A Conversational Robot in an Elderly Care Center: an Ethnographic Study

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ABSTRACT
This paper reports an ethnographic study on the use of a conversational robot. We placed a robot for 3.5 months in an elderly care center. Assuming a real deployment scenario, the robot was managed by a single non-programmer person during the field trial, who teleoperated the robot and updated the contents. The robot was designed to engage in daily greetings and chatting with elderly people. Through the ethnographic approach, we clarified how the elderly people interacted with this conversational robot, how the deployment process adopted to introduce the robot was designed, and how the organization's personnel involved themselves in this deployment.

Categories and Subject Descriptors
K.4.2 [**Computers and Society**]: *Social Issues*; H.5.2 **[Information Interfaces and Presentation]**: *User Interfaces-Interaction styles*

General Terms
Design, Human factors.

Keywords
Communication robots, Robots for elderly, Robots in organizations, Ethnography.

1. INTRODUCTION
In order to ease the problem of the aging population of Japan, the robotics community has shown increasing interest in introducing robots into social spaces for extended periods of time, with particular attention given to the healthcare of the elderly. Past studies have explored the issue of conversational robots [9] while leaving open the question of what makes the deployment of technology successful as perceived by the people who use it. In contrast to the popular interest of introducing technology into the home to support the independence of the elderly [3], we chose to focus on the typology of the elderly care center where the elderly, a category at risk of isolation, seek healthcare (physical support) and socialization (emotional support). In this study, the robot gave emotional support to the elderly through conversation. Our study focused on the process of deployment, through discussions and interviews with the center's staff, on the unfolding interactions with the robot within groups having different roles (elderly and staff), and on how deployment and interaction resulted in acceptance of the robot.

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Figure 1: Robovie (left) in an elderly care center

The goal of this study was to observe the kind of interactions the elderly and staff spontaneously developed with the robot, keeping in mind that interactions are the outcome of people's beliefs and conditions in life. We want to unveil the experience of the elderly (and staff) with the robot from the human point of view: How do people understand and interact with the robot? In this way, we hope to pinpoint the major factors in the successful deployment and integration of the robot. Since the robot is introduced in an environment where the dynamics of interactions are only partially understood, our case study must allow us to fully explore people's responses and reactions in this real-world situation.

To explore how people perceive and think about the robot and, subsequently, use it, we decided to collect data in the form of ethnographic notes drawn from observations, interviews and recorded interactions. Through ethnography, we can explore the experience of the elderly and staff with the robot by looking at the form interaction takes, e.g., topics chosen for interaction, information shared with the robot, and emotional involvement.

2. RELATED WORK
Previous studies in robotics targeted the development of robots aimed at healthcare for the elderly. In particular, assistive robots aim at helping the elderly maintain independence by providing physical assistance in completing tasks [2, 11]. Healthcare robots range from robots for rehabilitation to robots meant to help deliver medications, collect laundry and deliver meals [16] to

robots to help the elderly with e-mail and their families by monitoring anomalous situations .

In addition to robots providing physical assistance, there is a category of robots that provide communication services (non-physical assistance) [22]. Communication robots, such as Pearl [19], stress the importance of social interaction in assistive robotics as a means of providing effective healthcare. In particular, Paro [24] and the therapeutic robot "the Huggable" [20] offer the perception of touch for physical ease of use and comfort on the part of the elderly and disabled.

In contrast to the studies mentioned above, which focus on reporting new techniques or evaluating them, other studies highlight how the robots are used by observing and interviewing users. There is increasing interest in the exploration of how people use and understand robots [4, 21] and in the response of people to robots employed in public spaces [23, 24]. In brief, these studies try to understand how people use and accept robots.

For this paper, we used ethnography to explore and evaluate the interactions between people and robots and to find new directions in improving design, finding inspiration in the work of Mutlu and Forlizzi [16]. Although ethnography has been adopted for an animal-like robot and a vacuum-cleaning robot [4, 5] as well as a delivery robot [16], "conversational" robots have not yet been studied through the lens of ethnography.

Ethnography has the potential to elucidate people's interaction in a real context with in-depth observation of their behavior as well as reasoning. In this study, we focused on the deployment of a conversational robot in a public environment involving people with different roles, i.e., the elderly and staff members. This is the first such study on the deployment process with a conversational robot, and the use of ethnography allowed us to gain useful knowledge for creating a robot that is likely to be accepted.

