Meaningful Telerobots in Informal Care

A Conceptual Design Case

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ABSTRACT

While telerobots offer potentially unique ways to shape human-human relationships, current concepts often imitate existing practices, such as face-to-face conversations. Using the example of informal care, we explored whether the explicit use of the unique possibilities provided by telerobots can lead to meaningful extended or unique care practices. Initial in-depth conversations with five caregivers and care recipients about their care practices revealed three types of "care visits" (i.e., dedicated, short/spontaneous, reciprocal) as well as what makes them positive (e.g., mutuality, routine, autonomy). We combined this with the unique opportunities telerobots offer, such as masking the feelings of the caregiver. These were further condensed into three video prototypes of potential, robot-mediated care practices and further critically reflected together with the five participants. All in all, telerobots offer opportunities to strengthen relational autonomy, to disentangle roles and to establish less demanding or more activity-based forms of sociability in informal care relations.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**; **Interaction design process and methods**;

KEYWORDS

Wellbeing-driven Design, Robotic Telepresence, Informal Care Practices, Experience Design, Experiential Telepresence

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1 INTRODUCTION

Telerobotics provide humans with the possibility to be present and to be active in physically remote locations. Typical application areas are life-threatening environments, such as space or deep-sea exploration. In these applications, the telerobot replaces the human. From the perspective of the human operator, the telerobot is a remotely controlled tool, an extension of the self. Consequently, telerobots are often designed with a focus on mimicking human ways of manipulating the environment as well as to create a first-hand experience for its operator over the distance.

Whereas teleoperation focuses on performing tasks at a remote location, telepresence is about embodying a person, who is spatially distant. This adds a social dimension, which includes at least two people: the operating person, who is present through the telerobot, and another person, who is interacting with the operator through the telerobot. This implies to broaden the view from the mere pragmatics of teleoperating to potentially desirable socio-emotional experiences mediated through a robot.

In line with this, the present paper explores telerobot-mediated social experiences in the domain of informal care. Of course, autonomous social robots in care are an already well-researched topic [25–27]. However, from an experience-oriented perspective there is

a fundamental difference between a telerobot and an autonomous social robot. Autonomous social robots often create dyadic interactions between a human and the robot. The resulting social experience is with the robot. Telerobots mediate the experience between at least two humans [22]. The resulting social experience is through the robot. Thus, telerobots can be thought of as a medium and become part of a care "triangle" [34]. Instead of acting as a replacement for human caregivers as in the case of autonomous robots, telerobots offer the opportunity to reframe and extend the existing relationship between caregiver and care recipient.

So far, taking up this opportunity had been limited. Available telerobots mostly offer forms of "embodied" (video) calls [18, 19, 22] to provide the operator with the freedom to move around at the remote location [9, 32, 40]. Telerobots are predominantly designed to replace its operator in conversations, with perceptual realism and social presence as paramount design goals [9]. From our perspective, this view is limited. It neglects the multifaceted nature of everyday practices, of which conversations are often only a part, as well as the unique possibilities telerobots might offer.

Consequently, this design case study investigated telerobot mediated experiences beyond mimicking the presumable ideal of a human to human conversation. Starting from existing informal care practices, we explicitly explored how the very fact that care is provided through a robot can extend and enrich informal family care in unique ways.

We start this paper with a brief introduction into related work and our theoretical approach. Based on anecdotal insights into informal care practices, we then explored distinctive socio-emotional possibilities provided by a telerobot just because and not despite it being a machine. We summarize ideas and insights as three exploratory design concepts for human-telerobot-human interaction in informal care. Based on these concepts, we engaged in collaborative speculations with caregivers and care recipients about possible futures where robot-mediated care practices may be commonplace. We found that telerobots offer possibilities to strengthen relational autonomy in informal care, to help disentangle conflicting roles, and to provide less demanding or more activity-based forms of sociability. All three aspects address the inherently asymmetric nature of informal care relationships in terms of autonomy and social support.

2 DESIGNING MEANINGFUL TELEROBOTICS

2.1 Informal Care and Telerobotics

Informal care is an unpaid effort by non-professionals to support chronically ill, dependent, and in many cases older people. Typically, informal caregivers and care recipients are in an existing social relationship, such as children, who care for their parents. The major goal for the care recipients is to continue living in their own homes for as long as possible. Forms of practical support vary depending on the care recipient's requirements (e.g., cleaning, shopping, cooking) but always also involve socio-emotional support [7, 16]. In the light of an aging population and the desire to grow old in a familiar environment, there is an interest in Human-Computer Interaction to support informal care [35], not only from a practical but also from a socio-emotional perspective e.g., [5].

In general, telecare agendas moved past a solely problem-driven approache [13, 33]. Some work (e.g., [6]) already emphasizes the importance of addressing actual emotional and social needs of care recipients and family caregivers in robot-mediated experiences. There are general approaches that point towards the importance of foregrounding values, investigating lived experiences and reconfiguring social norms, ideals and categories [13, 37, 42].

Consequently, telerobots for care and aging could offer novel ways to satisfy emotional and social needs over a distance. However, research on telerobots tends to oversimplify the complexity of socio-emotional practices by reducing it to conversations [1, 8, 29]. For example, research in professional care, such as residential care homes, has explored telerobot-mediated visits from family members [1, 28, 29, 31]. Similar to a video call, operators dial into their telerobots to have a conversation with a family member with the additional possibility to move around at the remote place. Those "social" telerobots often have further manipulators, thus, the agency they offer at the remote place is severely limited. While more recent studies start to study how telerobot-mediated care practices may fit in the domestic life of informal caregivers and care recipients [4, 8, 10, 15], in most cases, telerobots remain enhanced communication channels to mitigate a lack of social contact [3, 18, 41].

