Abstract. As intelligent support systems move into the world of elder care and independent living, their behavior becomes a prominent aspect in the lives of people, raising the question of how to design for such systems addressing older people in a respectful manner. We provide a phenomenology-inspired design perspective on emotional and social robotics in elder care pivoting on the uniqueness and respect for older people’s perceptual-motor, cognitive, emotional, and social skills. Our approach aims at achieving an empathic relationship between the older person and the system by providing continuous, expressive opportunities to allow interaction and meaning to emerge. We illustrate our research-through-design approach with several scenarios and conclude this paper reporting the interview of an older person who experimented with early prototypes of the robotic system.

Keywords: empathy, phenomenology, interaction design, robotics, elderly

Introduction

We live in an aging world with a significant proportion of people over the age of 65. Demographic global data confirm the trend of a steady increase in life expectancy of the overall population. In this context, older people prefer to maintain independent households as long as possible and governments seek out alternative solutions to institutionalization to reduce the related financial costs.

This is the motivation behind a large body of research that has emerged in particular over the last decade. Various technologies have been developed to supplement human caregiving and to help to improve the quality of life for both older adults and their caregivers. These systems attempt to compensate for the decline of physical, sensory, and cognitive skills, as well as alleviate social isolation that accompanies aging.

Most of these technologies find a place under the big umbrella of assistive technologies (LoPresti, Mihailidis, & Kirsch, 2004). These are compensatory strategies that alter the patient’s environment and are directed mainly to an individual’s functional skills (Kirsch et al., 1988). However, central among the issues an individual faces during old age is the accommodation to loneliness and the lack of a social interaction, a fundamental feature of aging well. In order to counteract this problem, a particular kind of assistive technologies was developed in the area of so-called “social robots,” a term that emphasizes constant interaction, cooperation, and reciprocity between human beings and robotic machines. These robots are personal assistants (butler, companion, maid, caregiver) and are able to execute tasks as well as taking a social perspective in their behavior.

A number of projects have been funded within the EU Ambient and Assisted Living program to develop robots and smart home environments with the goal of providing support for older and impaired people living independently at home. The entire program faces the challenge of a user-centered design that puts the relationship between the robot and the older people at the core of the system development. Social, emotional, and cultural issues are at stake as well as technological ones. These projects aim at designing enhanced quality of experience, with a slightly different focus on the level of support offered to the person, e.g., assistive-rehabilitative or empowerment and comfort systems.

Examples of robots developed in the context of these research projects are Hector, a mobile platform that supports the daily routines of the older people and reminds the person to take the medicines or review the agenda for the day; KSERA (Knowledgeable SErvice Robots for Aging), which helps older people with chronic disease with their daily activities and care; MOBISERV (an integrated intelligent home environment for the provision of health, nutrition and MOBIlity SERVices to older adults), which aims to create an intelligent system comprising a robot, wearable technologies to monitor the health status, a tele-alarm, and health reporting system and a nutrition support system; ALIAS, a mobile robot platform with the capacity to monitor, interact with, and access information from online ser-
Design Vision

Our approach to designing for interaction between human and robot builds on a vision based on two main aspects: the respect for our human capabilities and the attempt to establish an empathic relationship between human and robot in order to sustain a rich and meaningful interaction. In the following we elaborate on our design vision and discuss the theoretical approach that provides us with philosophical though practical insights for designing.

Respect for Human Capabilities

Addressing people in a respectful manner is what we consider to be our main duty while designing intelligent products and systems. This paper focuses on respectful robotics, a concept that emphasizes the experience of living with a robot at home focused not only on providing support in some task execution. It leads to feelings of engagement, emotional well-being, and comfort (Marti, 2012) through rich, natural, and meaningful interaction paradigms. Respectful intelligent products and systems (here robots) also imply respectfully addressing human capabilities (Overbeeke, Djajadiningrat, Wensveen, & Hummels, 1999), as in the perceptual-motor, emotional, cognitive, and social skills necessary for a responsible and autonomous life.

Empathy Through Embodied Interaction

As mentioned above, besides the respect for human capabilities, our vision comprises the attempt to establish an empathic relationship between the older person and the robot, the aim being to sustain a rich and meaningful interaction.

Recently, the research on empathy experienced renewed attention due to the advancements in the field of social psychology and neuroscience research. Empathy is a fundamental feature of human beings that enables us to reach out and connect with others, to know what another person is thinking or feeling, and to actually “feel” another’s emotional state (Rueckert & Naybar, 2008). It is the glue that makes social life possible (Hoffman, 2000).