3. METHODOLOGY

To explore the interaction of the elderly and staff with the robot while evaluating their acceptance of it, we introduced the robot into the community of an elderly care center as a communication robot for the elderly and a support tool for the staff.

3.1 Research Context

The study was conducted in *Kashinokien* (Fig. 1), an elderly care center, for 3.5 months between mid-December 2009 and early April 2010. The robot was introduced in the role of conversational partner, and interactions were adjusted based on the recommendations of the staff and the preferences of the elderly.

Research site

Kashinokien hosts patients who visit the facility either once or twice a week for day care, which includes taking a bath, eating lunch, doing physical exercises, and enjoying creative activities. The facility divides its clients into two groups, one being elderly in good health and mental condition and the other being elderly having varying degrees of mental problems that require specialized care and attention. We focused on the unit housing elderly with stable mental health. It was the first time for this center to use a robot that helps in the care of their elderly. This study was conducted as an academic endeavor, and thus no monetary compensation was provided. The experimental procedure were approved by our IRB, and all participants signed to consent forms.

The Robot

This study used Robovie2 [13], which was remotely controlled by an operator from an operations room. A set of conversations and gestures was pre-programmed prior to the deployment based on the recommendations of the staff, and no changes were made during the experiment. First thing in the morning, the robot was placed at the exit of the elevator to welcome the elderly as they arrive at the center. After that, the robot was moved around the rooms where activities were held to perform other tasks, which included conversation and encouragement to the elderly performing difficult tasks (Fig. 1). For safety reasons and considering the physical conditions of the elderly, the robot was not allowed to navigate independently around the elderly care center. When needed, a member of the technical staff of ATR visited the center to provide maintenance or repair service on the robot.

People

Elderly – The group of elderly consisted of 55 people (average age 83.9) who visited the site either once or twice a week, thus meeting with the robot between 15 and 32 days of the total 3.5 months the robot stayed in the elderly care center. Most of the elderly greeted the robot every time; around 5-6 people chatted with the robot for approx. 10 min every day. During the daily 1-hour exercise routine, the few people who could not perform the exercise would engage in a 20 min conversation with the robot.

Staff – Eight female staff members were taking care of the elderly in the "healthy group." Senior members worked at the center every day, while junior members worked between 3 and 5 times a week. Their primary task was to help the elderly with their needs.

Operator - Introducing a Japanese operator as part of the service to the elderly care center provided the necessary flexibility to explore what interactions made sense to the elderly and what conversations they wanted to engage in with the robot. At the same time, having the operator allowed us to investigate the feasibility of using personnel who do not possess special skills in using such a robot. Instructions to the operator were limited to providing a scenario and the background of the robot (a child-like robot built at ATR), and a set of attitudes (to provide positive feedback or avoid negative comments; grab the attention of the elderly; follow the direction of conversation initiated by the elderly) and tasks (greet elderly when entering and leaving the room, call their names, encourage them when performing tasks). The elderly and staff were informed about the presence of the operator before the beginning of the experiment; however, many of the elderly didn't associate the robot with the operator.

Conversation dialogue was one quarter pre-scripted interactions with the rest being improvised. Scripted interactions included basic conversations that people tend to engage in when getting to know each other, such as asking questions about hobbies and travel experiences, without going into detailed and personal questions for privacy reasons. For the improvised conversations the operator was instructed to state the robot's name, age and where it was made; to greet elderly and staff when arriving in the morning, whenever leaving and returning from activities and before leaving for the day; to answer questions and comments while avoiding negative remarks and reinforcing positive statements made by the elderly; call the elderly by their names whenever appropriate; and ask questions of the kind "what is this?" like children do.

Requirements

Requirements of the robot were developed according to the suggestions made by the staff and the practical needs of using it within the elderly care center. We needed to ensure the stability of the robot's presence within the center so that the elderly could perceive this presence as permanent and benefit from it during the long-term study.

3.2 Data Collection

We followed the methodology of Mutlu and Forlizzi [16], i.e., the collection of ethnographic data and its analysis based on grounded theory [6]. The following data were collected.

