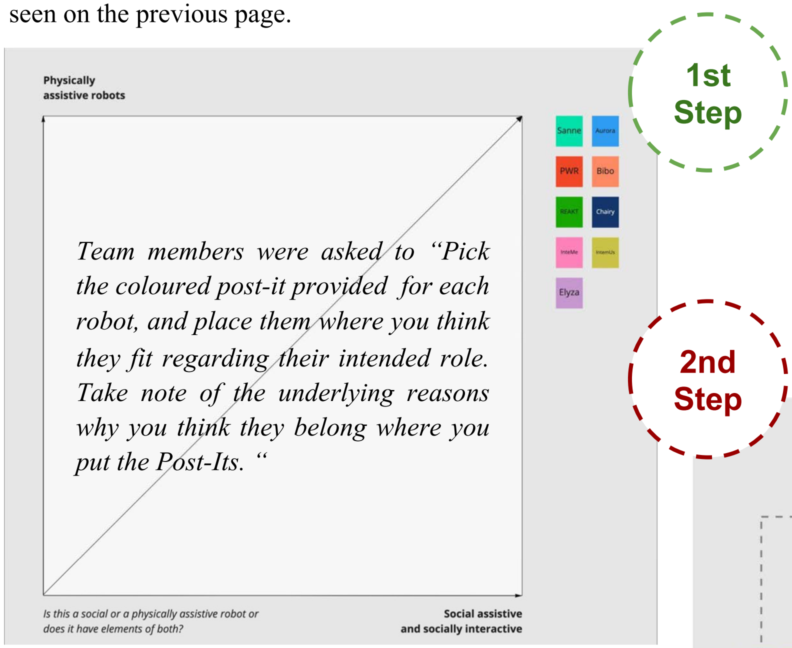


OUR PROCESS

For this group exercise, we took a moderated two step approach, using the whiteboard tool Miro:

First (1st step), every team member was asked to rate each concept individually, based on their understanding of the robot concepts and the axis. The Miro board provided a description of the typology as definition of the design space axis (given on the previous page) and then asked to place all of the robot concepts that our project has developed within the empty matrix. Everyone could do this individually over a two-week period.

Then, in a joint meeting (2nd step), we collectively reviewed the data and discussed homogenous and divergent ratings in the resulting charts. After the discussion everyone could adjust their initial rating, resulting in the plots seen on the previous page.



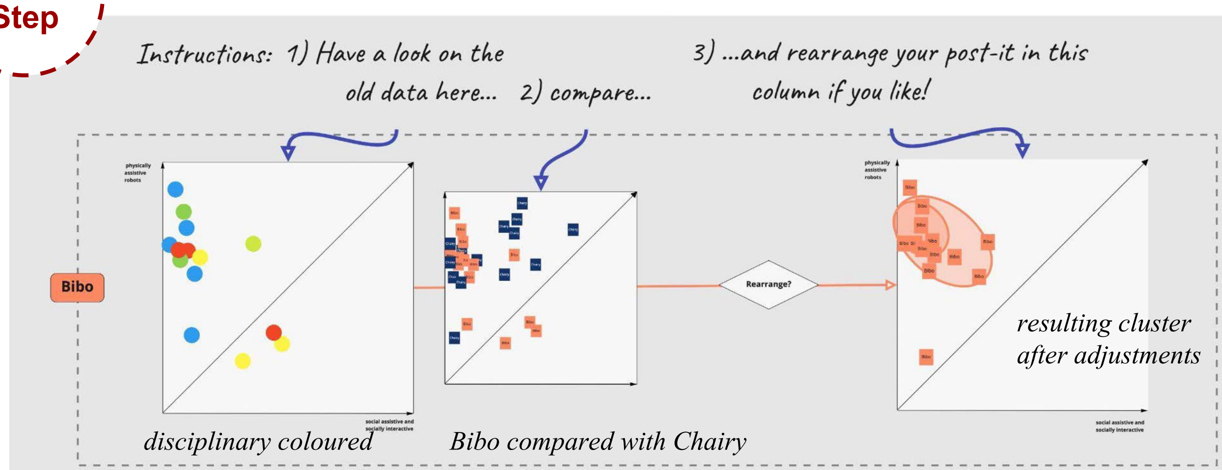
This first step of rating designs was done by each team member on their own

Two researchers surveyed the responses from the individual task, and began to look for commonalities and differences. For this, all post-its for one robot were put together. We further explored different ways of contrasting or accumulating the ratings, since we thought it useful to discuss robots in comparison to each other.

For this, we tried different combinations (robots that are clearly different as well as concepts related that resulted from a core idea). Additionally we coloured the diagrams with regard to disciplines, to highlight any disciplinary difference in ratings. We found this to be rarely the case, more common were individual differences.

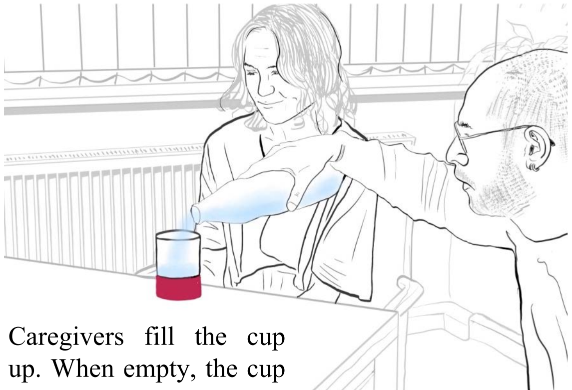
We then discussed the resulting graphs in a group of three researchers. In this, we identified the need for discussion for each robot concept (are there two camps of opinions, are there many outliers, is the reasoning clear or do we need to ask for clarification). This informed our moderation of the later group meeting. We also decided which comparisons to use and - where possible - sketched a suggestion for tentative clusters, covering the majority of post-its. In this, we are aware that the axis of our design space do not constitute measurable criteria and thus 'ratings' are always based on interpretation. Therefore clusters can be large and have no clear-cut boundary.

