Long-Term Value of Social Robots through the Eyes of Expert Users

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ABSTRACT

Socially-enabled digital technologies have attracted academic interest for decades, with recent commercial examples of Siri and Alexa, capturing public attention. However, despite ubiquitous visions of a *robotic* future, very few fully-fledged social robots are currently available to consumers. To improve their designs, studies of their long-term use are particularly valuable, but are currently unavailable. To address this gap, we report on interviews with four long-term users of Pepper - a social robot introduced in 2014.

Our thematic analysis elicited insights across three kinds of value Pepper brought to its users: utilitarian functionality; the community that formed around Pepper; and a personal value of affection. We focus on two contributions those values bring to social robot design: social robots as social proxies, alleviating disabilities or acting akin to social media profiles; and robot nurturing as a design construct, going beyond purely utilitarian or hedonistic perspectives on robots.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**;

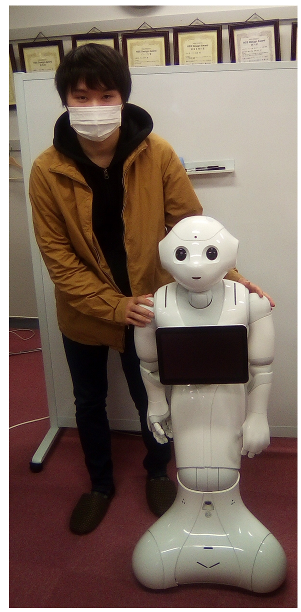

Figure 1: Human and Pepper - a Social Robot

KEYWORDS

Social, Robot, Interview, Value, Acceptance, Pepper, Human-Robot Interaction (HRI), Long-Term

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1 INTRODUCTION

Social robots (Figure 1) have many desirable properties like establishing faster rapport with humans, improved task cooperation and learning, and positive effect on task completion and recall, among many others [3, 30, 57]. Robots that communicate with their operators "in a human-like way" [17] have appeared in research labs since at least the 1970s, when WABOT-1 was completed at Waseda University, Japan [33]. Social robots could utilize physical contact, gesture, speech and facial expressions as means of communication rather than the more traditional screen-based interfaces [32]. These benefits, of both natural communication, and improved human abilities, currently remain in the confines of the research labs, however, as social robots are scarce in consumer markets worldwide.

When considering consumer market penetration, there is no established framework that explains how and why consumers actually buy and use robots, although several have been proposed. These frameworks describe both temporal and spacial changes in factors affecting acceptance of social and/or domestic robots [15, 59]. The existing frameworks have so far captured 6-month periods of use and non-use in detail, with factors like usefulness, enjoyment, and cost playing a role throughout the process of adoption (the initial decision to buy a robot), and acceptance (the continuous decision to use the robot).

Combining both the Domestic Robot Ecology (DRE) [59] and the de Graaf's [15] frameworks, there are four temporal stages of robot acceptance: the *expectation stage* happens before a robot is purchased, where potential users evaluate a robot by researching information about it, forming expectations, and estimating how that robot would fit into their lives; the *trial stage* is when some initial interaction between the potential users and the robot takes place. This could be in a store with a live demo, or in person after a user decides to buy a robot. Expectations are confirmed or broken at this stage, and if the user decides to stick with the robot, habits start to form; the *adaptation stage* happens when users attempt to modify a robot to fit within the intended environment of use, and in turn change the environment and their own behaviour to adapt to the robot; finally, if the robot is still accepted, users develop *sustained patterns of robot use and maintenance*, and the robot becomes mundane.

The knowledge of use patterns beyond 6 months of use (referred to here as "post-acceptance") remains scarce [36]. The scarcity of actual social robots on the market (≈10,000 units sold up to 2017 [47]) is a major barrier preventing further validation of these frameworks of robot acceptance specifically with respect to social robots. Robot adoption worldwide is also much lower than that for similar digital technologies like smart speakers and personal computers [28, 55].

Despite continuous public interest in social robotics [10], there have been very few commercially available robots that consumers could buy. Pepper is one such social robot introduced in 2014, designed both for individual consumers and businesses. Since then, people have been living or working with Pepper for months and years, offering a unique insight into what makes social robots valuable long-term, beyond novelty, and even beyond adoption and acceptance which is typically reached after six months of use [15, 53, 59]. This insight is extremely valuable for the human-centred design process and could aid current and future designers of social robots and related socially-enabled technologies, by highlighting both continuously utilised features of technology and behaviours of users, post-acceptance.