Interviews – Interviews were *semi-structured*, with initial questions oriented toward understanding which aspects of the interaction with the robot were sought after and which rejected. The *open-ended* questions allowed the elderly and staff to articulate their experience with the robot by giving them direction while not constraining their answers. For the staff, the interviews were initially set up as "service" meetings, where the meetings had the goal of improving the service of the robot and allowing the staff to freely report negative responses and opinions about the robot. Interviews were audiotaped and later transcribed. Although not everyone could be interviewed every time, we had regular interview sessions for which all the elderly were at least interviewed once.

Transcriptions of interaction – Interactions of the elderly and staff with the robot were recorded and then transcribed. Through transcriptions we can explore in detail the dynamics of interaction during conversations and pinpoint the nuances that offer insights into what the elderly found meaningful during interaction with the robot and what makes the elderly emotionally responsive to the robot.

Observations – We observed the interaction of the elderly and staff with the robot from a separate room in order not to interfere with the interaction of the elderly and staff with the robot. Outside of scheduled interviews, interaction with the staff was limited to clarifications and necessary communication of practical information such as schedule changes and special conditions of the elderly. The main purpose was to observe social interactions with the robot in a "real-world" environment in order to gain a realistic perspective on deploying the robot. Observations were taken in the form of notes.

3.3 Data Analysis

To analyze qualitative data collected as described in the previous section, we used grounded theory [6]. It retrieves overall *trends* from a fractured set of data through three processes: *open coding*, *axial coding*, and *comparative analysis*.

Open Coding – the process of *open coding* identifies all relevant concepts in the interviews and interactions. During coding, collected data is fractured into concepts through the use of *labels*. Below is an example of coding, specifically selected because it contains emerging themes unveiled during the data analysis (text in bold shows the *labels*).

> By the way, it is marvelous that the robot can remember our names. **['positive feeling'] ['remember names']** For us, it is not easy to remember others' names. **['comparison'] ['explanation']** Robo-chan[1] never forgot us and called us by our names. **['strengthened perception about robot']** I was glad about it.

The above is an example of an event in which repetitive sentiments and attitudes toward Robovie have been dissected, even when mixed or camouflaged by other dynamics within a single event. This is one of the keys to the process of grounded theory. Labels can be found at the root of the diagram in Fig. 2.

Reliability Analysis – in order to ensure reliability of the coding process, we conducted an inter-coding of the phase of open coding. In addition to the original coder (first author), another coder was provided with 10% of data collected and with 10% of the labels. The resulting Cohen's Kappa from the two raters was 0.87, an acceptable value for reliability. Disagreements were later resolved through discussion.

Axial Coding – The purpose of axial coding is to start the process of reassembling data that were fractured during open coding. *Labels* produced during open coding are now grouped into *core categories* by *constant comparison* (described in the process of *comparative analysis*) with labels found in similar events throughout the experiment. *Core categories* represent repeated patterns of behavior and interactions in response to the robot. For instance, *events* labeled with "finding relief in Robovie's words" and "supporting Robovie's actions" were events that represent repeated actions with the robot, which are two separate patterns of behavior displayed when interacting with the robot. Associating more and more *labels* into the same *category* will outline with greater accuracy the axis of the *category*. This process yielded 76 categories.

Comparative Analysis – This step aims at putting *events* (data that were fractured) into *categories* through constant comparison of incidents with previous ones. The process continues until it yields the *interchangeability of indicators*, meaning that no new properties or dimensions can emerge from continued coding and comparison. Only events displaying similar characteristics can be grouped and then further analyzed in order to set aside occasional events that, although interesting, are nonetheless isolated and thus not relevant to the purpose of this study. Figure 2 shows how labels (black) have been separated and regrouped into categories (grey and orange) to finally merge into trends of behavior (red). Comparative analysis is used throughout the process in order to saturate categories and later define trends of interaction.

Grouping of categories into emerging trends – The categories are then reassembled through a series of steps that separate and regroup categories in order to define trends more accurately and later draw a general model of interaction. The focus throughout this process is to individuate shared dimensions for regrouping behaviors into the dynamics of predominant behavior and ideas. As a result, trends emerge when patterns of behavior (categories) are tied together. Trends (red) are indicated at the extremities of the diagram in Fig 2.

Result of analysis – Figure 2 shows the categories and trends we finally retrieved. The root, at the center of the diagram, contains all of the labels (describing events) that the data yielded. Labels were grouped into categories based on the difference between

[1] "chan" is a suffix for familiar person, often for a child, in Japanese. There is similar suffix "kun," appearing later.