In the meeting (which used the miro board shown in an excerpt below), we then discussed each concept in turn, asking people who had placed their post-it within the tentative cluster for their rationale, as well as who had put it outside. This sometimes revealed that not everyone had the same understanding of the robotic concepts (some of which had not been discussed for a while, while others were more present in mind). It also had us return to the description of the typology. We reflect on this discussion in the following.



The team discussion was structured via a shared Miro board

THE ROBOT CONCEPTS ONE BY ONE



Caregivers fill the cup up. When empty, the cup can notify carers to refill it by blinking. The cup can be configured in how much it moves or blinks.

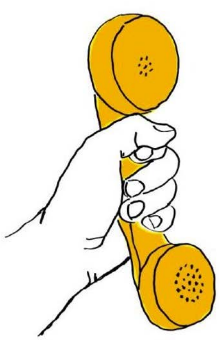
Concept 1: Bibo - the dancing cup:
The concept for Bibo is based on the observation that some people affected by severe dementia appear to stare into space, but react to outside stimuli. When caregivers move a cup closer to them, they notice the cup again and react - the cup gets back into attention and triggers a 'drinking schema' action. The core idea for Bibo is that the cup itself draws attention.

Bibo [13] lights up and wiggles a bit if it has not been picked up for a certain time. This brings the cup into attention again, which might evoke taking a sip. The cup stops moving, when touched.

Concept 2: Elyza
Elyza is a chat-bot assistant that communicates via in an old-fashioned phone. There are various modes of interaction:

(a) The phone rings, and when picked up, tells that it has announcements to make, for instance an overview of what is going on today at the residence home, or to remind of an upcoming appointment. Residents can also do simple conversations with Elyza.

(b) Residents can also pick up the phone and ask a question or ask for assistance (e.g. to ask for a caregiver to bring them something to drink).

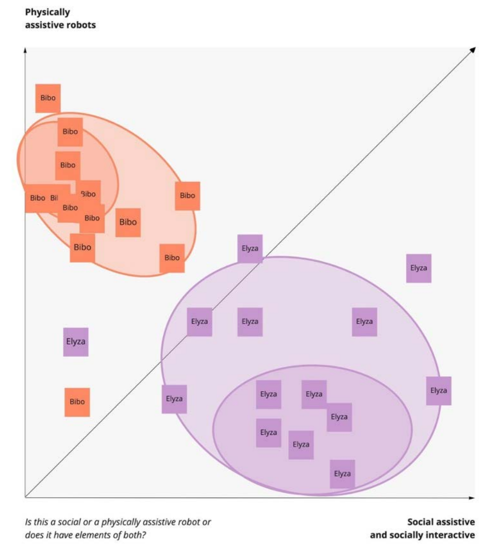


(c) They may also ask Elyza to play music over the room sound system, to call a relative, or to record a voice message for a grandchild.

Elyza can also call for help if the resident acts unusual, indicating a health issue.

ELYZA: Hallo Erich, its ELYZA, your virtual assistant. I have to tell you something!

How it was discussed. Bibo (salmon-orange) and Elyza (violet) are here shown as contrasting examples. Most team members placed Bibo towards the top-left corner, characterizing it as primarily physically assistive. There is some variance in how high this is rated, with some arguing that it can only do one type of action and can only support one very specific task. Most saw little social aspects, as the cup is a personalized object for single users. It was agreed that Bibo triggering conversations might be an (unlikely) side-effect, while a few team members saw this as reason to put it a bit further to the right.



How it was discussed. Elyza was rated as a primarily social robot, as it can provide cognitive and social assistance.

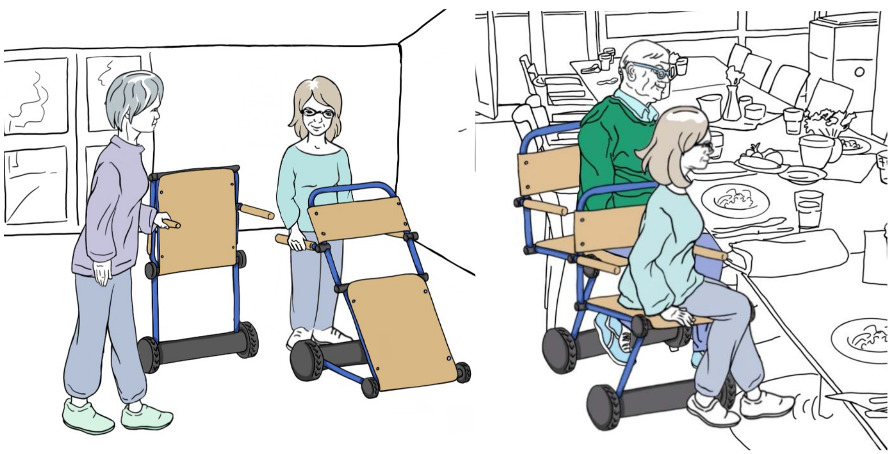
Another reason for this rating was that Elyza can support the resident in initiating social interactions with other people. Yet Elyza is not intended as a social companion.

Initially, some team members had placed Elyza further on the top left, because they assessed it to provide utilitarian function (overlooking that the definition of physical assistive robots requires them to execute physical tasks). After discussion, most then agreed, that the robot is a chatbot and thus cannot do physical tasks on its own. Others argued that Elyza can nevertheless trigger real-world effects (e.g. start the CD player, call for someone to bring water). This is why Elyza also takes up considerable space on the vertical axis (physical assistance).