In order to explore empathy in design, we investigated the theories that might be inspirational for the development of new concepts of empathic interaction. Two prominent theories have emerged to explain the phenomenon of empathy, the simulation theory (Gordon, 1986) and the theory of mind (Premack, & Woodruff, 1978). The simulation theory proposes that we understand the thoughts and feelings of others by using our own mind as a model. By “simulating” the emotion of others in ourselves, we intuitively understand what that experience might be like. This theory is supported by evidence of so-called “mirror neurons” in humans that fire during both the observation and the experience of actions and emotions (Rizzolatti, Fogassi, & Gallese, 2006).

The theory of mind takes a different perspective, focusing on the cognitive process of understanding that others have an internal mental landscape that differs from our own. This ability allows us to “read” other people’s mind and to understand that others have thoughts, beliefs, and emotions that may differ from our own.

While the simulation theory focuses on actions and emotions, the theory of mind emphasizes the cognitive dimensions of empathy. Interestingly, these theories have been influential in different fields of research, from the clinical work on autism (Baron-Cohen, 1995), to philosophy and social psychology, and more recently in technology design. For example, in the field of human-computer interaction, Bickmore (2003) and Paiva et al. (2004) attempted to emulate empathy in virtual agents. In design research, Koskinen, Battarbee, and Mattelmäki (2003) developed methods and techniques as inspiration for design, in order to understand how people make sense of emotions. In the field of assistive robotics, Tapus and Matarić (2007, 2008) developed a model of empathic interaction based on verbal and nonverbal communication with robots. These corpora of multidisciplinary research share the idea that empathy has a beneficial effect on attitudes and social behavior.

Theoretical Approach

In this paper we take a phenomenological stance in designing a robotic system that respects the uniqueness of our perceptions of our surroundings. We take inspiration from the phenomenology of perception (Merleau-Ponty, 1962) and ecological psychology (Gibson, 1979), particularly in their focus on the role of context and affordances in shaping our perception. Phenomenology stresses the unity between human beings and the environment, placing the body at the center of human existence, as a primary means of experiencing the world. The main concepts pivot around the interaction between world and person, the emergence of meaning in interaction. This leads us to design for interaction, mapping the materiality and functioning to the actionability of people. Our take on this is that we want to design respectfully toward the capabilities of the person. Our perceptual-motor and emotional skills are dominantly governed by continuous and expressive qualities. This means that the interactions we design for should be of continuous
and rich nature as opposed to discrete predefined ones. The way we interact with the world is continuous and holistic; the world is always there, and we derive meaning from its direct yet rich qualities.

Our research is also inspired by the concept of **embodiment** as a way of theorizing the relationship between embodied actions, technology design, and our experience. This approach (Dourish, 2001) provides a foundation for understanding how we are physically and socially engaged while acting in the world.

Following the principles of designing for embodiment, we explore empathy in human robot interaction through a series of walkthrough scenarios, described in section “Care-O-Bot’s Interaction Design.” These scenarios focus on understanding action-possibilities, sharing viewpoints between the person and the robot, coupled presence, and perceptual crossing (Auvray, Lenay, & Stewart, 2009), and expression-rich and moody interaction, as explained below.

As previously stated, a major challenge to our research is to develop a robot that is able to engage in rich, empathic, and respectful interaction with older people in order to encourage a prolonged, subtle, and stimulating effect beyond the initial impact. We believe that empathy is not a result of an internal judgment or a merely cognitive activity. Rather, it is a social product that emerges dynamically as an outcome of the interaction whereby actions and perception of people synergize with one another. Synergizing in the context of human-robot interaction is, for example, when both robot and human are looking in the same direction (e.g., toward a source of noise), robot anticipation to opening a door, sharing joy or fear when watching a movie together.

For this reason, the empathic behavior in our design is not expressed through the replication of human emotions and verbal expressions. Rather, it is realized through the exploration of innovative concepts of social behavior based on the idea that social skills involve the perception of how the behavior of one agent (either the robot or the older person) and its perception resonate with the behavior and perception of the other agent.

This vision and theory are adopted in our iterative design process to address the actual skills of the older person in a continuous and reciprocal interplay with the home environment including the robot. In the following, after introducing the context of our research, we present interaction design solutions that follow the phenomenological approach and provide empathy in human-robot interaction. We conclude this paper with an interview with an older person who tried out our design through experienceable walkthrough scenarios.

### Care-O-Bot’s Interaction Design

Our vision and theoretical approach are reflected in three design solutions integrated in Care-o-Bot, the robot used in the Accompany project (Acceptable robotICs COMPanions for AgeiNg Years). The project developed a robot companion, Care-o-Bot, as part of a smart environment to facilitate independent living of older people at home. In the context of this project, we explore rich and natural ways of interaction, focusing on empathy as a means to enable meaningful and engaging relations between human and system.

The interaction design solutions follow from our approach to redress the balance in respectfully addressing older persons’ capabilities and building an empathic relationship between the older person and the robot.