In the design of social telerobots, many roboticists start from the premise that robot-like characteristics actually impair the social experience for humans [36]. Consequently, they aspire to create telerobots which become "invisible" in use [39] or resemble humans. The robot is perceived as inherently deficient given its machine nature. This holds true for care visits through telerobots, where more agency (compared to a simple video call) is supposed to enhance the operators experience. From the "visited" person's perspective, the physical embodiment allows for mediated social touch (e.g., hugs, handshakes) [30, 32, 44]. All in all, these designs attempt to mimic a face-to-face visit with a focus on conversation. What seems missing is a broader understanding of the opportunities for meaningful mediated socio-emotional experiences which make use of the unique capabilities the robotic medium entails.

2.2 Telerobotic "Superpowers"

From our perspective, the focus on replicating the elements of a human encounter, is bound to fail eventually. In many cases the technology is not and will not be able to mimic human-human experiences. A mediated hug, for example, may require a lot of technological effort until it resembles a real hug. But even if, people may not be able to ignore the fact that they hug through a machine.

To create alternative approaches, it is helpful to not think of telerobots as a solution to the problem of not being in the same place, but as a possibility, a resource to provide alternative types of meaningful experiences which make explicit use of the unique aspects of telerobots (i.e., possibility-driven design [11]). In this sense, telerobot-mediated human-human interaction should become meaningful not despite but because they are mediated. Ideally, they offer forms of socio-emotional experience in informal care which are not in competition with existing face-to-face visits but complement and extend them.

Currently, some approaches in Human-Computer Interaction as well as Human-Robot Interaction suggest to reflect more on what

is unique to humans and unique to technology [12, 23]. [43], for example, discussed psychological "superpowers" of robots, that is, socially relevant capabilities, which are especially easy to attain by robots because of their "mechanistic nature". An example is patience: Human listeners can easily get impatient while listening to the same joke or story over and over. However, there are situations where patience is key to being thoughtful and respectful. In these situations, a robot's inherent technical nature allows for endless patience, which actually makes it a "social superpower" when interacting with humans. This notion has been put into practice by researchers who explored the superpowers of three specific autonomous robots together with the developers [12]. To explore the unique potential of telerobot-mediated care, we engaged in a conceptual design case based on the premise that novel practices can be established based on unique telerobotic features. Specifically, we took a research through design approach [14, 47] by designing exemplary telerobot-mediated practices of informal care to better understand the opportunities telerobots offer as well as the challenges they pose. At this point, telerobots are not commonplace in family care and conceptually often thought of as a replacement for caregivers. By making a conceptual design case we challenge preconceptions, illustrate our approach to the design of telerobots and reflect on the way robot-mediated experiences could shape informal care.

3 EXPLORING THE DESIGN SPACE OF INFORMAL FAMILY CARE AND ROBOTIC MEDIATION

To better understand the intersecting design spaces of informal family care and telerobots, we first gathered existing, care practices through in-depth interviews with members of three households. Our objective was not to get a representative overview of informal care practices but to collect anecdotes of care practices as grounding and inspirational input to the design process. We then gathered and critically reflected unique opportunities of telerobotic mediation. Both was input to a conceptual design process. The anecdotal evidence makes sure later ideas were grounded in the everyday life of real people, while the unique opportunities fuel new telerobot-mediated experiences. In doing so, we turn our understanding of current care practices into sketches of future robot-mediated care practices that extend and enrich existing care practices.

3.1 Gathering Existing Anecdotal Care Practices

We conduct five separate, semi-structured conversations with informal family caregivers (CG) and care recipients (CR) from three independent German households (H1-H3). We decided to talk to members of three different households to get a minimal amount of idiosyncratic practices from heterogeneous care arrangements. Further, it was important for us to learn about both perspectives (i.e., caregivers and care recipients) to understand how the relationship could be extended. We included mentally healthy older adults with self-reported need for care and their caring relatives (see Table 1). The responsible institutional review board provided ethical approval. Participants were compensated for their time with 50 €. Our process included asking the CG of pairs to indicate whether it is suitable to include the potentially vulnerable CR in the study. In the case of H3, CG did not recommend inclusion. The participants in our study were exclusively female and the care arrangements were based on an underlying mother-daughter relationship. This was due to availability and sufficient to obtain inspirational anecdotes from existing family caregivers and care recipients.

In the conversations, we asked participants to describe their relationship with the other person, a typical care visit, established practices as well as examples of especially successful instances of care, that is, moments in care which felt especially enjoyable and/or meaningful. We talked with our participants online via video conference due to SarsCov2 contact limitations . Each conversation took approximately 1 hour. The purpose of this step was to immerse ourselves in first-hand accounts of lived experiences to gain a richer descriptive understanding of especially successful (i.e., meaningful, enjoyable) care practices.