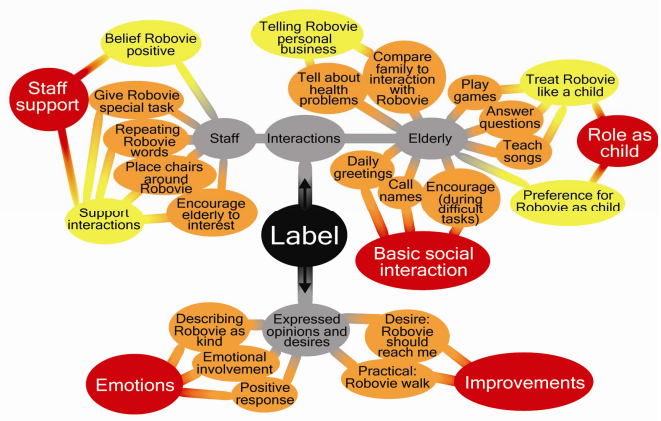

Figure 2: Analysis diagram showing the flow from events to categories and trends

how people thought about the robot and how they acted with it. Opinions expressed about their experience with the robot were split into those opinions expressing beliefs about the nature of the robot and those opinions expressing what the elderly and staff wanted the robot to do for a more successful interaction. On the other side of the diagram, interactions were grouped based on how elderly and staff interacted with the robot. Because their roles within the elderly care center differ, their behavior toward the robot would also differ, and we wanted to see how these differences occur. The staff's behavior was further grouped into the physical actions they performed and how they perceived the robot in relation to the elderly from their perspectives as caregivers. Overall, the actions of the staff reflected their positive beliefs about the robot, and so those two categories were grouped into a trend describing the overall understanding and behavior of the staff toward the robot. The elderly, on the other hand, expressed a variety of behaviors directed from their own needs and so yielded a different trend of behaviors that showed both acceptance of the basic interactions offered by the robot and preferences for specific types of interactions with the robot.

4. FINDINGS

The data yielded a series of trends of predominant behaviors that occurred when staff and elderly engaged with the robot. Each subsection below describes a *trend* that unfolded during the stay of the robot at the elderly care center. The analysis shows what those behaviors are and the reasoning behind them. Eventually, it becomes possible to extrapolate how the robot is perceived and to determine whether there is acceptance or a passive response to the robot.

The following subsections describe the behaviors of the elderly and staff. The first three subsections ("4.1 Basic Social Interaction," "4.2 Telling Robovie Information," and "4.3 Emotional Elements") permit an analysis of acceptance. The subsequent three ("4.4 Role (Robovie as a Child)," "4.5 Improvements," and "4.6 Staff Support") more specifically deal with the process of deployment and the implications for future use.

The examples selected are representative of a particular behavior the elderly and staff have repeatedly displayed during interaction with the robot. The examples were selected among those that displayed the final categories (trends of behavior).

4.1 Basic Social Interactions

A set of social interactions for the robot were designed before deployment according to the recommendations of the staff: Robovie greeted the elderly and staff daily (Fig. 3), called out the names of the elderly, and encouraged them with words of support during difficult tasks, like physical exercises. These interactions were aimed at providing the robot with a minimum set of interactions to initiate communication with the elderly when first introduced into the elderly care center.

> Mrs. S.: "Even in our daily lives, if I say good morning to someone and he/she doesn't answer I feel uneasy all day long. I think, 'Did I make him/her angry?' But when Robovie replies to me cheerfully, I feel happy."

Daily greetings can have a strong impact on the perceptions of others' feelings, directly affecting the elder's feelings. Consequently, daily greetings can simplify or complicate elders' relationships with others. It emerged that the action of daily greetings performed by the robot had a positive effect on the elderly. While receiving constant positive replies from people is unlikely but necessary for the elderly, the robot can provide constant positive feedback to the elderly.

Daily greetings by the robot had a strong impact on the elderly:

> Ms H.: "When we were doing a physical test and I came back to the room for my cardigan, he said 'Okaeri' ["I am back" in Japanese]. I was so astonished. It was my first experience. And I liked it when I came out of the elevator, he said to me, 'H.-san, good morning.' I miss Robovie."