#### Care-O-Bot Description

Care-O-bot is a mobile robot conceived to support older persons at home (see Figure 1). The robot has a machine-like appearance. It is equipped with omnidirectional drives, a seven degrees-of-freedom manipulator, a three-finger gripper and a tray that can be used to carry objects. Its “head” contains range and image sensors enabling object learning and detection and 3-dimensional supervision of the environment in real time. The robot can move autonomously, and fetch, carry, and manipulate objects.

Care-o-Bot is part of an intelligent home environment enhanced with a multiangle camera fusion system and sensor network providing information about the living patterns of the older person, current states of objects present in the environment (e.g., a dirty cup of coffee) and the environment itself.

![Figure 1. Care-O-Bot to support older persons at home.](https://example.com/care-o-bot.jpg)

#### Design Solution One: The Graphical User Interface – Understanding Action-Possibilities

The first design solution explores empathic behavior between the person and robot hinges on an embodiment of high-level functions that by definition utilize the cognitive skill of the person. We explore how to approach high-level functions that are transcribed in formal language, and
thereby symbolic and representational by nature utilizing our cognitive skills, through an embodied access. More in detail we use the contextuality as well as the bodily aspects of functions, derived from the phenomenology of perception and ecological psychology, in an embodied way.

Older people are enabled to interact with the robot and to access complex functions via a graphical user interface (GUI) accessible through a tablet. Two modes of use are provided, the first being from the perspective of the older person, the second being a view from how the robot sees the environment (see Figure 2). What the person is actually able to see and access on the tablet is a number of action-possibilities that the robot can execute in the environment in order to support the person either through collaborative or assistive ways. The number of action-possibilities is reasonably rich but limited to the tasks that are technologically feasible and executable by the robot.

We develop action-possibility as a practical construct, for a person to access functionalities to be performed by the robot, inspired by both lines of thought. Our take on the concept of affordance (Gibson, 1979) is that the action-possibilities one can perform are enabled by the body’s possibilities to act, i.e., by our individual capabilities of sensing and actuating. We drink from a cup because its form (shape, weight, materiality, and the fact that it is filled with something to drink) has the action-possibility to be handled by my hands to supply fluids to the mouth. Growth (and decay) of people’s bodies makes surrounding objects shape-shift in their action-possibilities. We further extend the concept of action-possibility by a subjective experience perspective on context. This means that people’s needs and desires find their way into the concept: When you’ve just had a drink and lost your thirst, it is very unlikely that the action-possibility of “drinking a glass of water” is then desirable. Previous interactions and rituals between the robot and the person therefore define the likelihood of an action-possibility.

In order to access high-level functions, the first mode of interacting on the GUI is from the person’s viewpoint. The interface shows what actions the robot is capable of executing in the current given context. Action-possibilities are dependent on the current states of the environment and the person, the actual feasibility, and the desires of the person. They are shown with a different size in relation to current relevance. Most relevant action-possibilities are presented centrally and larger than less relevant ones, making them easier to reach on the screen than the smaller ones. The desires and factual states of the actors (robot and people) and physical states of the tangible objects and environment are thus taken into account for shaping the likelihood.

Once a task for the robot to execute is selected by a touch, the GUI switches the perspective to the “eyes,” i.e., the life-world, of the robot (Stienstra, Marti, & Tittarelli, 2013). While performing the task, the older person can see what the robot is doing through the robot’s eyes and also sees what action-possibilities the robot sees from its point of view. On completion of the task, the interface returns to the view from which the action was executed, be it from the view mode of the robot or the older person. The action-possibilities displayed are updated as the context changes through the task executed by the robot (e.g., after closing the door, “closing the door” action is most likely not an executable anymore and is substituted by another action-possibility namely, “open the door”).

The robot-view mode provides similar action-possibilities that are relevant, but it does so from the point of view of the robot itself (Marti & Stienstra, 2013). While performing the task, the older person can see what the robot is doing through the robot’s eyes and also sees what action-possibilities the robot sees from its point of view. On completion of the task, the interface returns to the view from which the action was executed, be it from the view mode of the robot or the older person. The action-possibilities displayed are updated as the context changes through the task executed by the robot (e.g., after closing the door, “closing the door” action is most likely not an executable anymore and is substituted by another action-possibility namely, “open the door”).

The robot-view mode provides similar action-possibilities that are relevant, but it does so from the point of view of the robot itself (Marti & Stienstra, 2013). This means that, while the robot is not at the same location of the older person, it provides a different set of actions to be performed. For the view, the relevance is not ordered by location but merely indicated by the label size. The location of labels depends on the objects of action as this view displays the actual view from the robot’s camera. So if an action-possibility concerns a dirty cup, let’s say “clean coffee cup,” the label will be displayed on top of this cup seen from the robot’s perspective.