Findings. The care recipients enjoyed a care visit most, when it allowed them to take part in the life of their family, when they did not feel to be burden, when they were able to symbolically compensate their children for the effort (i.e., reciprocity), and when the care givers engaged in socio-emotional practices beyond the care-related chores. An exemplary practice that shows the desire for company is the Kaffeeklatsch. The caregiver takes a break from household chores, sits with the care recipient, while having a coffee and a stimulating chat. These moments are typical instances of socio-emotional care. Short telephone calls at the end of the day to exchange latest "news" provide a similar function. The calls are often initiated by the care recipients. To reciprocate the effort of her daughter), one care recipient, depending on her daily condition, prepared meals for her daughter, who drops in after work. Symbolic gifts (e.g., sweets, socks, money) for caregivers/visitors followed the same intention.

The care givers enjoyed a visit most, when they can encourage their parent to remain active and to look at the bright side of life, when they created a situation, where the parent is comfortable with accepting the help, when they can successfully align care activities with own life activities, and when they successfully coped with the socio-emotional aspects of this visit (e.g., control own negative emotions, instill positive emotions in the caregiver). One caregiver encouraged shared activities and a division of tasks with an emphasis on what the care recipient is good at. For example, the daughter instructed her mother to dry the dishes during dish washing or to get the laundry from the washing machine. Seeing her mother active and engaged in shared activities, eased her daughter's worries about her health.

Overall, we found a variety of types of "care visits" which can be grouped into three categories: dedicated visits, short visits, and reciprocal visits. *Dedicated visits* consist of both, practical care activities and socio-emotional care (i.e., conversations). The care activities itself become embedded into social exchange (e.g., chatting while doing the dishes), with a certain amount of visiting time always being allocated for chit-chat. A meaningful moment of care always includes the socio-emotional, while the practical care is not as defining. In *short visits* caregivers swing by briefly to say "hello" or to get or to bring stuff. These brief visits are driven by the intention to make sure that everything is okay with the care recipient.

Table 1: Overview of Participants

Household	Participant	Gender	Role	Relation	Age
H1	CG1	Female	Caregiver	Daughter	46
H1	CR1	Female	Care Recipient	Mother	76
H2	CG2	Female	Caregiver	Daughter	51
H2	CR2	Female	Care Recipient	Mother	81
H3	CG3	Female	Caregiver	Daughter	61

They are especially meaningful when they become part of daily or weekly routines, such as visiting on the way back from work. Both, caregivers and care recipients value the brief moment, but abide by a mutual agreement not to extend it. *Reciprocal visits* consist of practices to allow care recipients to experience life outside their own four walls. On the one hand there are events, such as birthday parties or a visit to the cemetery, which are inherently meaningful to the care recipient. On the other hand, care recipients initiate contact (e.g., phone calls) to preserve some of their autonomy. Care givers enjoy this, since it reverses the relationship at least momentarily – the care recipient socio-emotionally cares about the care giver. This seems especially important since in informal care children often care for their parents, which reverses longstanding roles and practices. Reciprocal visits are thus moments of reactivating the underlying parent-child relationship.

Note again, that while some of these practices are certainly widely shared at least in certain cultures, the purpose of gathering them was to empathize with the lifeworld of participants as well as to get inspired. For example, the practice of dog sitting played an important role in one household. This neither represents the caregiving population nor implies that a shared robotic pet would result in the same positive experience. Instead, the collected practices allows us to empathize and better understand experiential qualities and underlying mechanisms of socio-emotional care.

3.2 Unique Opportunities of Robotic Mediation.

We now turn our attention away from what people experience in meaningful informal care to the unique possibilities telerobots may offer. Based on a collection of robotic "superpowers" identified by [12], we conducted brainstorming sessions among the authors to draft a non-exhaustive list of unique opportunities telerobots may offer through the very fact that they are machines. In these sessions we drew from personal anecdotes, domain knowledge, technological expertise, and inspiration from previously gathered practices.

Findings. In the following we present a non-exhaustive list of opportunities to shape socio-emotional experiences in informal care through:

- **Distributed Body and Multi-Tasking:** Robotic telepresence allows a caregiver to control multiple bodies or body parts simultaneously. Thus, a caregiver could split into multiple embodiments, each with a dedicated purpose and capabilities, such as a stationary conversation part placed on the table, a mobile manipulator part moving around the room, multiple mobile parts. This allows an operator to perform multiple activities at the same time, such as acting in other parts of the flat, for example, through distributed cameras or interfaces to smart home appliances while chatting with the care recipient. In addition, depending on the design of the mobile parts the operator could be given completely new capability, such as flying around.
- **Straightforward Communication and Masked Appearance:** Robotic telepresence allows a caregiver to reduce or remove inappropriate emotion-laden connotations from social interaction. As a care giving robot, for example, one could more easily avoid being perceived as annoyed by the task at hand, which might prevent misunderstandings/conflict and reduces guilty feelings of the care recipient. Thus, robotic telepresence allows a caregiver to "mask" their current mood, appearance or state. This could, for example, be beneficial when the caregiver does not want to reveal current feelings or worries.
- **Total Recall:** Robotic telepresence allows a caregiver to record and thus "remember" with every detail what happened during a "visit". These "memories" can be stored and re-experienced.
- **Extended Availability:** Robotic telepresence can be combined with pre-programmed and autonomous modes (e.g., even where the telerobot implicitly learns from its operator) to create the impression of an unlimited availability of the caregiver to the care recipient.
- **Time Travel:** Robotic telepresence allows a caregiver to revisit the past or pre-program actions for the future. Communication is not time-bound, thus, enabling asynchronous acts of care and kindness.