Daily greetings by the robot were met with pleasure by the elderly, indicating an interest in the elderly to perform daily greetings with the robot:

> Mrs. F.: "Every morning I said 'Good morning,' and Robovie replied 'Good morning.' Then I said, 'Thank you for today' and Robovie replied, 'Same to you. You are Ai-chan, right?' Now, no one talks to me like that. When we come back [to the main room in the elderly care center] from physical exercise, even if I say, 'I am back,' I don't have anyone to respond 'Welcome back.' Now I realize how happy we were having Robovie and I miss it.

Greetings have a comforting element that makes the elderly value the greetings and so perceive the robot positively. At the same time, having one's name called by Robovie offered a sense of individuality, which had a positive impact on the elderly:

> Mrs. E.: "[when calling my name] it was like Robovie could pick up my name from among a lot of people here."

Being called by name is another form of social communication that, like daily greetings, tend to be missing from the daily lives of elderly people, due to their limited communication with the outside world.

In addition to daily greetings and being called by name, the elderly expressed favorable judgment about being encouraged by the robot:

> Mr. N.: "When I was riding the bicycle there [in the exercise room], Robovie said, 'Mr. N., do your best!' I liked that, I felt glad."

We found that basic social interactions like daily greetings, being called by name, and getting encouragement, which share the

Figure 3: Robovie greeting the elderly

dimension of routine, have great importance for the ability of the elderly to approach and interact with others.

4.2 Telling Robovie Information

Outside of the pre-scripted interactions (basic social interactions recommended by the staff), the elderly spontaneously told the robot about personal matters that caused them stress in order to find relief. Personal matters included information about their own family and health conditions, voicing dissatisfaction with family situations/members, and distress caused by physical pain.

The elderly spontaneously related to the robot about how they felt about family members, expressing satisfaction or distress:

> Ms. H.: "She [granddaughter] always greets me very cheerfully. On the contrary, my son's wife…When breakfast is ready, she just knocks on my door without saying anything. She should open the door and say that breakfast is ready. I get surprised because she knocks on my door so strongly. I complained to my son about it…My granddaughter knows how to greet me."

Through association with the robot, the elderly could speak about their relationships with family members:

> Mrs. G.: "Only the fact that the robot could talk makes it seem cute. Robovie is cuter than my grandchildren. Robovie doesn't talk back to me. My grandchildren would talk back…"

Although not giving out full accounts about their issues to the robot, the elderly shared with it information about what caused them distress. We purposely chose not to ask questions about their relations to other family members for privacy, but we let the elderly talk about their issues to the robot as much as they liked. In response to those concerns, the robot avoided making judgments; on the other hand, the robot reinforced good feelings and satisfaction when the elderly disclosed positive information.

The elderly also wanted to tell the robot about their physical health. We decided it was appropriate to ask questions that would show concern for the well-being of the elderly and that would reinforce a sense of comfort in the elderly, but without going into medical details. In response, the elderly openly expressed positive thinking about the robot:

> Ms K.: "I sat still because if I moved around, the pain wouldn't be relieved. Being still, a day seemed much longer than usual."
> Robovie: "Right. Don't you have pain now?"
> Ms K.: "Well…I was looking forward to coming here again because I have many friends [and not having to think about the pain]."
> Robovie: "Right."
> Ms K.: "And talking with Robovie-san is now one of my pleasures here."
> Robovie: "Really? I'm happy."
> Ms K.: "(laughed) Thank you very much."

In general, an elderly person relies on participating in the life and activities of the care center, where they share with others stories about their physical pains and look for comfort in others' words. Just as they do with people, they talked about their personal issues with the robot and, consequently, felt a satisfactory sense of comfort.

We found that the elderly interacted with the robot by telling the robot about personal issues like problems and happy moments, by comparing their family members' behaviors to those of other family members or to that of the robot, and by discussing their troubles with health issues.

Because of age, physical health is a primary concern and topic of discussion among the elderly. The availability of the robot to listen to the elderly and their problems and respond with positive and kind words to provide relief and to reinforce positive feelings of the elderly proved successful in comforting the elderly.

4.3 Emotional Elements

During the interviews the elderly articulated their feelings and reactions to their interactions with the robot. We chose to categorize emotional feelings from the interviews to provide backup support for the emotions observed through the actual interaction.