In the following, we illustrate the use of the GUI through walkthrough scenarios. These kinds of scenarios are low-fidelity prototypes used in the iterative design process (as
part of our research-through-design approach) created to explore the qualities of interaction. Our walkthrough scenarios are derived from the more elaborated objectives and applications described in the interaction design solutions and prepared for an explorative assessment of concepts.

**Walkthrough Scenario: Understanding Action-Possibilities – Switch the Light Off**

The older person asks (by using the action-possibilities displayed on the GUI) the robot to “switch off the light” in the room. The robot executes the given command. The light is turned off, and the GUI displays the new action-possibility “switch on the light.” The older person uses the interface autonomously, without any external support.

**Walkthrough Scenario: Understanding Action-Possibilities – Bring Me the Water**

Similar to the previous walkthrough, the older person asks the robot via the GUI to bring a bottle of sparkling water. The robot executes the given command. Two bottles are available on a shelf: still and sparkling water. The robot moves toward the bottles, grasps the one with sparkling water and puts it on the tray. Then it moves toward the older person and puts the bottle down beside him. During the task execution, the label “Bring me the bottle” disappears since the action is ongoing. The older person uses the GUI autonomously and monitors the action execution through the robot-view mode.

**Design Solution Two: The Robot’s Behavior**

**Empathy Through Coupled Presence**

The second interaction design focuses on continuous interaction between robot and older person emerging within togetherness. While a robot is not asked to execute any specific task, it joins the older person at appropriate times. This means that the robot rests to recharge, but also that it takes up a position near the older person while watching television.

We approach togetherness in a dynamic and lively way using the concept of perceptual-crossing earlier coined by Charles Lenay (Auvray et al., 2009) and further explored in robotics for children (Marti, 2010) and dynamic products (Deckers, Levy, Wensveen, Ahn, & Overbeeke, 2012).

Perceptual crossing is the recognition of an object of interaction that involves the perception of how the behavior of the object and its perception relate to our own. In this sense, a shared perceptual activity influences the behavior of interacting entities in a very peculiar way: We perceive while being perceived. This means that people interindividually coordinate and reciprocally influence each other’s movements in social interaction, and patterns of coordination dynamically influence the behavior of the interacting partners. The robot, as an autonomous agent, represents a tremendous opportunity to experiment with the mutual regulation ofjoint actions. The focus on perceptual crossing allows us to design the robot’s behavior without representing complex internal states and inferential mechanisms of shared intentionality.

The concept is implemented through a sustained-continuous movement of the robot on a rotational and bowing axis. The torso can rotate around vertical axis and bend (“bowing”) at two points in the forward and backward direction. Cameras in the smart environment fuse their data concerning the older people’s position and orientation based on the shoulders. In short, the robot tracks the older person’s position and keeps moving toward this point (on the rotational axis) while the orientation and distance of the older person toward the robot influences the pace in which this real-time redirection is accomplished. Facing the robot makes it move more directly (on a continuous scale) compared to when the back or shoulder is projected at a larger distance.

This work aims to result in some kind of participation in a shared context, allowing empathic relationships to emerge between the older person and the robot. Presence is achieved in an unobtrusive manner, as the robot is continuously present and directed to the presence of the older person, making the older person aware that they share the same context.

**Walkthrough Scenario: Empathy Through Coupled Presence**

The robot stands still in the living room. The older person quickly passes beside the robot and then moves toward the chair and sits. The robot reacts to the presence of the person by bowing forward with the purpose of creating a subtle reciprocal interplay emerging in interaction. The purpose of this brief scenario is to create a shared context so that an empathic relationship can emerge between person and robot.

**Design Solution Three: The Robot’s Behavior**

**Empathy Through Expression-Rich and Moody Interaction**

The third interaction design is explored by two means, one by exploring auditory-based interaction and the other a more tangible approach. The “Call Me” and the “Squeeze Me” (Stienstra & Marti, 2012) are interaction devices that enable the older person to get attention from the robot, simply to make the robot come closer in order to start a more elaborate interaction toward higher-level assistance or col-
laborative functions. The “Squeeze Me” device is a simple force-sensing resistor integrated into the backside of the tablet. Through this simple device, the person can “squeeze” the tablet to get the robot’s attention. Once the input is entered through the tablet, the pressure exerted by the person on the device is directly mapped onto the values of the robot’s movement. This means that the expressions applied on the mediating device by the human are mapped to the expressive behaviors of the robot in the modality of motion in forthcoming interaction. A short pinch results in a sturdy movement, a hard squeeze results in a quick movement and a gentle touch in a slow approach. This direct mapping inherently exhibits a natural relationship while maintaining the richness of expression exhibited by the user. Similar to the “Squeeze Me,” the “Call Me” utilizes expressive intonation (loudness, length, dynamics, timbre) of the messages given by the elderly directly mapped on the robot’s movement. The expressiveness in a whisper results in a gentle movement while a shout results in more abrupt values demanding rapid attention.