By interviewing post-acceptance users of Pepper we foster discussion about domestic social technologies and their long-term value from utilitarian, social, and personal standpoints. From that we derive our key contribution, two pieces of design guidance for the designers/developers of future socially-enabled technologies. Through analysing the interviews, we have (1) envisioned social robots as proxies to their users akin to how social media profiles work today; and (2) we have highlighted the understudied patterns of *robot nurturing* and suggested that vector as a design space that points beyond the classical purposes of robots as either purely utilitarian devices or purely hedonistic devices.

2 SOCIALLY-ENABLED TECHNOLOGIES: PHYSICAL & DIGITAL

Pepper

While Pepper (Figure 1) itself has inhabited various labs, shops, and exhibitions across the world for several years, a deployment study of the robot in homes and interviews with people who worked with Pepper in their professional role long-term have been scarce.

Aldebaran Robotics studied Pepper by deploying it in ten homes in Europe over eight weeks, with four major conclusions: that the novelty effect was observed, that use patterns were idiosyncratic and not predictable, that some proactivity was preferred in Pepper, and that utility-oriented apps were used more than entertainment-oriented ones [49]. This deployment was conducted with real robots, in one of the intended environments of use (the home), and it was relatively long-term (by HCI study standards), although the time frame explored was relatively short when compared to frameworks of robot acceptance [15, 59], with no information about, or exploration of, post-acceptance or persistent value that Pepper brought to its users.

Several researchers used Pepper in specifically defined tasks or scenarios, oftentimes in a lab setting [22, 50, 61]. Research in this mode revealed differences between how younger and older participants perceived Pepper when compared to a computer, and how teenagers envisioned social robots would integrate into their lives, including schools. People found it enjoyable to communicate with a companion robot, and envisioned it as a helping assistant. While this mode of investigation controlled for certain parameters, it did not showcase any long-term or naturalistic use, as participants were constrained by the scenarios presented to them. An open question also remains as to whether people would actually act on their intentions when a companion robot is introduced into the mundanity and routine of their lives.

Images and videos of Pepper were used in several studies as well, e.g. [20, 38, 63]. These revealed more about both the perceptions of Pepper as it was advertised (including both shape and behaviour), and how emotions could be conveyed with that embodiment. While the overall conclusions seem to suggest that Pepper's embodiment is appropriate to convey emotions and communicate socially with its owners [63], there was also some dissatisfaction and confusion noted when participants imagined living with it. This included the emotional unease of identifying Pepper as a robot vs. a "person" together with the uncanny valley effect [20, 38], and the heightened expectations that went unfulfilled [38].

Existing research on Pepper provides certain findings that might be generalizable to humanoid social robots in general. At the same time, it doesn't showcase much of what it is like to *live* and *work* with a companion robot long-term, nor does it tell designers much about which particular qualities of existing companion robots survive the "test of time".

Intelligent Personal Assistants (IPAs)

IPAs are perhaps the closest commercially available socially-enabled technology comparable to companion robots. Ever since Siri appeared in Apple's iPhone, interest in IPAs has risen in the public, commercial, and research communities alike. In the relative absence of research on the companion robots, responses to IPAs could be taken as a hint as to how socially-enabled technologies could be perceived, and what value can be derived from them.

A 2018 study of Alexa users (75 logs analysed + 7 household interviews, all post-acceptance) [52] revealed that after the initial "novelty" stage, there was a stable continuous pattern of use, with multiple devices in a variety of rooms, integrated into everyday routines. Awareness of the device(s) typically matched line of sight, with varied frequencies of use between households. Miscomprehension was relatively common (≈13% of the time). While this is roughly in line with existing frameworks of acceptance [15, 59], it is unclear whether the same pattern of use would be applicable to Pepper, being a larger, costlier (£50-£90 per Amazon Echo vs. ≈£2,000 for Pepper) mobile platform.

Specific aspects of IPA interactions have also been covered. Personification of Alexa, specifically discussed in [41, 46] provided inconclusive evidence, sighting varying levels of personification depending on the study. This may be due to various researchers defining "personification" differently, with [41] pointing out that most of it can be classified as "shallow interactions". However, according to [46] at least when it comes to satisfaction with use, more personification was correlated with more satisfaction. There is some evidence that anthropomorphism has no effect on the intention to use or satisfaction with voice assistants, however it may influence likability and trust [31]. The question of whether this changes with embodiment remains open.