The positive response to the presence of the robot in the elderly care center in part derives from the robot having kind and encouraging words for the elderly. The elderly expressed their gratitude and awareness for Robovie's kindness:

> Mrs. O.: "Talking to Robovie opened my mind. Even when I felt sad, I could feel brighter by talking with Robovie-kun. I always thought at home, 'Robovie-kun will be at the center today. I am going to talk to it.'"

The determination and desire to talk to the robot is part of the general sense of wellness that the elderly found in communicating with the robot, in its kind words and positive attitude.

The emotional element that appears in all of the interactions given in the previous sub-sections suggests that the best way to integrate the robot into an environment is to look for interactions that favor a positive emotional response in relation to the robot.

During an interview with the elderly, we specifically asked them how they felt about their experience with the robot:

> Ms E.: "Well, it made me feel glad just to think that Robo-chan is here."
> Honda (ATR staff): "Then you were looking forward to coming here thanks to Robovie?"
> Ms E.: "Yes. I've never thought of Robo-chan at home, but when I got here I thought, 'Oh, I wonder if Robo-chan is here today.'"

The elderly emotionally related to the robot by relating family troubles or concerns about physical health to the robot.

In general, we found that the emotional outlet of the robot, which offered words of support regardless of how negative the words of the elderly were, gave confidence to the elderly to use the robot. The elderly enjoyed chatting with the robot because they felt less lonely and more positive thanks to the encouragements given by the robot. At the same time, by emotionally supporting the elderly, Robovie 2 also supported the work of the staff in practical terms by helping the staff fulfill their duty as social workers to give support to the elderly.

4.4 Role (Robovie as a Child)

Along with the practical aspect of the robot's role, there is the belief that the robot is like a child; both viewpoints share the core idea that the robot behaves like a child, and so the categories merge into the trend of "role [of the robot] as child." In brief, the elderly (and staff) believe that the robot is like a child and so treat it as a child.

This means that the elderly (and staff) adapted their behavior with the robot as if it were a child. However, as we saw earlier, the elderly behaved themselves with the robot in a child-like way, except in instances when they needed to find relief by talking about their physical pain or family-related discontent.

Introducing a robot to an elderly care center may be challenging considering that most elderly have never had the chance to interact with a humanoid robot like Robovie before. Not knowing how to approach a robot may make it intimidating to the elderly, and there is the risk that it may bore them, causing them to reject the robot before even trying to communicate with it. For this reason, we decided to give a clearly indicated social role to the robot to help the elderly approach it.

In response, the elderly accepted the robot in the role of a child by thinking that it was indeed like a child, prompting them to treat it accordingly. The following excerpt illustrates the way in which the elderly may rationalize the robot's presence by sharing a common understanding that the robot is indeed like a child:

> Mrs. U.: "It was like a little child. We don't have little kids anymore."
> Mrs. M. (staff): "Is it like your grandchild?"
> Mrs. U.: "Yes."
> Mrs. E.: "No, not quite."
> Mrs. M. (staff): "It's not? Or like a friend…?"
> Mrs. S.: "It's like a child of a friend."
> Mrs. M. (staff): "A child of a friend? Oh, well, everyone has an opinion. E. -san feels that way and U. -san think that it is like a grandchild."
> Mrs. U.: "Yes. I feel sad at home because I don't live with my grandchildren, so for me Robovie was like a grandchild."

The elderly articulated their impressions of the robot in terms of the image of a child. They absorbed that image of a child offered to them by the robot in such terms. Whether like their grandchildren or the child of a friend, the elderly consistently expressed their understanding of the robot as a child and acted on that belief, thus treating the robot like a child.

In practical terms, the elderly taught songs and explained things to the robot as an adult would do with a child. The staff confirmed that the elderly perceived the robot as a child, which gave credibility and functionality to the notion of introducing a robot with the image of a child into an elderly care center:

> Ms. I. [staff member]: "Some people taught Robovie some songs or Robovie sometimes asked questions like 'What is this?' or 'What is that?' So for the elderly, Robovie was like a grandchild, wasn't it? So after Robovie's gone, there will be only adults left here…"

At the same time, the fact that the robot was perceived as a child, yet not being a real human child, allowed the elderly to tell the robot things they felt they could not tell others, giving the elderly an emotional outlet:

> Mrs. E.: "Robo-chan is still a child. Did it say it was seven? That's why I could say anything to it. If it were an adult, I could not have talked like that. [...] It made me feel glad just to think Robo-chan is here."