The auditory intonation and squeezing by the older person are mapped to the expressive movement of the robot in approaching the older person for pursuing elaborate assistance or collaboration. Expressions people manifest with their bodies are of a rich nature, and so are the interactions we have with others. We here address the robot in similar manner. These mappings are based on the close relations between input and output to achieve an intuitive interaction with intelligent products and systems (Stienstra, Bruns Alonso, Wensveen, & Kuenen, 2012).

In order to further explore empathy, on top of the direct mapping, we apply a separate moody interaction layer. This means that during the day the mapping is dynamically transformed in reductive or amplification manner (through use). A vivid and lively interaction results from this, allowing for a personalizing relationship. With a natural relationship as reference, the moody interaction evokes denial, overenthusiasm, and stubbornness, and requires the person to adjust her behavior in interaction. A relationship is constructed through these shifting interactions: We target for empathy through moodiness within a natural response. The moody interaction does not have any functional role during the interaction, and one might wonder why it would have any benefits. Furthermore, although the older adult may learn a respectful behavior toward the robot, she might also think that the robot has broken down and keeps squeezing and/or shouting at it to try to get the robot to move. The moody interaction is a provocative construct that points to the reality of our lives and sociality. Design as critique or provocation is a common practice in the design field. Tony Dunne (1999) and Fiona Raby (2001) popularized “critical design” as an approach to designing artefacts that embody a critique on consumer culture. The purpose of “critical design” is to provoke and inspire, to make us think and question fundamental assumptions that can make a valuable contribution to debates about the role technology plays in everyday life. We believe that design challenges, like the one we face in devising rich and empathic human-robot interactions, leave plenty of space for alternative solutions. The role of the moody interaction design concept is to explore sociality in human-robot interaction and to reflect on values, some of which are ethical values. We will return to this later in the paper, when we report an excerpt of an interview with an older person on his view on moody interaction.

Walkthrough Scenario: Empathy Through Expression-Rich and Moody Interaction: Squeeze Me

The person sits on the chair holding the tablet and the robot stands still in the charging position. The tablet equipped with the squeezable device is used to get the attention of the robot. The way the device is squeezed is mapped to the way the robot approaches the older person. The robot moves faster if the intensity of the squeezing is increased. If the person insistently continues to squeeze, the robot reacts negatively, turning its shoulders to the older person. The purpose of this scenario is to experience continuity in interaction and to target for empathy through moodiness within a natural response.

Walkthrough Scenario: Empathy Through Expression-Rich Interaction and Moody Interaction: Call Me

Similar to the “squeeze me” scenario, the “call me” scenario utilized expressive vocal messages given by the older person directly mapped onto the robot’s movement. Instead of entering a command by squeezing the tablet, the older persons trigger the interaction their voice. Intonation is continuously mapped to the movement of the robot. The expressiveness in a whisper results in a gentle movement, while shouting demands more rapid attention. Also in this case a moody interaction may emerge from the interaction.

Methodological Approach

Our methodological approach builds on iterative cycles of research through design and constant consultation with people who have experimented with early prototypes of the robotic system. The design and evaluation approach are described below.

Research Through Design

Our approach to designing solutions is the so-called “research through design.” In this framework, designers do not necessarily seek to solve problems. Rather, they seek to explore
opportunities by making concepts that are evaluated in context to feed the iterative design process. As we design for a possible future, instead of understanding the world as it is (in a traditional scientific sense), our work builds on an explorative approach associated with Archer’s research through practice (Archer, 1995), a process in which knowledge is generated through an iterative design process that takes place with experienceable prototypes in context.

The research through design approach requires (design) research to address complexity holistically in order to grasp the particularities of a specific situation and the uniqueness of participants (in our case the older person). The approach follows the school of Donald Schön’s “reflective practitioner” (Schön, 1983), a practice-based approach to designing. A more complete overview of research through design approaches can be found in the book Design Research Through Practice: From the Lab, Field, and Showroom, by Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redström, and Stephan Wensveen (2011).

It is important to note that this is an iterative, not a sequential process. This kind of research is knowledge-directed, since it must produce new knowledge through testing and raise new theoretical questions to be explored in the next iteration cycle.

Confronting with People: Preliminary Evaluation

The interaction designs and corresponding walkthrough scenarios presented above were developed within an iterative design process with low- and high-fidelity prototypes in order to explore the qualities of the interaction with the older people. According to the research through design approach, at this initial stage of design we conducted a preliminary evaluation of the design solutions, interviewing an older person who had tried out our prototypes. This kind of evaluation must be intended as an explorative step, leading to a later stage of the design process the execution of structured evaluation sessions with a large number of people, already planned in the Accompany project. The interview reported below is a qualitative exploration that allowed us to get preliminary insight into our concepts, to fine-tune toward nuanced interaction modalities that provoke empathy through a rich palette of expressive behavior, and to raise new theoretical and ethical questions to be further explored in the project.