All in all, particular technical attributes of telerobots offer a number of possibilities for alternative approaches to address socio-emotional aspects, such as time pressure and stress, courtesy, pride, vanity, and worries.

4 THREE STORIES OF MEANINGFUL CARE THROUGH TELEROBOTS

4.1 New Telerobot-Mediated Informal Care Practices

To create new meaningful practices of informal care through telerobots based on the preliminary work described in the previous section, we organized two ideation workshops among the authors. To stimulate a creative process, we framed potentially desirable experiences as questions, e.g. "What if you could visit any time?" or

"What if you could help your caregiver with the chores?" In both workshops, participants combined these questions with unique opportunities offered by telerobots to create consistent and positive stories of care through telerobots. All in all, we created 10 stories. Each story essentially described usage scenarios and envisioned emerging socio-emotional experiences. An example is "Time Lapse: In this story, the robot remains active and a potential conversation partner for the care recipient, even if not teleoperated momentarily. Before operating the robot, the care giver can rewind and fast forward through events and conversations that occurred in his/her absence to bring himself "up to speed". We rated the 10 stories according to novelty, feasibility, and attractiveness. The ratings were discussed within the group and highly-rated stories were combined into three final concepts:

Distributed Cooperation. In this type of care visit, operators to split into several telerobotic devices to share activities with the person to be cared for. This concept was inspired from one of the idiosyncratic practices gathered in the initial conversations. In this practice, the caregiver encouraged her mother to actively engage in activities around the house (see section 3.1). Further, the concept made use of the potential "superpower" of a distributed body. Distributed Cooperation's goal is to create feelings of autonomy and competence for care recipients, because instead of solely taking away activities from the care recipient, it implies a mixture of symbolic action and adaptive division of tasks. For example, when cooking together the co-located care recipient could position the robotic devices, hand out the required ingredients and clean the work surface.

Reverse Visit. This type of reciprocal visit, provides the care recipients with a way to effortlessly participate in the family life of the caregivers. The care recipients constant need for support restricts their autonomy. A telerobot allows to temporarily transcend the limitations of one's own body, and to become resilient, powerful and insensitive to pain. In this sense, a telerobot could equip the care recipient with attributes, such as physical agility, which are in reality already restricted. Reverse Visit's goal is to empower the care recipient, to again foster feelings of autonomy. Instead of having to ask their children for a visit, care recipients get the ability to move around freely, feel at home and to be included in daily family life, beyond the limitations of their aging human bodies.

Doppelganger. This type of telerobot extends the common conception by providing autonomous functionality, when it is *not* teleoperated. In this time, it can take requests from the care recipient, can record certain events, and perform preprogrammed actions provided by or learned from the care giver. All this is orchestrated in a way to create a rather ambient feeling of togetherness, a positive "ghost" presence-in-absence of the caregiver. This setup allows for "time travelling" and "total recall", since the caregiver can revisit events and request from the time of absence before entering telepresence. Doppelganger's goal is to literally extend the caregiver. From the care recipient's perspective, an important person is now available round the clock. This can alleviate moments of loneliness and worry. Thoughts and ideas can be immediately voiced by the care recipient, without any need to note something down or memorize it. It may also reduce negative feelings stemming from the conflict between the recipient's need for socio-emotional care and the desire not to be o burden to the caregiver. For the caregiver the Doppelganger may reduce worry about the care recipient as well as guilt due to time restrictions. The possibility to revisit moments which happened while "being not there" allows for extended conversations. Of course, privacy arrangements have to be made, that is, the care recipient must always be aware that the robot monitors and should be able to control it.

4.2 Video Prototypes

To bring our concepts to life, we created three video prototypes in the form of animated storyboards with voiceover [38]. These videos serve as diegetic prototypes [20] and explore fictional everyday experiences of the given concept in use. Note, that their focus is on the new care practices and experiences emerging from them. The robot itself, its exact technical features, form as well as user interface remains rather vague. Intended feelings and personal meanings of the three practices are made apparent through direct speech, an omniscient narrator, and particular scenes.

Keeping in mind that eyesight might vary among the intended audience of the videos, we paid special attention to communicating our concepts in a comprehensive voiceover and dialogue between characters. We used a split screen visualization to show the experience of the two involved parties simultaneously (i.e., left – remote location; right - operator). Each video has a runtime of approximately 5 minutes. Creating the video prototypes helped us to further develop the three initial concepts by situating the concept and related experiences further.

In the first video *'Remote Cooperation via the X3 system'* we show how caregiver and care recipient use a modular telerobot to prepare a meal together. The second video *'Reverse Visit using a visiting ball'* tells the story of a reciprocal visit where the mother attends a party at her daughters place via a telerobot. The third video, *'Doppelganger RoboBert'* shows how a care recipient lives together with his son's doppelganger, a telerobot that is sometimes operated and sometimes autonomous, but always maintains some likeness to the son. As an example for the more detailed content of such a video, we briefly describe the storyline of the third video. The video itself is in the supplemental material.