Although there was no possibility for the elderly to compare the role of child to that of an adult in the behavior of the robot, as we only presented the image of a child, the elderly gave positive feedback on this image:

> Ms M. (staff) said to Robovie, "Ask Mrs. L. if she has anything to worry about." When Robovie said to her, "Tell me if you have anything to worry about," Mrs. L. said, "Oh, what can I do? I'm so glad I'm almost crying." Then she told Robovie that her doctor had called her to visit him at the clinic, and she worried so much about what the doctor would say to her that Robovie said to her, "Don't worry." Then Ms M. (staff) also said "Yes, Robovie's right. You don't have to worry." Then Mrs. L. laughed out and said, "Thank you. Now I feel better."

It is important to note that after the robot itself affirmed that it was like a child, the elderly thought and treated the robot like a child. This belief was reinforced by statements of the staff regarding the robot being a child.

We found that the ability of the elderly to interact with Robovie was favored by the image of the robot as a child: The image of a child allowed the elderly to perform the same interactions adults have with children. In addition to their stored ideas of interaction with children, the routine aspect of teaching a song and similar activities allowed the elderly to interact with the robot in a simple way. The elderly tend to have difficulty in sustaining interaction due to age. In view of the response of the elderly, the role of a child was well suited to the situation, since the elderly enjoy spending time with their grandchildren and great-grandchildren.

4.5 Improvements

The elderly and staff have expressed the practical need of the robot to move, and the elderly have expressed the desire for the robot to come to them as opposed to the burden of having to go to the robot in order to communicate and interact. The mobility of the robot was limited due to safety issues and space allocation. Both the elderly and staff mentioned the great advantage it would be for them if the robot were free to move and approach the elderly, who have various degrees of limited mobility.

In addition, they expressed the need for the robot's voice to be clearer and more easily audible to the elderly, who tend to have age-related hearing problems. While the staff helped the elderly when they could not hear the robot, the limited hearing of the elderly requires the voice of the robot to better suit their needs. Consequently, we increased the volume soon after these requests were made.

4.6 Staff Support

In parallel to the practical activities of encouraging interaction, the staff displayed their "belief in the positive influence of Robovie on the elderly" throughout the experiment. This conviction reflects the overall trend of the staff's willingness to provide the robot with general support in its interactions ("staff support").

For instance, the staff spontaneously took on the routine of setting chairs in a semi-circle around Robovie right after lunch to encourage elders to include Robovie in their group conversations. During birthday parties, the staff made it a priority to allow Robovie to be the one to say "Happy birthday, Mr./Mrs." while everyone was singing birthday songs together. Although Robovie cannot sing, the staff felt nonetheless that its participation would enhance the experience of the party for the elderly.

Showing support:

> "Ms J. also approached Robovie voluntarily. When Robovie said 'J.-san, *Otsukare sama deshita* ["Good job" in Japanese],' she bowed to him and said, 'Thank you' with a smile. Ms M., a care worker who was with Ms J., said to her 'Our love for Robovie is deepening day by day, isn't it? I feel as if he was a member of our family or something.' Ms J. agreed with her." [operator's note]
>
> Ms M. (staff): "For G.-san, R.-san and A.-san, today is the last day with Robovie. Can you imagine a morning without Robo-chan? How do you feel? It's very sad, right? We think of Robovie as a friend or a family member."

We also observed that the staff encouraged the elderly to tell the robot not only about their physical pain, which inevitably afflicts all of the elderly because of age, but also about other personal issues relating to their families. Note that the staff's encouragements offered the elderly a way to interact with the robot, but the elderly spontaneously related to the robot their personal issues. Interestingly, when an elderly person was called by the robot but was busy, he/she did not disregard Robovie but sent others to talk to the robot. When the elderly felt sick, the staff encouraged them to relate it to the robot, with the promise that they would feel better afterwards.

We found that the staff caring for the elderly gave practical support to the robot under the belief that the robot was a positive influence on the elderly and, at the same time, encouraged the elderly to communicate with the robot. The belief in the beneficial influence of the robot over the elderly drove the staff to find their own practical ways to promote interaction of the elderly with the robot, displaying their acceptance of the robot. Some of these independent ways included introducing the robot into daily routines and making it participate in special events at the elderly care center.