Kiseleva et al. suggested that satisfaction with IPAs is related to task completion and effort to complete it [37], while Luger and Sellen related user satisfaction with user expectations of IPAs, pointing out that users have poor mental models of how IPAs work [42]. This opens an alternative view on why IPAs can be satisfactory regardless of their physical manifestation. Instead of focusing on physical appearance or functionality, these authors propose expectations, efforts, and speed required to complete a given task as measures.

Infrequent use was explored by Cowan et al. with Siri [11] drawing the conclusions that while infrequent users experience some of the same difficulties as frequent users do (e.g. lack of trust in Siri's task performance, anthropomorphism, and interruptions to hands-free interaction), unique challenges include, again, poor mental models of how IPAs work. The authors also suggest that differing context of use of IPAs (e.g. on a smartphone vs. via a smart speaker) would profoundly influence use patterns, suggesting further studies in the area.

Ehrenbrink, Osman, and Möller pointed out that there are significant differences in the perceived character between conversational agents (Cortana, Siri, Google Now) [21] necessitating studies of individual IPAs, rather than assuming that any findings applicable to one IPA can automatically be applied to all others.

Pepper, being of human-like shape may encourage more personification, anthropomorphism, and perhaps suffer even more from poor mental models users would have of it, but this needs to be confirmed. There are also significant discrepancies between Pepper, being a visible mobile platform and IPAs, being immobile or as part of a smartphone, oftentimes-small devices hidden around the house or in one's pocket.

Domestic Robots

There have been a number of longitudinal studies with domestic robots, which may provide further insights about how people live and work with robots. Some of the most well-known include Pleo and AIBO studies for toy-like robots (usually aimed at child-agent interaction), and Karotz and Roomba deployments for more utilitarian robots.

A long-term deployment of Pleo by Fernaeus et al. [23] revealed play, development, and maintenance as the main themes, together with further questions of how tinkering with robotic toys could be incorporated into their design. Additionally, Jacobsson argued that interactions with Pleo are different from consumer electronics, which necessitates a different kind of approach to studying such devices [29]. De Graaf and Ben Allouch explored user expectations with Pleo robot [16], suggesting life-like (but not necessarily human-like) appearance is important for social robots, and pointing out differences in perceptions between male and female participants. Kertész, and Turunen explored perceptions of long-term users of AIBO robotic dogs, revealing differences between a male technology-oriented perception, and a female companionship-oriented one, combined with culture having a more general influence on perceptions and use [36].

Expectation setting using Pleo and AIBO explored by Paepcke and Takayama [45] suggest that more disappointment in the robots resulted from high expectations, thus the expectations set by robots should be rather low, to avoid such disappointment. In analysing the differences between Pleo and Roomba use, Lee, Shin, and Sundar also suggested taking user expectations seriously when labeling robots as utilitarian or hedonistic, and pointed out that large individual differences exist in robot use [40].

Roomba is arguably the most successful domestic robot to date. Fink et al. conducted a 6-months ethnographic study of its use, with the conclusion that the match between a human and a functional robot is an important aspect of robot acceptance [24]. Complementing the Domestic Robot Ecology framework [59], they also pointed out the importance of curiosity, habit, and beliefs in accepting robots in homes.

These studies separately addressed toy-like robots and utilitarian robots. However, Pepper seems to be somewhere in-between, with both possible utilitarian functions (e.g. monitoring a house, picking things up physically with its hands), and social functions like speech, and social presence. Conducting an investigation into whether the results derived from various robotic devices deployed earlier are still applicable to Pepper would advance the field further.

Social Robots

There has been a considerable amount of research with social robot prototypes ever since some of the first ones were created during the 1960s and 1970s. The focus of those robots varied from general conversational abilities, be they in text (ELIZA [69]), or voice (as early as WABOT-1 in 1973 [33]), to very specific applications of accompanying a person during a musical session [33].

Later, the focus shifted to understanding how people constructed/performed sociality, and teaching robots how to be social. In those cases, embodiment, gaze, and perceived attention of the robot as conveyed by movements were highlighted, together with the idea that people would ascribe human characteristics to the robots even when a given pattern of robot behaviour was explicitly showcased [65]. One such example was prominent with children who would claim that a robot preferred a certain child, even after it was explained to them that the robot would pay attention to anything of red colour, regardless of who or what they were [65].