"Doppelganger RoboBert" introduces us to the daily routines of Gustav, who lives together with a telerobot embodying his son Robert. Tongue in cheek, he calls it RoboBert. RoboBert visually and behaviorally resembles Robert. A remote virtual reality interface allows Robert to feel present at Gustav's place and to express himself as RoboBert. Not only can he feel present, but he can manipulate the environment (e.g., hold the door open for his father) and thus show care through symbolic action. When Robert has to leave the robot during a late breakfast to do some work, the conversation continues even without his immediate presence. Only the robot's resemblance to Robert diminishes slightly, while some key behavioral characteristics are maintained (Figure 1a). Throughout the day Gustav spends time with the robot in autonomous mode. At one point Robert slips back into the telerobot after a long and especially exhausting day. He is in a foul mood. But RoboBert masks Roberts frustration, remains friendly and allows Robert to support his father in distress, despite his own bad mood (Figure 1b). Later in

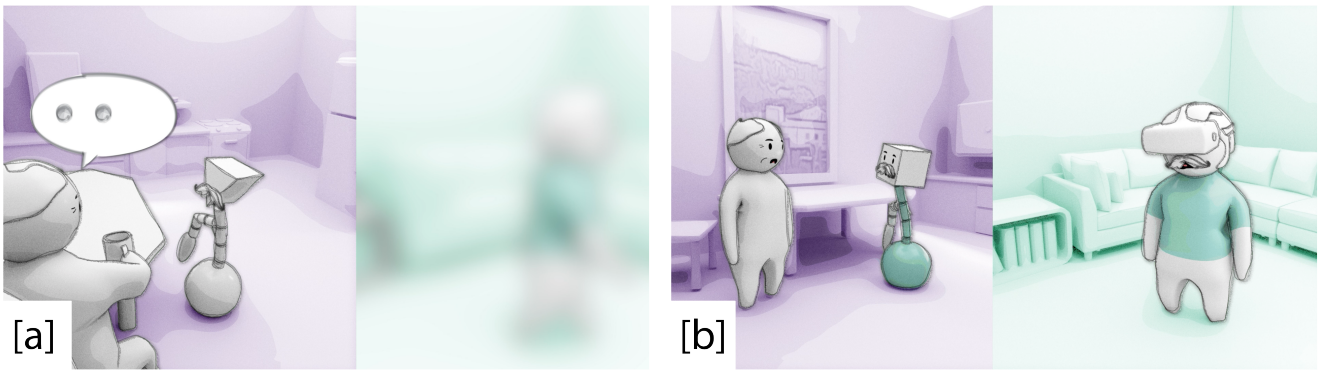

Figure 1: Stills from 'Doppelganger RoboBert' – a) Gustav talks with the autonomous RoboBert while Robert is offline b) Robert is in a bad mood while operating RoboBert, but the telerobot gives nothing away.

the day, Robert catches up on the time Gustav spend with RoboBert in autonomous mode. Through this, he gets a pretty good idea how his father is doing.

5 PUTTING TELEROBOTS INTO CONTEXT: COLLABORATIVE SPECULATION

To further contextualize and critically discuss the concepts represented by our video prototypes, we further used a form of anticipatory ethnography [24]. Specifically, we presented the three video prototypes to the participants, who initially described their care practices to us (Section 3.1). Each of the five participants watched all three videos. A whole session took about 90 minutes. We allocated around 20 minutes of the session to show the video prototypes and ensure that the participants understood, what they had seen and listened to. After each video we prompted participants to relate the story to their own life and imagine fictional situations from their individual everyday life with such a telerobot.

Analytically, we focused on whether participants were at all able to relate the concepts to their everyday life. Our intention was not to verify the design, but rather to critically reflect together with participants on what might be and how our telerobots would change the experience of family care. We were particularly interested in the extent to which the videos invite situations, thoughts and feelings of personal everyday use, as well as strong or mixed mixed feelings about certain aspects of our concepts. We then dived deeper into positive and negative issues emerging from reflections about the potential everyday use of our imaginary telerobots.

Distributed Cooperation. Regarding *'Distributed Cooperation via the X3-system'*, participants pointed out that a certain amount of synchronization may be needed to cooperatively manage daily activities. CG3 imagined that doing the chores together via the X3-system would entail a daily structure which would be good for her mother. *"So that you say we start together in the morning with breakfast. [...] Then I go to work and, in the afternoon, we continue with lunch."* (CG3). The two care recipients imagined that the X3 system would make it easier for them to ask for help. CR1 explains: *"It is easier, because it is not like 'I want something from you', but I also do something. We do it together."* While we envisaged the X3-System to be a collaborative experience, the caregivers saw it as a means to streamline their assistance. They recounted situations where they experienced interdependence as cumbersome, such as explaining over the phone how to turn off a smoke alarm, use the door intercom or troubleshoot technical problems with the television. From this, they expect that the possibility of intervention via the X3-system sorts out the trouble of instructing. All caregivers imagined using the system to regularly check on their parents, regardless of household chores. CG1 explains *"I could imagine, that if I cannot reach her and I could activate the thing from my side, [...] that I can just leave a message 'Get in touch. Is everything Okay?'"* CG3 imagines to use the X3-eyes to regularly check on her mother. She found it less intrusive, because it allowed her to make sure everything is okay without disturbing her mother.

In sum, the *'Distributed Cooperation via the X3-system'* was seen as leading to a healthy" synchronization of everyday activities. Not only does it allow care recipients to express their needs more freely, it also has the potential to make family members feel more in tune with each other. However, caregivers also asked themselves to which extent they would use the system to check on their parents and at which places and situations they would operate the telerobot system.