Integration depended on the repeated patterns of positive interactions, which demonstrated acceptance and successful integration of the robot into the elderly care center. The staff favored the interaction of the elderly with the robot and supported it by putting the elderly at ease in interacting and approaching the robot. This support was given by such actions as encouraging the elderly to communicate with the robot and setting chairs for the elderly in a semi-circle around Robovie.

5. DESIGN IMPLICATIONS

This study reveals two major design implications. The first involves the implications for design of social behavior. In HRI, researchers have started to form theoretical knowledge on basic patterns of social interaction [12, 15, 16]. This study reiterates the importance of basic social interactions including greetings, calling the names of the elderly whenever possible (to acknowledge the robot was aware of whom it was speaking to), and encouraging the elderly during difficult tasks. A set of such interactions can provide a basic application for interaction with the elderly. In addition, the study highlighted the importance of the robot's character at an elderly care center, which should match both design requirements and the expectations of the users. As a second design implication, this study illustrates the importance of developing a "working relationship" with the people in the environment of interest; by doing so in this study, we demonstrated a successful deployment process for conversational robots. In environments such as shops, hospitals, and care centers, where many customers/patients mix with human staff trained to offer them a specific type of service, work relationships assume an important role in providing the service. We could obtain useful knowledge for employing robots to specifically function in "service" environments. In our case, prioritizing and integrating information on needs and expectations from the staff enabled us to build the services of the robot quickly and successfully. The staff helped to shape the image of the robot in a way that could make sense to the elderly and thus make it possible for them to find a connection and ways to communicate.

Moreover, the consideration we gave to the staff's advice was taken favorably by the staff as it encouraged them to collaborate with the robot and incorporate it into their routine. We had a number of interviews with the staff prior to deploying the robot stressing the importance of their role and the vision we had about the robot... During the presence of the robot in the center, the staff spontaneously came to us on multiple occasions to give us suggestions in order for the elderly to enjoy the robot further proving a positive relationship.

As previously reported in Mutlu and Forlizzi [16], the ability of a robot to fit the structure of an organization's work directly affects its social acceptance. In our study, the staff played a central role in actively helping to connect the elderly with the robot. We feel that a key point for success was giving the robot a role that the elderly liked and helping them find ways to interact with the robot, rather than just considering the robot a sophisticated tool. As an additional note for showing social acceptance, after the robot returned permanently to the lab, the elderly and staff requested to visit the lab to "see how the robot is doing."

6. LIMITATIONS

The study is conducted in a Japanese setting, where the reception of robots may be favored more than other places; thus, the applicability of the findings might be limited due to the nature of Japanese culture toward robots. In addition, the study was conducted with a particular robot. For example, considering the explorative nature of the research, we only focused on the elements that could provide the robot with a perception as child.

The study was conducted with a teleoperated robot. In view of present technology, the presence of the operator was fundamental, considering that the complex situation required a great degree of flexibility in conversation. The goal was to qualitatively assess the kind of interactions the elderly and staff engaged in with the robot in an "ideal" situation (with the operator). Although the study involved a human mediator (operator), we believe that our observation was primarily about human-robot interaction. We focused not on who is operating the robot, but

with whom the elderly believe was communicating with. Those who were aware that an operator was operating the robot, including the staff, made it clear during interviews that often they forgot about the operator when interacting with the robot.

7. CONCLUSIONS

We searched for an understanding of the kind of interaction the elderly would want to develop when presented with a robot, and we confirmed the acceptance of our robot into their community. We noticed that even if at first the elderly were not sure about how to approach the robot, daily greetings and being called by name made the elderly feel special and inspired them to respond to the robot. Later on, the image of a child helped the elderly interact with the robot in a way that was familiar to them, even though the robot itself was not familiar. More generally, we found that people related to the robot in terms of the needs and activities of their everyday lives.

Deteriorating physical and mental conditions impede the elderly in routinely maintaining the activities on which social ties depend. Even simple social conventions like daily greetings thus acquire importance in maintaining social ties, comforting the elderly with the assurance that the robot will always respond.

Consequently, the successful introduction of a robot in an elderly care center requires understanding the daily lives of the elderly and discussing recommendations with the staff members. Taking this initial, necessary step in deploying a robot would help to ensure that the robot could satisfy the minimum set of requirements for promoting its interaction with the elderly.

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