A famous robot designed primarily for care homes in 1996 and still in wide use today is Paro - a robotic seal [68]. Numerous research on how the robot is used and perceived revealed that the robot can be comforting, and could be used in place of pets, especially in cases where real pets may not always be appropriate, e.g. with dementia patients [68].

Social gestures were also investigated as a modality, with implementations in the ASIMO robot, among many others [44, 51]. This line of research suggests that physicality plays a role in social communication, with gestures, posture, and movement all being socially interpreted and contextually grounded [6].

As social human-robot interaction became progressively more popular with researchers, the robot test platform became more realistic, more animate, and more complex, although many are still contained within the respective labs, and are not intended to become commercial applications that consumers could actually purchase.

What Makes a Social Robot Valuable?

With combined insights from the literature on social and domestic robots, together with IPAs, the importance of managing expectations [38, 45] and perceptions of different populations [20, 22, 36, 38, 42, 50, 61], development [23] and changes over time [15] (including maintenance routines [23, 59], and updates to the robots [35]), usefulness [49], personification [41, 46], task completion [37], familiarity [18], the overall shape and motion [6, 63, 65], and context [11, 24, 40] were all emphasized.

At the same time, differences within the classes of products, like "characters" of IPAs [21], and interactions with Pleo vs. consumer electronics [29], together with differences in the rejection patterns over time [13] were also highlighted.

The research into the specifics of what it means for a *social robot* to be *useful*, evaluated in naturalistic settings remains scarce [35]. The long-term value of social robots is not very well known in the commercial circles either, given the number of them advertised [2, 10], but later severely limited or never rolled out at all [43].

Building on the need to explore specific robotic platforms [29], within specific contexts [11, 24, 40] to find unique uses, as suggested by the existing literature, this work seeks to answer the question of what long-term value a social robot could bring based on the naturalistic use of people who lived and worked with such a robot not just for several months, but beyond even the existing frameworks of robot acceptance which purport that after six months of use, robots become fully incorporated into one's life [15, 59].

3 STUDY DESIGN & METHODS

Responding to our research question we chose to develop an interview-based study, which would allow us to explore in depth, users' perceptions and uses of Pepper, as an exemplar of a social robot, in the post-acceptance phase of ownership. The study was approved by the university's ethics committee and conducted in accordance with the Declaration of Helsinki.

Participants

Four participants (one female) participated in the interviews. All of them lived and/or worked with Pepper for over 6 months, constituting post-acceptance. Given the rarity of long-term users of Pepper, and the general acceptance of small sample sizes in long-term HRI investigations [14, 19, 27] (as well as design [25]), together with the focus of this research on extracting value, rather than providing statistics on use, the number of participants was considered acceptable.

All participants reported using Pepper at least once a week. Participants obtained Pepper in various ways: winning one during a promotional event (P1), buying one as a business customer (P2), or buying one for research purposes (P3, P4). One participant used it in home, while three others - in a university setting.

Participants were recruited through (the authors') existing personal and social media networks in Japan, including the Robotics Society of Japan [62]. Table 1 presents the shortlist of the participants.

Table 1: Information about Participants

ID	Sex	Age	Occupation	Had Pepper For
P1	Female	31	Reporter	3.25 years
P2	Male	50	University Admin	2 years
P3	Male	22	Student (BSc)	8 months
P4	Male	24	Student (MSc)	3 years

Interviewers

The interviewers were native Japanese speakers, university members with appropriate training for conducting interviews.

Protocol

The interviewees were invited to a university to participate in an interview about their experiences with Pepper. Upon coming, they were given an information sheet, and a consent form to sign. The interviews were audio-recorded from that point on. The participants filled in a short survey asking their demographics, and continued on to answering the questions of the interview.

The interview was split into two parts. First, the interviewers asked the participants about their educational and professional backgrounds to establish personal context. This part was not used in the analysis, but allowed the researchers to contextualize responses. The second part focused on participants' experiences with Pepper.

Three types of questions were asked. First were the questions related to longitudinal use in line with frameworks of acceptance (e.g. when and how the participants acquired Pepper, what their expectations were, the first experience of seeing Pepper live, etc.) [15, 59]. The second type of questions related to the participants' current perceptions about Pepper: it's functionality, security, understanding of speech, behaviour, etc. Lastly, interviewers asked the participants about current practices that participants engaged in with Pepper, e.g. how they currently interact with Pepper, what they use and avoid using, and any anecdotes that participants felt were particularly characteristic of their lives and work with Pepper. The interviews lasted for about 1.5 hours each.