Concept 3: Chairie

This is a concept for a mobility assistant/helper that can adapt to the situation and the needs of users. Chairie merges the functions of a side-walking companion, a walker and a wheelchair within a single product that can shape-change.

Chairie can be called over by its owner (this uses voice recognition) and adopts the right shape according to their degree of mobility and current need. It can also ask the user if they want to rest and sit down, and then transform into a wheelchair. Caregivers can also command Chairie, for instance to come closer, return to its place or leave the room, while they interact with residents, allowing them to focus on the care task). Furthermore, Chairie can act as a companion and can activate care home residents, for instance, it approaches a resident and (with voice output) suggests going for a walk, or proposes to walk to the lunch area together.



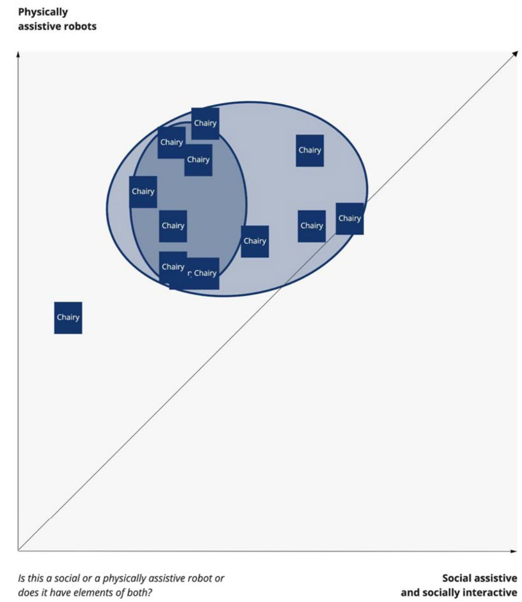
Chairie can shape-change. This allows it to adapt to ongoing situations, but also helps to reduce the number of appliances taking up space in care homes.

The design is intentionally simple, mimics common furniture, and avoids anthropomorphic features (reducing the risk of unmet expectations from the attribution of human like characteristics [21, 10]. With the furniture-like design we attempt to align its appearance with the overall theme of walking aids and mobility.

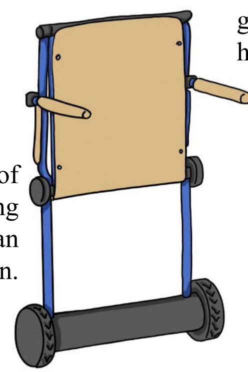
How it was discussed: Chairie received quite high ratings regarding its physical assistance level (comparable to the cup) and more diverse ratings for its social assistance aspects. An interesting argument was that while a walker makes it possible to be social with others, it is not social itself.

After some discussion of the envisioned conversational abilities, most agreed that Chairie has elements of a companion robot.

One team member discussed "that it walks with you, people might relate to it more like a helper's dog. (...) that's enough for people to easily project the thought of social agency and interact with it and probably give it a name. The fact of coming with you is enough to trigger that."

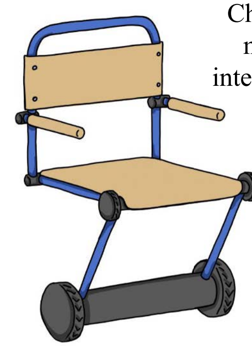


The raised armrest of the side-walking companion offers an arm to lean on.



When walking behind the walker, the two raised armrests can be grasped with both hands.

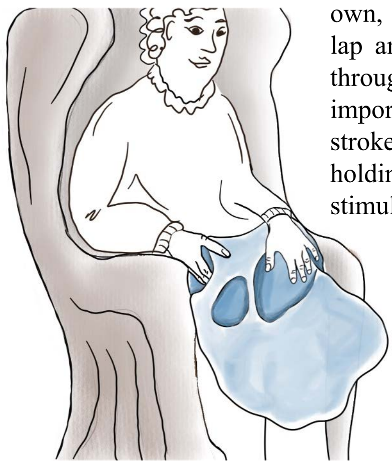
As a wheelchair, Chairie looks modern and integrates with furniture.



Chairie in its three shapes: as a side-walking companion, a walker and a wheelchair.

Concept 4+5 IntiMe + IntimUs

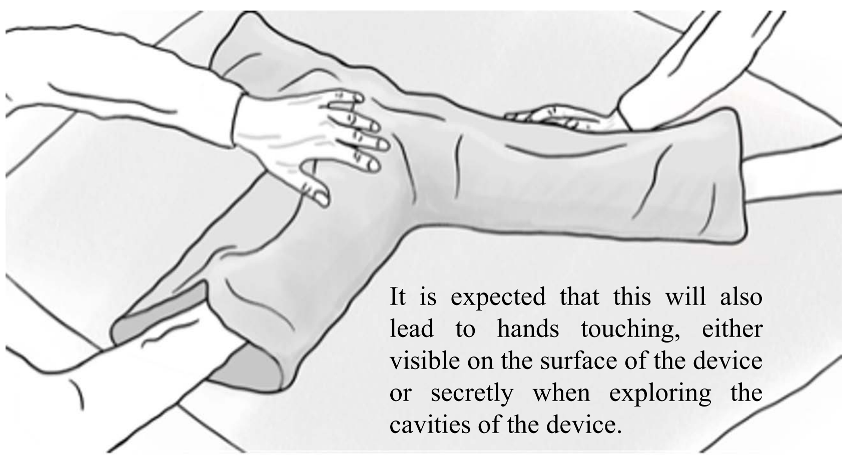
Both artefacts were developed to address the lack of space and opportunity for intimacy in many care homes. Both artefacts respond to touch (e.g. stroking) by vibration and sound. Thereby the user experiences the touch as reciprocal. In addition, the intensity of vibration and sound mirrors the intensity with which the user touches the device, creating the impression that the interaction can be brought to a climax. The devices are made from soft materials like felted wool, which as a material is itself already enjoyable to touch and explore.