Reverse Visit. The *Reverse Visit* led participants to variably apply social norms of living together and visiting to their imaginary experiences. The caregivers saw themselves as the host and wanted to be in control of the visit in terms of time and places. CG2 argued *"If she [the mother operating the telerobotic ball] rolls somewhere alone where nobody else is, no one can answer her questions."* CG3 did not want to be interrupted by her mother in inconvenient situations *"I might have an argument with my partner [...] or I have an important talk with my child, with which my mother has nothing to do."* Caregivers picked up on the idea that the telerobotic ball should attract attention during operation (e.g., through a flashing light). Even though shared spaces could exist alongside places of retreat, caregivers preferred to regulate visits through technical constraints of the visiting ball, for example by a function which CG3 equated to the function of a doorbell or a ringtone.

Caregivers extended the concept to shared activities, where they take their parents outside (e.g., concerts, vacations, bicycle tours) or to family rituals, such as coffee table conversations. Interestingly,

both care recipients (CR1, CR2) imagined rather passive forms of togetherness (e.g., sitting in the backyard just observing), which would give them a sense of belonging without being too demanding. CR1 questioned her entitlement to be at her daughter's place at any time. She explained: *"Whenever I want to see my daughter, I have the feeling that I intrude."* While a barrier now, it would remain a barrier, even if the telrobot would allow to just be there, whether her daughter wants or not. The respective caregiver imagined that she would feel monitored and that participation via the telerobotic ball would not provide practical help for her mother. CG2 imagines that it would take some of the pressure off the care arrangement. She explains *"It somehow soothes one's own conscience. You always have a bad conscience and think 'Why are we not visiting her more often?' And like that she could take part in our life by herself. At least a little bit."*

In sum, caregivers asked themselves to which extent and under which circumstances they would let care recipients visit their home via a telerobot. Whether care recipients felt entitled to visit their family at any time and who would be in control of such a visit, remained debated. Although a spontaneous visit through the telerobot seens much more unobtrusive than a real spontaneous visit, some participants still cared very much about existing norms of courtesy and privacy.

Doppelganger. The *Doppelganger's* ability to mask emotions resonated well with the participants' real-life experiences. CG1 said: *"Of course, you get irritated sometimes [by too many requests at an inconvenient time] And of course, it does make sense that the care recipient does not notice every mood, especially to avoid her getting the feeling that she is some kind of suppliant."* However, CG1 also wanted to be transparent and open with her daughter. *."If it is not the right moment or not even possible it should be allowed to express that"* CG3 imagined that both, she and her mother, should have the ability to switch between masked and real emotions. She elaborated: *"It would be feedback for me in the moment where my negative emotions are too much for her and she turns them off – now the load is too much and we need to wind it down."*Two caregivers voiced their concern that traveling into the past of the autonomous Doppelganger could lead to potentially unpleasant or awkward situations: *"If she has guests and they are talking, it might happen that I think What is she saying? How does she talk about me?"*(CG2). CG3 explains that she would prefer to use this feature strictly in situations where she feels that something weighs heavily on her mother's mind. The care recipients imagined that they would talk more openly with the telerobot if the caregiver is not operating it. CR1 says: *"Honestly speaking, I think I would do more when I am alone with the robot."* However, they did not mind if caregivers (re-)experienced such conversations. CR1 elaborates: *"That would not be bad. Then she knows what I am doing throughout the day"*. Furthermore, care recipients imagined interactions with a Doppelganger to feel more personal (compared to any other robot), but believed that they would need some time to get used to the partial resemblance. Participants were rather vague about the characteristics that they imagine the robot to assume in autonomous mode (i.e., visual features in form of caricature, or repeating the caregiver's silly jokes). CG3 emphasized: *"It's good that there is some recognition possible. It should not be a cold machine. [. . .], but it should also be recognizable that it is not a real person."* In sum, the Doppelganger remained ambiguous. The idea of a personalized and always present Doppelganger of the caregiver is perceived as entertaining. However, participants had some reservations about the unknown experience of hidden emotions or (re-)experiencing the past of their doppelganger. Caregivers want to be emotionally open and honest with care recipients, but at the same time know that moody reactions make their care recipients even more reluctant to share their needs and accept care.

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6 DISCUSSION

The present conceptual design case study explored the idea that social experiences in informal care do not necessarily need to be diminished by the use of telerobots but might even be extended. In contrast to social robots, which often aim at replacing human-human relationships, we suggested to enrich existing relationships

through the specific possibilities telerobots offer. More specifically, the telerobot makes it possible to interact with an extension of a close person, be it care giver or recipient. Ideally, this version should complement its human operator.

6.1 Design Implications

In the following, we further discuss design implications for robot-mediated relationships addressing *autonomy*, *roles*, and *sociability*.

Extend and tailor relational autonomy. In close relationships as well as care, autonomy plays an important role. Prior work on telerobots has mostly taken a capacity-centered approach to autonomy. This implies that telerobots predominantly support autonomy by expanding the care recipients' or caregivers' action space. For care recipients, an added capacity is the ability to visit places outside their home [3, 41], whereas for care givers, it is the flexibility to instantaneously appear at the care recipients place [29]. This is a quite limited, functional perspective on autonomy, which ignores the relationship between caregiver and care recipient.