Evaluating walkthrough scenarios with empathic and personal-meaning-related contents like the ones presented above is challenging. In fact our scenarios depict narrative accounts of everyday life activities focused on the quality and texture of experience rather than only on the identification of traditional usability issues.

For this reason we adopted a qualitative approach inspired by research methods focusing on the true experience of people with health problems (Curry, Nembhard, & Bradley, 2009). These methods provide a multidimensional understanding of a person’s experience of a health condition which goes beyond an everyday or common sense awareness, and which leads to a more informed, nuanced, and empathic caretaking practice (Kearney, 2001; Mattingly, 1993; Shepard, Jensen, Schmoll, Hack, & Gwyer, 1993).

We used interpretative phenomenological analysis (IPA) for qualitative data analysis (Smith, Flowers, & Larkin, 2009). This methodology is inspired by phenomenological philosophy and focuses on the elicitation of personal meaning and understanding of the first-person perspective through intersubjective inquiry and analysis. The main objective of the methodology is to situate personal meaning in a context.

IPA is usually used in the healthcare context, though the methodology is not focused on the disease itself, but rather on the participant’s perspective about the strength, wellness, and quality of life.

In the context of our research, we used IPA to develop in-depth accounts of the older person’s experience in interaction with the robot. Our objective was to stimulate the verbalization of experiences of some personal significance on the interaction with the robot and to understand how the older person makes sense of this relationship in ordinary everyday life.

The basis of the method is phenomenological: We perceive the world through our engagement in it, and the meaning of the experience is a function of the relationship we can establish with the world around us. Therefore, key concepts of the approach are experience, meaning of experience and first-person perspective, the role of context in shaping the experience, and reflective practice on real accounts.

IPA relies on idiographic inquiry to collect and analyze data. Idiography is concerned with the particular and distinct experiences of particular people and the particular contexts in which those experiences occur (Eatough & Smith, 2008; Smith et al., 2009; Smith, Harré, & Van Langenhove, 1995). Each evaluation session focuses on single cases. The case is central to the inquiry, since the researcher attempts to understand as much about one case as possible before moving on to the next. Convergence and divergence across datasets are considered only later, after single in-depth analyses have been completed. Data consist mainly of the description of first-person accounts in the form of verbatim records. The analyst invites narratives and reflection on personal experiences using metaphors and past memories.

Explorative Assessment Setup and Protocol

In the following we report the results of an evaluation session of our scenarios carried out with a 75-year-old person. He is considered healthy and fairly autonomous at home.
He lives with his wife of the same age. He voluntarily joined the test and signed a written informed consent. The objective of the evaluation was to get a preliminary insight into the experience of interaction with a simulated or Wizard of Oz version of the robot.

The Wizard of Oz is a technique used to present advanced concepts of interaction to people (Erdmann & Neal, 1971). An experimenter (the wizard) processes inputs from the person and emulates system outputs. The aim is to show and explore future system capabilities that are not yet implemented together with the prospective user (the older person). This method allows design solutions to be explored at an early stage in the design process, particularly for systems that go beyond readily available technology. Designers who play the wizard can gain valuable insights from being closely involved in the user’s activity.

Even if having a human disguised as the robot cannot provide final answers concerning the effectiveness of the prototyped solutions, it does allow rapid testing and fine-tuning of ideas and brainstorming with people about the role the robot can play in their life. Theatrical representations of future usage scenarios, like the Wizard of Oz, have been largely adopted in design practice. In her seminal work *Computer as Theater*, Brenda Laurel (1991) articulated a theory of interaction that explains how concepts such as catharsis, engagement, and agency manifest themselves in representational, theatrical contexts. She proposed applying techniques borrowed from theater to evaluating interaction design concepts. She explained that in early concept evaluation the goal is not primarily on how to accomplish real-world objectives, but rather how to accomplish them in a way that is as pleasing, emotional, and amenable as in an artistic performance. Having a wizard act out so as to underline nuanced interactions helps to shape an enjoyable, rich, and meaningful experience in the person, and it provides the designers with insight on fine-tuning the concept to reach a similar effect in the real life.

Setting

The evaluation session was carried out in a laboratory equipped with three video cameras, a projector to display the simulation environment, two chairs (one for the participant and the other for the analyst), a computer to run the simulator, a tablet to control the robot, and a mobile phone connected to the tablet (used in the Wizard of Oz evaluation session). The evaluation ensued in three phases as described below.