IntiMe is supposed to be used on ones own, where the artifact sits on one's lap and provides pleasant stimulation, through slight vibration. More importantly, the device responds to the strokes and the touches of the person holding it, as if it were enjoying the stimulation as well.

IntimUs is supposed for use by multiple people in a more playful setting, supporting playful exploration and intimate touch (of the hands) in semi-public spaces.

The device is intended to be used on a table, e.g. in the activity room or living room in a care home. Placed on a table, multiple people can engage with, e.g. stroke, the device.



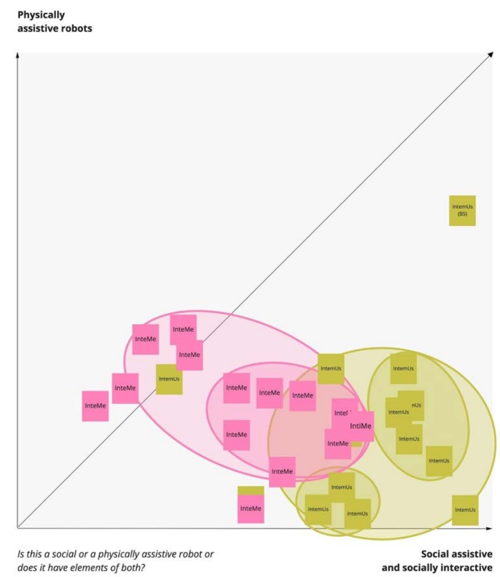
It is expected that this will also lead to hands touching, either visible on the surface of the device or secretly when exploring the cavities of the device.

How they were discussed: The graph shows that IntimUs is rated more social than IntiMe (pink), but as slightly less physically assistive. Despite fairly clear clusters emerging, most in the team felt they had to stretch and adapt the given definitions to handle these two. One discussion point for rating IntimUs was that the object itself is not social, but the outcome of the interaction is. "InitmUs isn't social in and of itself. It facilitates social interaction - this doesn't make it a social object". On the other hand, the concept creator argues "I understood both IntiMe and IntimUs as social actors in themselves, because they respond to your touch and create a response", focusing on the interaction (or conversation) with the robotic object.

We found that the standard definition (and understanding) of socially assistive robots seems to require that the robot itself should offer companionship. What about robots that support emotional well-being in an indirect way, and where people do not interact with the robot but (mediated by the robot) with others?

IntiMe was even more difficult. One team member said "I rated it as a quite physical thing, as it's about sexuality, which is quite physical" (plus, the blanket-like artefact would be physically manipulating the user's body). At the same time, this "is the most social and emotional thing", as another person responded.

This makes us notice that the definition of 'physically assistive robots' seems to focus on purely utilitarian tasks, which focus on reducing work effort or providing convenience.



IntiMe challenges our definitions of what 'social' means ("how can you be social with yourself") and the artificial split between physical and emotional/social interactions. We were also struck by how both concepts aligned with the 'socially assistive' dimension, even though one is more social and the other more emotional – which the definition of socially assistive robots convolutes.

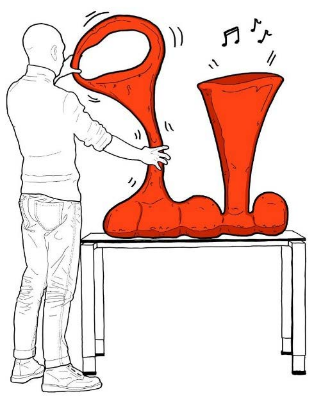
Concept 6: REAKT - Smart Pneumatic Pillows
REAKT is a multipurpose platform for pneumatic actuation of inflatable cushions and interactive objects to assist in care scenarios.

Modular textile air-chambers of various shapes and sizes are dynamically inflated and deflated to provide physical support for a variety of tasks. Integrated compression sensing capabilities also enable the use of inflatable objects as tangible input devices to support physical activation, to enhance or promote sports exercises, augmented physiotherapy, or to control specific apps and games. The interactive inflatable objects can also be used as collaborative interface for creative expression by interacting with musical games through rhythmical deformation and squeezing of objects.

The textile air-pads are entirely flat when deflated and do not contain any active or sensitive components. Therefore, they are fully mechanically compliant, washable, can be disinfected, and are easily replaced when damaged.

Depending on the application scenario, the cushions can also be integrated with existing clothing, chairs, beds, and furniture to augment them with physical support or input sensing capabilities.

Our prototyping work has focused on *three scenarios*, one more social/entertainment related and two focused on supporting physical movement of care residents.

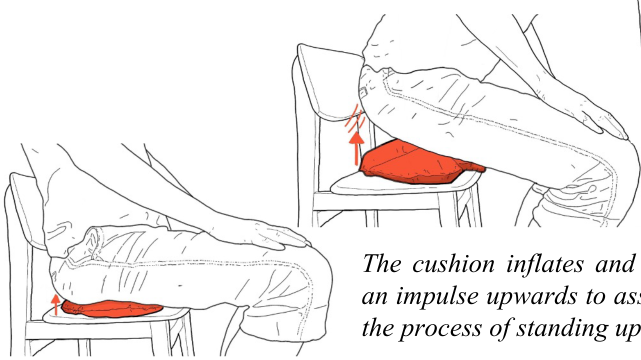


Social interaction through music: Deformable, soft props act as input devices for playful, collaborative interaction with music. As a user begins to touch, squeeze and deform the inflatable input devices, musical notes and loops are gradually layered on top of each other, creating a collaborative soundscape.