In the care arrangements we witnessed, autonomy was not only a matter of regaining some kind of mobility or saving travel time. For example, considerateness for the other person led to self-limiting behavior, when care recipients were reluctant to ask for help to avoid being a burden on their relatives. In these cases, caring itself is detrimental to autonomy, even if necessary. Telerobots can offer alternatives. In a relationship where the recipient feels like a burden, a telerobot could counteract this impression. For example, the idea of "masked emotions" and "unlimited availability" are conducive to relational autonomy, because they enable the regulation of the desired intensity of togetherness even in an asymmetrical way. From the caregiver's perspective, "masked emotions" allows to care for a close other without immediate self-disclosure, and "unlimited availability" allows to restore autonomy in the face of relentless requests for more time. From the care recipient perspective, knowing that the telerobot can extend and support the caregiver may take away some of the experience of being a burden. Consequently, idealized and self-serving representations of the caregiver (and recipient) may be more conducive to relational autonomy than realistic representations. Of course, idealized representations, such as provided through "masked emotions", can be seen as inauthentic. Perceived volition and personal effort are important for the feeling of being cared for and could be undermined by always compliant representations. Whether and how this would really arise and would have a negative impact needs to be further explored. However, we believe that it is quite clear that while a person operates the telerobot, the robot itself is not the person, but an alternative version of the person, equipped with alternative capabilities due to its robotic body. Consequently, from a relationship perspective it seems quite likely that people distinguish between how people act in robotic bodies compared to their own bodies. For example, imagine practices of intimacy, such as hugging. While a person may certainly be hurt or even worried, if a close other suddenly avoids a hug, this will certainly be seen differently, given the person would be present in her or his robotic body. As long as hugging is not a possibility designed into the robotic body, people would not expect hugging. In the same vein, telerobots may offers practices to restore relational autonomy, which would be seen as offensive, when being done as the "real" person, i.e., in one's real body. In this sense, robotic mediation can even work as a relief by enabling experiences of relational autonomy to counteract unwanted forms or too intense forms of emotional dependence.

Disentangle and extend roles. The relationship between caregiver and care recipient is inherently asymmetrical, which is likely to affect the underlying interpersonal relationship and self-image. Especially when children care for their parents, well-practiced roles become at times uncomfortably reversed. In the present cases, caregiving children typically assumed both roles at the same time: caregiver and child. As a result, the two different relationships dynamics were often intertwined and shaped existing care practices and family life.

As a caregiver, children start to visit their parents regularly, whereas the parents remain homebound, waiting to be visited. Current telerobots often do not question, but rather further reinforce such patterns [6, 21]. Being aware of this allows designers to develop alternatives or extensions to existing practices. In our case, we imagined practices around reciprocal visits. Enabling parents (the care recipient) to visit their children (the care givers) autonomously through telerobots can disentangle care visits and dedicated family visits. When visiting through a telerobot care recipients can assume the role of a parent or grandparent primarily. In addition, telerobots for care recipients offer (symbolic) opportunities to reciprocate as a way to reduce the inherent asymmetry in care relationships. When, for example, child and parent cooperate in a daily activity (e.g., cooking), the asymmetrical caregiver and care recipient relationship becomes more balanced. In our anticipatory ethnography, care recipients assumed a rather passive role when visiting through the telerobot. This could, of course, change with actual experience and further appropriation. It is imaginable, for example, that care recipients reciprocate the care they receive by watching the children through their robotic presence. For the caregiver this may not even appear related to the caregiving tasks, yet it can have a positive impact on the care arrangement.

When telerobots are used to question existing roles, they reconfigure and extend the given care arrangement. This may need time to settle in and in some cases it may not even be desired by caregiver and care recipient. For example, we imagined the "reciprocal visit" as fully spontaneous. In our concept, the telerobots should be available for the elderly person, whenever s/he feels like visiting. However, whether this is acceptable depends on the actual relationship between parents and children. A telerobot could require that operators are to be admitted by people present at the location of the robot, following a "calling" practices (i.e., to pre-announce their presence in form of the robot) [1], or could allow them to enter freely, that is, to just show up. For example, studies about the use of telerobots in long-distance relationships show that allowing the other the freedom to come and go creates a valued experience of cohabitation [45] while of course reduces autonomy and privacy. Consequently, the potential modes a telerobot offers, will mediate the negotiation of mutually agreed levels of closeness and related practices. Designers should thus not only cater for existing notions and practices, but make alternative offers for user to try out. While most users may right away agree that they do not want to invade

the others persons privacy by showing up unannounced, more "daring" modes may offer at least impulses to engage in new practices and to assume alternative roles.

Other forms of sociability. In the present case study, we explored new forms of sociability instead of mimicking existing practices (e.g., phone calls, hugging). On interesting aspect is the combined use of synchronicity and asynchronicity when designing telerobots. Engaging in shared activity synchoniously goes beyond the social as reduced to conversation. Shared activity has an activating effect on the care recipient. Besides experiences of autonomy and a softening of the role as care recipient, shared activity requires coordination and, thus, entails specific forms social experiences (as compared to the experience of conversations, see also [17] for differences in strategies to create technology-mediated closeness). Of course, shared activity fosters concurrent and subsequent communication as well. In addition, sharing daily activities through telerobots can foster a sense of routine and habituation. So far, most technologies (e.g., IoT devices [2]) are used to support shared activities over a distance. Often the connection between spatially separated users is built on top of independent engagement with the devices, which works well for asynchronous interactions. The operators of telerobots currently act more as bystanders in simultaneously shared activities [46]. We propose to further extend this by designing an explicit support for coaction, where joint activity is mediated so that the lines between local user and operator become blurred. This implies that telerobots for shared activity need not to make one operator self-reliant in task fulfillment but take into account both interacting humans.