In our scenarios we used hybrid low-fidelity prototypes, a combination of working technology as well as the use of simulator, and, as explained above, a Wizard of Oz to act out certain behaviors of the (temporarily) replaced robot.

First Phase: Familiarization

The experimenter briefly illustrated the protocol of the session to the participant. In order to familiarize the participant with the context and with the robot, she showed him a brief video explaining the robot functionality and the use of the tablet to control the robot. The GUI was presented in very general terms, introducing only the robot-view mode and the older person-view mode and how to shift between the two. No other instructions concerning action possibilities and their likelihood (represented in the size of labels) were given concerning the interface.

Second Phase: Simulator

Since the prototyped solutions were still not fully integrated in the real robot, the second phase of the evaluation was performed with a simulated version of the robot (see Figure 3). A large projection of the simulation environment was displayed on the wall to recreate an immersive atmosphere. The participant was invited to imagine being at home and interacting with the robot using the tablet to switch the light on/off and to bring a bottle of still/sparkling water. The objective of this phase was to familiarize the participant with the robot and to actually try out the interface.

![Figure 3. Older person using the graphical user interface to control the robot in a simulated environment.](image)

Third Phase: Wizard of Oz

The third evaluation phase was carried out in Wizard of Oz mode. For this phase of our evaluation session, a second experimenter played the role of the robot acting out its movements and executing commands. The experimenter wore dark glasses to reduce the expressivity of the eyes. She carried a tray, similar in size to the one mounted on the
Care-O-Bot, and a mobile phone. The phone was linked through a wireless connection to the tablet. The commands entered by the older person through the GUI of the tablet were sent to the Wizard on the mobile phone. Each time the command was executed, the Wizard sent the feedback to the GUI on the tablet. The mobile phone was also used to transmit the robot view mode, through the integrated camera.

The Protocol

An experimenter sat beside the older person and conducted the evaluation throughout the three phases. During the third phase the scenarios were introduced one at a time. The inquiry process developed in the following steps: (1) in-depth interview and reflection on the real-life experience through narratives; (2) analysis of what mattered for the older person in the real-life experience; (3) identification of emergent themes related to reflection, imagery, and metaphors.

Results

The session was video recorded and the interview transcribed. Three experimenters worked independently on data analysis, trying to remain faithful to the particular life world of the older person while also illustrating more recurring general themes (Smith & Eatough, 2006). The interview was transcribed using ELAN, a software tool used for conversation analysis, which allows one to identify the occurrence of words and the semantic context associated to the real-life experience of the person. The involvement of three experimenters was useful by increasing the sensitivity and openness toward the meanings within the data and confronting the data interpretation. In this way an impression was constructed of the recurring themes as well as the specific experiences of the older person (Smith & Osborn, 2008).

The focus remained on the older person’s attempt to make sense of the experience, and the analysis progressed from the particular to the shared and from the descriptive to the interpretative (Smith et al., 2009). The three experimenters read and cross-read their notes, highlighting points of interest and finally discussing them in a joint session. In the following we report excerpts of the in-depth interview between the experimenter (E) and the participant (P), the older person.

Second Phase: Simulator

E: Imagine being at home. You’re thirsty. Look at the tablet.

P: I can ask the robot to bring me the water ... can I choose? I like sparkling water.

E: Sure you can.

P: It’s amazing. My first impression is that I’m not alone. Feeling lonely is the worst sensation you can have. Having a pet can help but interacting with a robot that is similar to a person is fine too, I don’t see a big difference. We can engage in a relationship, in mutual respect. I do not feel alone.

E: Interestingly, that is the essence of this design: The more you interact with the robot, the more you can establish a personal relationship.

P: This is natural; if there is a friendship I can share my feelings and reduce the distance.

E: What would be your feeling if the robot were to watch television beside you?

P: I would not feel alone. Watching television together means learning from each other. I would feel a reassuring presence beside me and he could change my mind about a program. For example, if he realizes that I am not paying attention to the program, that I change my expression, he could try to guess my feelings and propose watching a different program next time. He can learn my habits, and I can learn what he can do for me.

Third Phase: Wizard of Oz

Walkthrough Scenarios: Switch the Light Off and Bring Me the Water

E: Did you notice any change on the interface during the scenario?

P: Yes, it changed when the light was turned off. It was very natural to see the change, I could see what could be done next.

E: What are your impressions? How do you feel?