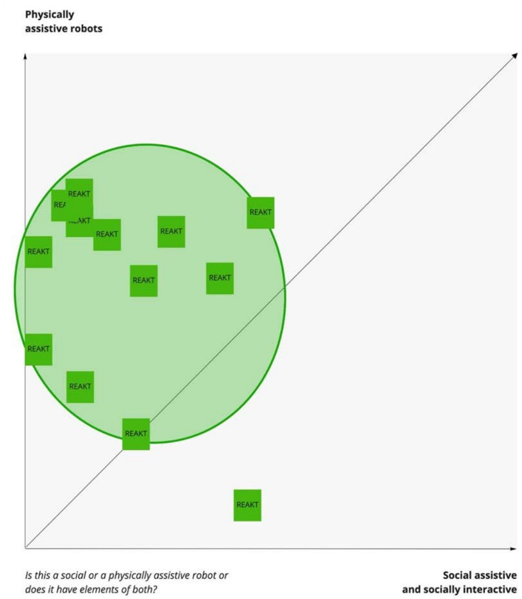
Bed transfer & support: Body sized air cushions integrated into a bed sheet can support people of reduced mobility to get up or turn around in bed, either autonomously or with some assistance from a professional caregiver.

Getting up & sitting down: Air cushions on top of a chair assist during the transition from sitting to standing (and back).

This can also be used as an unobtrusive, low-threshold way to promote casual physical exercise or assist physiotherapy for users with reduced mobility and the elderly.



The cushion inflates and gives an impulse upwards to assist in the process of standing up.



How it was discussed. One of the difficulties in discussing REAKT and placing it lies in the variety of applications envisioned for it, with some being physically assistive and others having entertainment and social value (playing games or generating music). In essence, REAKT is more of a platform as it allows for multiple use cases and application scenarios, and not one specific robotic concept.

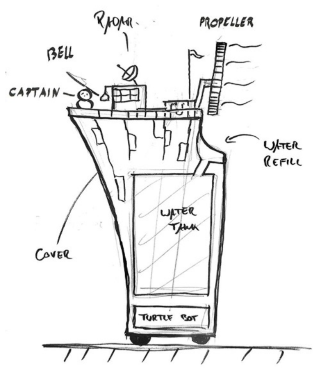
The ratings given differed largely based on which of the applications the team members remembered best and found most salient, and whether they rated the concept's theoretical potential or the current state of prototypes. The two types of applications depicted here would each take up another area of the design space matrix. Thus, REAKT occupies quite a large section of the matrix, to capture this diversity of applications.

Concept 7: The PWR, a plant-watering robot

On surface level, the plant-watering robot is to take care of plants in a care home by watering them. But in going about this pretextual task, the robot will provide something interesting to observe, to talk about, which interrupt everyday routines of residents. Central to the robot's design are the notion of *distributed agency* [16] and a playful, narrative way of visualizing the robot's actions. The overall robot resembles a ship, with a captain on deck, and various elements that show the current state or indicate upcoming actions of the robot.

'Distributed agency' refers to the impression that a robotic device entails more then one agentic component, and/or that the robot controls machine parts of itself. This concept design explores whether a robot with such a distributed autonomous control relation can evoke amusement in observers as well as successfully inform them of upcoming actions.

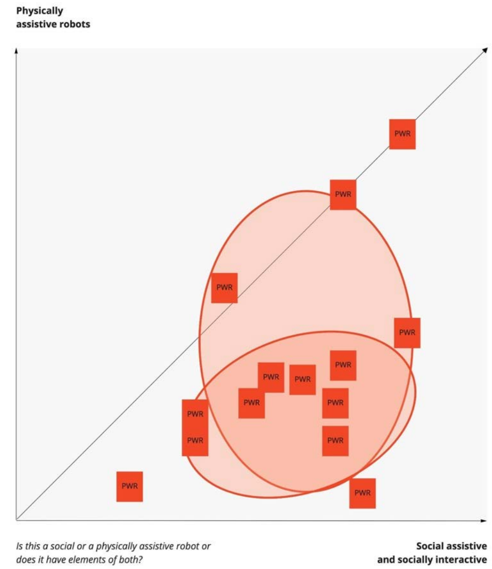
A small figurine on top of the mobile robotic platform is seemingly in charge of all actions. The figurine acts as captain that governs the ship, and interacts with different elements, such as a control panel. The captain's actions have a clear effect on the ship. For example, if the ship is about to turn left, the captain swivels left, and soon after the propeller – the visible engine of the ship – turns right.



We initially explored various options for the figurine, such as figurative, humanoid, zoomorphic and animal-like characters. A well-timed and rhythmically coherent interaction behavior of all involved elements, that is, the robotic platform, the figurine and interactive elements will be core to the mechanism.

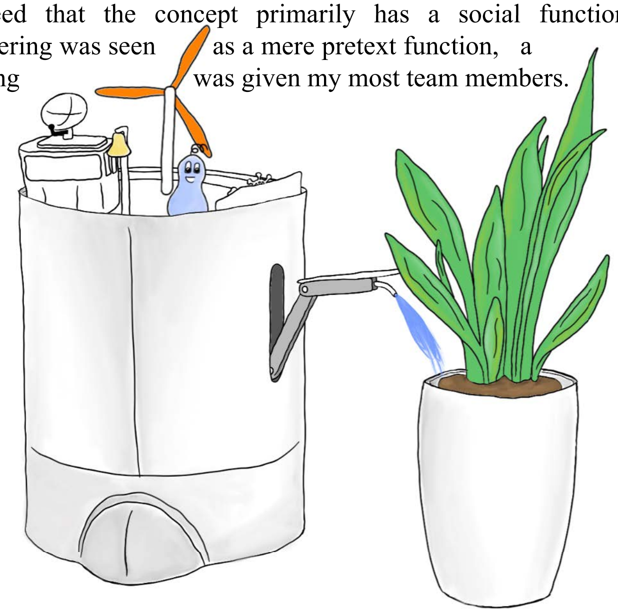
How it was discussed: The PWR was rated relatively high on the social scale but rather low regarding physical assistance. The ratings differ more than for other concepts, showing that team members estimated the potential of this robot differently. Diverging ratings on the social scale can be traced back to different interpretations of how 'direct' or 'indirect' the social effects are.