Conversely, asynchronicity does not require participation of the other person at the moment of experiencing. Yet, the presence of a telerobot remains a social opportunity for spontaneous interactions or self-disclosure, even if no operator is present. The robot acts as a stand-in for its operator; however, as long as robots can offer at least to some extent autonomous interaction, even the stand-in can play a role in social interaction. Attribution remains an important challenge for asynchronous interaction. Ideally, the robot is seen as a stand-in for its operator (and not just as an inactive machine), yet it must remain clear when one interacts asynchronously or synchronously. We found that visual and behavioral resemblance could be a design strategy to strengthen attribution for the co-located user. For operators who (re)experience an asynchronous interaction with their robot-self through an interface (e.g., by watching a recording) it may also be challenging to claim the experience. This topic needs to be further explored.

Contrary to more conversation-based practices with telerobots, practices around shared activity or presence in absence allow for new kinds of sociability. Extending the continuity of occasional visits into forms of living together not only satisfy relatedness differently but also enables the formation of subsequent practices (e.g., coffee table conversations). Designers can support this by anticipating the range of novel opportunities that interacting through a telerobot entails.

6.2 Limitations of the present approach

Meaningful opportunities to reshape and extend a human relationship are always dependent on qualities of the existing relationship and thus hardly ever universal. To sensibly approach this for the domain of telerobots in informal care, we used a small sample and design-oriented methods to empathize with our participants. Whether some links or patterns can be generalized needs to be further explored.

Our conceptual design case builds upon capabilities which are easy to attain by robots especially because of their mechanistic nature. However, our three usage scenarios pose some further technological challenges that are not discussed in our contribution. A doppelganger that mimicks the remote operator must have means to recognize, learn and display characteristic behaviour that has been expressed during operation. Naturally, telerobots for remote cooperation and visiting must be easy to use, convey an adequate impression of the remote situation and allow for navigation and timely response. While our videoprotetypes include some illustrations in the style of familiar technologies (e.g., head-mounted displays, controller, robotic arms), we think that more work is needed to identify suitable technologies. Those technologies that convey the socio-emotional experience, rather than the feeling of being there.

Even though the concepts we presented to our participants resonated with them, some expressed reluctance to change the status quo. They reasoned that their existing practices provided enough satisfaction but pointed out that other people in different situations might need such concepts. Testing the concepts with new participants could yield further insights. People with different family relationships such as daughter-father, son-mother, and son-father should be considered. While we touch upon the role shift that occurs when adult children care for their older parents the experience of roles might vary between genders and relationships. The individual handling of rewards and distress in family care depends on ideals and stereotypes alike. For example, studies suggest find that men perform caring roles pragmatically while women approach the caregiving process with more sentimentality and emotions [48]. In our design case we used the reported practices of female participants as inspiration for robot-mediated care practices. This suggests a gender bias in our collected positive practices and feedback on robot-mediated experiences. Opportunities to strengthen relational autonomy, disentangle roles and create new forms of sociability should be explored for various care arrangements, while taking into account gendered experiences.

7 CONCLUSION

In the present paper, we used a "research through design" approach to explore whether and how telerobots can provide alternative forms of informal care based on the unique possibilities the technology offers. In other words, we explored the design space for mediated socio-emotional experiences that are meaningful precisely because the medium is a telerobot not despite of it. We found this promising for strengthening relational autonomy, disentangling roles and providing less demanding or more activity-based forms of sociability. While we show the potential of human-telerobot-human interaction in a fundamentally social setting, we also reveal tensions in current care arrangements, thereby highlighting the emotionally exhausting, asymmetric nature of current informal

care. In this respect, instead of reinforcing these demanding structures, we can use the technicity of telerobots to provide freedom for the caregivers as well as care recipients alike.

While our concepts illustrate such alternatives, the participants questioned the feasibility and their own willingness to alter current care practices. For those who want to be caring, or are expected to be, it may seem unfavorable to achieve this goal with technology. Further, we found that some reluctance was motivated by manners that participants are proud of, such as mutual consideration, open expression of mood, or respectful distance. Care recipients who postpone their own needs to minimize the burden of care, might also not request a doppelganger of their caregiver. Similarly, family care givers who pride themselves on their personal effort may not gain the same satisfaction from technologically-mediated acts of care.

What seems missing in this reflections is the coexistence of robot-mediated care and personal care visits. The telerobot potentially provides alternatives, such as forms of less demanding sociability, when for example only passively visiting the family or guiltlessly interacting with the doppelganger. These are of course not to replace current, emotionally more intense face-to-face exchanges, but to balance autonomy in favor of the care recipient and release some of the pressures apparent in socio-emotional care for both, care recipient and caregiver. The telerobot has a double role in this: on the one hand, it is able to establish new practices through its very design (functionality, presentation, interaction); on the other hand, it acts as a justification for trying out and establishing additional care practices in line with an reimagined relationship between caregiver and care recipient.

All in all, the present paper provides a starting point for future research into social telerobotics. Our findings offer food for thought for the design of telerobot-mediated socio-emotional experiences. While design case studies as the present remain anecdotal, it hopefully leads to further more systematical exploration of extended "social" telerobots, be it in form of extended design fictions or even functional robots.

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