P: It’s amazing. I saw the world through the robot’s eyes. It was as if I did the action myself. It was as if he knew my intentions ... If I can take the robot’s perspective I can reflect on the environment around me. For example, I’m used to switching the light on and off. I do this automatically without thinking. I don’t “see” the world around me any longer ... my actions are out of habit. If I see the environment around me through the robot’s eyes, I actually see the objects around me, I reflect on what was left in a certain place. I feel more active, and this helps me to remember where I left an object. Interacting with the robot shapes my memories and my intentions. This is not simply an interaction with the robot, but rather a robot-person-context interaction. I like it. It is very interesting ... If I can look through the robot’s eyes I can monitor my house. This makes me feel safe.
E: Wouldn’t it be the same with a video surveillance system?
P: I don’t think so.
E: What’s the difference?
P: Trust . . .
E: Do you trust the robot?
P: If the robot is my companion I think we can become friends and can help each other.

Walkthrough Scenario: Empathy Through Coupled Presence

The person passes close to the robot. The robot bows and follows the person from a distance.
E: How do you feel? What does it come to your mind?
P: The first term that comes to my mind is “availability.” He recognized me as a companion. It was enjoyable. It was like when one is recognized by a dog. By simply bowing and following me but keeping a certain distance he showed his availability to do something for me. I do not know if he speaks any language but I don’t think I need to talk to him. You don’t need to interact verbally with your dog. You know it is available for you, it recognizes you, your little gestures, your smile.

Walkthrough Scenario: Empathy Through Expression-Rich and Moody Interaction – Squeeze Me

The experimenter shows how the squeeze-me device works (see Figure 4).
P: (P smiles) I like to be kind with my friend and he is kind with me, too . . . What happens if I continue to squeeze all the time? Is one time sufficient?
E: You can try . . . so what happened?
P: He refuses to come to me
E: Why?
P: Maybe because I’m angry and he prefers to avoid me.
E: So he doesn’t like to be squeezed too much . . .
P: (P laughs) . . . He behaves like my wife . . . (P laughs again)
E: How would you like the robot to behave with you?
P: Always friendly, so I should be friendly too. I know it is not easy . . . sometimes nature prevails over education.

Walkthrough Scenario: Empathy Through Expression-Rich and Moody Interaction – Call Me

E: What is your impression? Do you like to interact with the robot using your voice? Would you like the robot be able to interpret the intonation of your voice?
P:

Figure 4. Older person using the Squeeze Me prototype.

Reflection

The outcomes of the evaluation were highly nuanced and offered a fine-grained understanding of the feeling of the older person, his perception of what was going on, what really mattered for him during the real-life experience. Interestingly, he considered the interaction with the robot as a way to reflect on his skills and to provoke a reappraisal of the home environment. No usability problems were experienced with respect to the GUI. The older person only mentioned the need to stop the task being executed in case the command was entered by mistake.

During the interview he used a language that was closely related to the meaning of his real-life experience. During the execution of the first scenario, he mentioned having the impression of entering into a relationship and of mutual respect with the robot. This statement was particularly impressive considering the objective of the evaluation and the design itself. Furthermore, he used narratives and metaphors to explain concepts (my dog, my wife), giving the impression of being engaged with the robot. Empathic and personal meanings emerged naturally from the interaction in a continuous action-reflection flow.
Discussion

The prototyped interaction designs and subsequent walkthrough scenarios presented in this paper illustrate the potential of designing social robots that behave in respectful ways toward older people. The concept of respectful technology involves redressing the balance of how technology approaches the unique skills of the targeted interactants, in this case being the robot and smart environment toward the older person. We believe that, in a world where technology is increasing in importance and complexity with respect to older people, perceptual-motor, emotional, cognitive, and social skills should be addressed in ways that best fit the uniqueness of each individual. The scenarios given here address this vision from different perspectives.

The basic theme addresses emotional skills through a social-perceptual-motor interplay, whereas the forms of “squeeze me” and “call me” expand this empathic bonding through moody interaction. Moody interaction allows for both positive and a negative interplay. We believe that feeling the good as well as the bad aspects on a rich and continuous scale provides grounds to reach intersubjective understanding – or at least bonding. We are aware that the moody interaction paradigm is provocative and presently does not contain a functional feature. Rather, the moody interaction is implemented to explore empathy between the human and the robot by exploiting a rich expressive reciprocal interaction. Higher-level functions that would mainly address the older person’s cognitive skills when applied in traditional manners are addressed here via the resonation of older person and robot through shared viewpoints; providing the older person insights into what is possible for the robot to do in a continuous flow of interaction.

The interactive prototypes described above offer a context for experience, rather being just assistive aids. Our design serves to enrich this experience toward stimulating feelings of engagement, emotional well-being, and comfort, thus making living with the robot pleasurable and gratifying. Our prototypes aim to offer rich action possibilities and a context for experience that is meaningful for people. These values are lost wherever a purely functional approach prevails.

We believe that a new design agenda for the development of assistive technologies should include societal sensitivity to make technologies experiential and respectful of the person in the wholeness of his/her hopes and desires.

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Declaration of Conflicts of Interest

The authors declare that no conflicts of interest exist.

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