The interaction design of the robot puts residents into an observer role. This raises the question whether a robot can be considered socially assistive if it does not directly interact with residents present in the room.



The PWR breaks with the predominant view that only direct interactions are socially relevant and valuable events. The discussion concluded that this indirect interaction may foster residents´ emotional and cognitive wellbeing and may even result in emotional attachment. It was agreed that the concept primarily has a social function. In consequence, as plant watering was seen as a mere pretext function, a fairly low physical assistive rating was given my most team members.

At the same time, some team members rated the physical assistance quite high, assuming that this robot may help to increase the amount of plants in a care home, thus fulfilling the criteria of a 'physical' task.



Concept 8+9: Sanne and Aurora

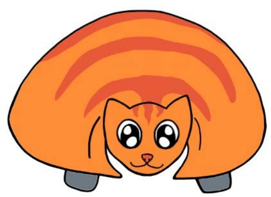
Sanne and Aurora are both floor-cleaning robots that in addition to this task, have an intentionally designed social role to support residents wellbeing. Alba is described on the next page. Our care home partner had previously trialed a Roomba for cleaning, but residents were scared of it.

Sanne is a playful floor-cleaning robot in the form of a cat. Cleaning the floors is the main utilitarian function, as care staff noted that this task is physically demanding, time consuming and needs to be performed daily. Given the robot would enter the residents' spaces, in particular shared living spaces, and residents will thus react to it as a social agent, we designed Sanne to have a second function – as a playful and friendly robot with zoomorphic appearance [8].

The robot should be perceived as an amusing zoomorphic inhabitant, as mascot of the home, but it should also be easy to ignore. Sanne's appearance and behavior was inspired by zoomorphic dementia toys and information on how dementia affects perception and cognition [9].

Sanne is petted on the head by a resident.

Bright orange with red stripes is highly visible and known as activating colours for people with dementia.



Sanne has a round face and large eyes, inspired by dementia toys already in use (to be friendly, funny and cute).

The shape communicates a sense of direction when moving, the tail can indicate direction.

Here, Sanne wiggles at a distance from the resident and the resident stretches out her hand, waving at Sanne to come closer.

The robots movement should be predictable for residents: Sanne thus slows down when approaching residents, and then sits on the spot, wiggling sideways to draw attention.

Only if residents react positively, will Sanne come closer.

The cat-like appearance reminds of a domestic pet, known to many as friendly, yet which sometimes also wants to be left alone – Sanne should not be disturbed when cleaning.

Sanne intentionally has the comic-style shape of a cat, to not mislead residents about its robotic nature, given concerns about deceiving elderly people into believing that robots are living and feeling creatures [14, 21, 24]. The robot rather resembles a 1970s children toy in bright colours and smooth shapes.

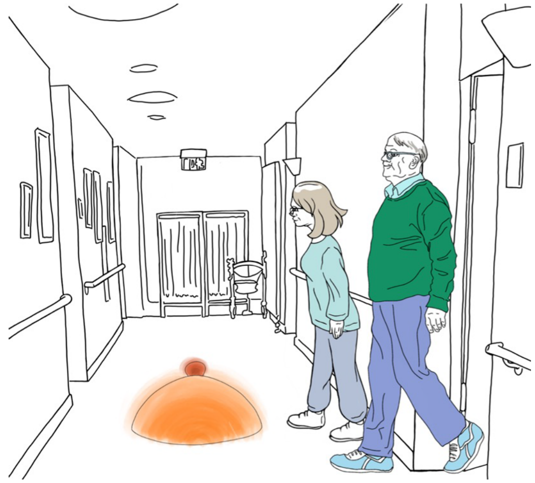
A prototype of Sanne was tested in a Wizard of Oz study [11], which confirmed that almost all care home residents reacted positively: they were interested, wanting to pet Sanne and interact with it, talking to Sanne and luring the robot towards them, or in a neutral way, i.e. they ignored the robot. None of the residents that encountered Sanne showed any signs of fear or distress.

Aurora is a derivation of the idea of a floor cleaning robot for care homes that has a secondary function and personality. The aim was for an aesthetically pleasing robot that positively influences the well-being of residents. Aurora's design is intentionally abstract and attempts to avoid the interpretation of being a robotic pet (cf. [7]).

Aurora will have similar movement patterns as Sanne, wiggling before approaching residents closer. Different to the playful character of Sanne, it is intended to convey a contemplative, poetic mood and to have an ethereal presence.

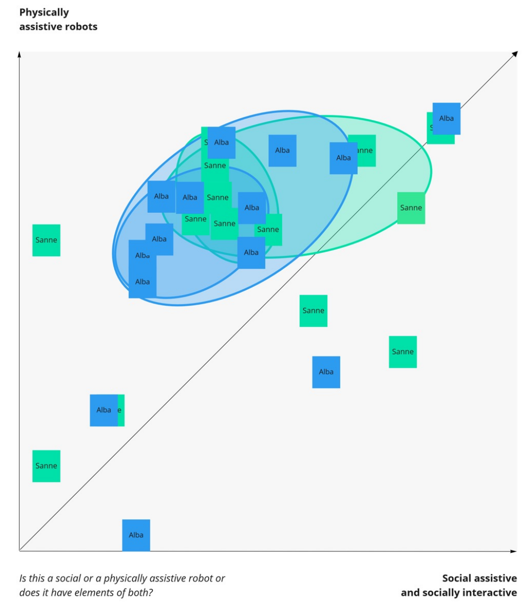
Aurora has an abstract shape, soft and elegant, inspired by northern light lamps. It can change colour, and through this convey a relaxing mood during cleaning activity, or provide an awareness of the time of day (or upcoming activities) via matching colours.

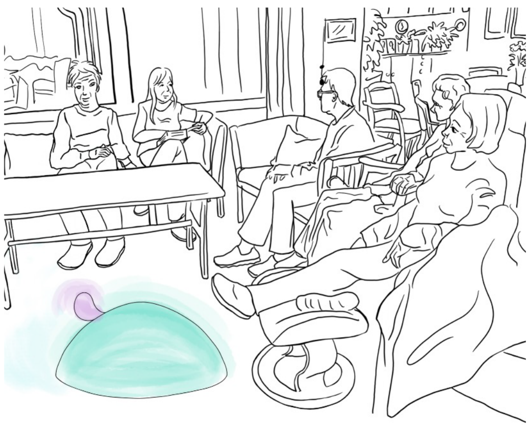
Aurora's colours communicate the passing of time, in particular in connection to meals and house chores.



The tail light provides visibility, and glows to signal stops and changes of direction.

The luminous appendix indicates the back to give a sense of direction while moving.





the light is blue-green during the day (relaxing), and gets blue in the evening

The round-oval form is intended to appear pleasant and reassuring while approaching residents.

Colour choices were influenced by statements from care staff and knowledge on dementia (red increases appetite, orange and red stimulate, blue-tones are relaxing).

warm colours are associated to meals

How they were discussed. Sanne was consistently rated as a bit more social than the adaption of the concept, Aurora. For both, many ratings are placed close to the diagonal, acknowledging that with Sanne and Aurora the cleaning function is not just a pretext (as with the PWR) and the robot's physical task has the same relevance as the social-emotional aspect: "it combines both intentions, it wants to do something functional, but wants to be social in the process". One reason Aurora may be slightly less social is because people will not interact with it as directly as with the more agentic 'cat' Sanne (which also actively approaches people and attracts their attention), and that Aurora "is more of an ambient thing" in the background. Nevertheless Aurora fits the definition of social assistive robots, since it supports emotional wellbeing.

Both for Sanne and Aurora, while there is a clear cluster of votes, several ratings are outside. This was due to a few people who found the task of cleaning floors to be of little utility or that remained sceptical about the potential of these robot concepts to contribute to residents psychological wellbeing.

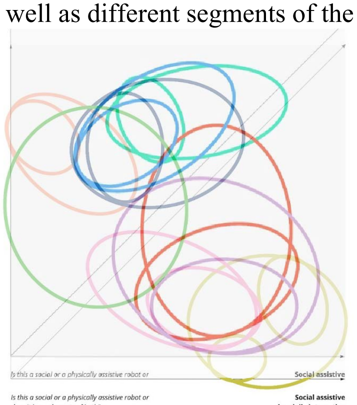
DISCUSSION

The Design Space as a Discussion Facilitator

This team exercise was surprisingly effective in providing a structure for discussion and enhancing shared understanding of the concepts, but also of the design space dimensions. Looking at the initial plots of ratings made differences in understanding visible that had previously remained latent, and forced people to explicate their interpretation of the robot concepts. At the same time, team members revised their understanding of the definitions, in particular, what they understand to be 'assistive', what is 'physical', what deemed to be 'social' – and what not.

Through discussing edge cases, we began to explicate tacit assumptions and understandings – and definitions that at first appeared clear and encompassing revealed their limitations. Being asked to adapt the position of post-its after discussing each of the graphs ensured that everyone felt responsible to ask for clarification and to contribute.

Below, he combined cluster plot shows all our concepts in one. Naturally, as we hope for all our robots to be useful, the left bottom corner remained empty. The overview shows that the clusters take up different areas of the design space, from 'very social and just a bit physically assistive' to 'mostly physically assistive', as well as different segments of the middle in this graph.



Most of our robot concepts combine the two characteristics to some degree, i.e. none were rated as having zero social assistance, even the Bibo cup was rated as having a small social element.

Reflecting on the Typology of Physically Assistive versus Social Assistive Robots

While we had agreed to refer only to the intended outcomes of a design for the mapping exercise, these will nevertheless be important in practical use. For example, assistive objects that are primarily designed and intended to be physically assistive (like the Bibo cup) can gain social aspects, for instance by triggering conversation. Similarly, the social or emotional relevance of an object could grow through use, for instance as someone gets emotionally attached to their mobility support. Some of our concepts have such 'second order effects' as a main purpose, for instance the PWR, and here, we only include these in our ratings.

Our discussion had us reflect our concepts deeper and at the same time frequently raised questions regarding the definitions chosen for the design space axes. Several of our robot concepts serve as 'edge cases', that reveal ambiguities as well as gaps in the typology of assistive robots underlying the matrix. In the following, we highlight key insights, and discuss key questions.

First, the 'social robot' category subsumes a huge variety of aspects (social, emotional, and cognitive support) which deserve a clearer distinction, while the definition of 'physically assistive' is far more clear-cut and also more narrow. **Second**, we noted that some of our concepts did not really fit into either category, indicating that this differentiation is not encompassing. **Third,** the division of physical versus socio-emotional assistance artificially splits up social and physical aspects of care, where the physical is also affective and social. **Finally**, it exemplifies the limitations of categorial descriptions when it comes to the description of an always intertwined empirical reality.

To start with, the classification relates social assistance to emotional and cognitive well-being, and relates physical assistance to utilitarian, functional physical tasks. Having one of the categories labeled 'social robots' created confusion, as this is a rather broad category which includes robots for cognitive and emotional wellbeing, which do not have to be social in the sense of direct interaction.

Why is only physical assistance tied to being 'effective'? This classification further connects physical assistance with the aim to reduce labour or effort. We found this to be a too limited perspective. It had us struggle to rate Elyza, which is not intended as a social companion and can even activate or trigger real-world effects, such as making a call or playing music over the stereo - but does so via a 'social interface'. The distinction between 'physical' and 'social' did not allow for a clear identification of functional help provided by a conversational agent making a phone call. Elyza can also support memory and organisation. We wondered why such kinds of cognitive support are subsumed under 'social (and emotional) assistance', and not considered to be 'effective' (or utilitarian), whereas only physical assistance is labeled as effective. A team member felt: "(this) is missing something, that's functional but not physically functional. There is a category missing."

What about physical interactions with affective and social impact? In discussing several other concepts, we also stumbled across an artificial split between the categories of the physical (effective) and the emotional/social. This was in particular the case with IntiMe, a robot that behaves solely physically, that manipulates residents' bodies, and by doing so fulfils an emotional (or even social) need for sensual (or even sexual) stimulation. It was clear to us that in terms of its effect and impact, IntiMe should be rated as highly social-emotional. But we found it hard to categorize the amount of 'physical assistance' since the phenomenon of sexuality is highly interlinked between physical and emotional needs.

The physical thus might not always be 'effective' (in terms of reducing labour). Some physical interactions are highly social and affective, and contribute not just to physical wellbeing (being 'fed and clean'), but also to human needs of being caressed or sensually-sexually stimulated.

What actually is meant with 'socially assistive'? We also repeatedly argued about the labeling of one of the main categories as 'socially assistive'. This, again, came up when discussing IntiMe: "I understood that for the social dimension, the object itself has to be social, not the outcome", and somebody else responded: "How can you be social with yourself?" Thus, we came to ask ourselves what is considered to be 'socially assistive'?

Rather than being a social actor, some of our robot concepts provide a form of social facilitation or mediation. For instance, Elyza can provide social facilitation, Chairie can be a social mediator by enabling (and motivating) people to go out and meet others. IntimUs is the strongest example for a social mediator in helping residents to connect and interact, also on a physical level. Yet IntimUs, on itself, has no social role and does not engage in social interactions.

What do we mean with 'social'? Or - Why are emotionally assistive robots subsumed under the 'social' category'? We discussed that the definition of 'social' in how social robots are usually thought of implies a direct (or focused) interaction with the robot (the definition of it as a social being), whereas one of our concepts (the PWR) does not interact with residents. Nevertheless, the PWR is intended to contribute to emotional-cognitive well-being - which would designate it for the rather wide scope of 'social robots'. Similarly, we expect residents to interact less with the abstract cleaning robot Aurora than with its cat-like sibling Sanne. But the intention with Aurora also is to support wellbeing, in this case by creating atmosphere and tuning residents to the activities at this time of day. The issue is here the labeling of the main category as 'social robots', as ascription of social agency implies an ability to engage in social interaction.

What is the role of speech? According to the literature, anticipating behaviour in a situation [5] – and this can also be non-verbal – is necessary for an object to be granted a social status. In particular, the potential of an object to talk is perceived as a significant indicator for the ability to anticipate behavior. I.e. if an object can talk, then this is interpreted as indicating that the object is social, and it raises high expectations. Thus, it may be better to avoid speech interaction, or to limit it to voice commands for the robot.

CONCLUSION

We have illustrated creative concepts for care robotics that go across the standard definitions or combine them. These concepts were developed from an ethnographic approach and through a creative design approach, including speculative design strategies. Discussing our concepts through the lens of this common distinction revealed gaps and ambiguities in these definitions. This on the one hand shows the value of our design approach, which attempted to 'rethink care robotics', with which we hope to inspire thinking about care robotics in different ways. On the other hand, our discussion problematizes common labeling of robots as 'social' or 'physical'.

In our analysis of our own concepts for care robots and in the resulting discussion, we recurred to a common, but rather simple distinction between physically (effective) assistive robots and socially assistive robots. We chose this simple differentiation as it allowed us to view this as a 2-axes design space, but also because it is frequently referred to, albeit there are various other attempts to further differentiate care robots or social robots specifically (e.g. [20, 23]).

Nevertheless, our discussion highlighted questions of a general relevance. We repeatedly returned to the fact that social and physical aspects of care cannot be described as distinct aspects. While this was always true for human care practices, the increasing connectivity and complexity of technical systems leads to more and more scenarios, where this is also the case for (semi-)autonomous care technology.

At least to us, it is an open question how these two definitions have evolved. The main distinction between the category of social robots and physically assistive robots appears to be whether the robot interacts with a person or with material objects (including bodies). This has reminiscences of the mind-body division in philosophy and science, which still is reproduced in disciplinary boundaries [12]. But it is also likely that this distinction results from surveys of robotic projects, where some roboticists focus on HRI (addressing challenges in fine-tuning social interaction, speech, gestures and facial expressions) while others focus on technical software and hardware challenges in object manipulation and navigation. What if we would instead create definitions and a typology based on an analysis of human needs in care? A typology that builds on categories which take into account the complex and interwoven ways in which the interplay of subjects and objects may work toward this goal. While this might result in categories for which no robots exist yet, it might have more long-term value.

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