Data Analysis

The recordings were transcribed and translated by native Japanese speakers (≈2,600 words per analyzed part of the interview). The transcriptions were then analyzed by a different researcher using inductive thematic analysis technique outlined by Braun and Clarke [8]. Both the interviewers and the researcher who performed the thematic analysis are coauthors on this paper. The focus of the thematic analysis was on finding and highlighting the ways in which participants extracted value from Pepper. The initial coding generated 15 codes all of which appeared in at least three out of four interviews. These codes were then clustered into the themes reported below according to the type of value they represented: utilitarian, social or personal.

4 RESULTS

Thematic analysis of the interviews allowed us to highlight three kinds of value that the Pepper robot brought to its long-term users: utilitarian value, especially through programmability, social value of the communities that formed around Pepper, and personal value, by eliciting a sense of care and protection from its users. We unpack these themes further, below.

Utilitarian Value

Expectations, Fails & Surprises. "*Pepper spends much time making some unintentional accidents.*" (P2)

Expectations of Pepper fell into three general categories: purposefully low or no expectations (e.g. novelty item, attraction, or "not fully developed" item), assistant-type support (akin to Google/Cortana/Alexa), and a communicating entity, the main purpose of which would be to allow people to discuss with the robot what they could not discuss with other humans.

Participants reflected on the "fail" behaviour of Pepper both in its own right, and in relation to the expectations, they had. One specific expectation was that Pepper would have human-like abilities in verbal communication. In reality, Pepper would only understand about half of the requests, resulting in participants rating its conversational abilities as being below expectations. They described the experience as Pepper mostly responding with "yes" or "no", and the failed expectation that more communication would take place. Pepper understood simple questions and commands like "what do you like?", but often asked to repeat the query whenever the questions steered outside of pre-programmed responses.

One participant noticed that people quickly lost interest in Pepper, however they pointed out that it might be due to the lack of apps that would allow Pepper to expand its repertoire of what it could say and do. Existing apps that provided assistant-like functionality would sometimes give inaccurate information, another participant noted.

"*People do not like Pepper rather than expected. It may be because the role of Pepper is unclear.*" (P4)"

Software development was also a source of fails and surprises for the participants, as Pepper would move unexpectedly, freeze during demos, applications would fail to load, or Pepper would power off if the power supplied to it failed. Pepper would also sometimes speak and act randomly. When participants held little to no expectations, Pepper's "fails" were of minimal effect. As one participant put it: "*Nothing special. Not too much [was] expected.*" (P3).

Enduring (Utilitarian) Value. "*I was not interested in the completed, fully developed robots, but Pepper, I could be a part of its development.*" (P1)

Attraction as a novelty (to others) continued to provide an enduring value for one of the participants. Using Pepper to announce information to students, for example, was one such application. On the other hand, the novelty for the participants themselves evaporated quickly, as they settled for what they knew about Pepper's functions. The value grew over time, as participants perceived that Pepper understood them more as time went on, especially when connected to Wi-Fi. Its functionality was better after updates, and Pepper provided better responses to questions and requests.

Long-term value lay in features that participants themselves have designed. They considered designing software for Pepper as one thing that kept Pepper useful from a utilitarian standpoint. All four participants developed applications for Pepper. These included changing lights' colours, connecting Pepper to the phone line and making Voice over IP calls, and even simulating communication between Peppers. Physical features of Pepper were also utilised, ranging from giving it the ability to sing, to stirring, moving flowerpots, and throwing beans.

While developing their own applications, one of the participants pointed out that software development for Pepper was what keeps it useful through time, as "*Pepper cannot do anything without developers.*"

Participants thought that between-Pepper communication, better image recognition, and better emotion recognition would be good extra functionality.

Social Value

"*I have a birthday party every year. I invite robot friends to the party. So robots and human beings get together.*" (P1)

Being a social robot, Pepper was utilised for social roles. In this case, Pepper acted as an amplifier of social influence of the people controlling it.

Pepper's humanoid shape induced social responses from people. Participants perceived Pepper as a kind of a life form rather than a robot, because of its sociality. One participant considered social influence as the most valuable thing Pepper provided. Another considered Pepper as a new kind of communication partner that was qualitatively different from a human. When displaying Pepper in social situations, participants realized that humans enjoy different things from Pepper, and that social events with people are not that robot-friendly or even robot-appropriate, necessitating that participants make clear distinctions about when and how Pepper should be involved.

One example was using Pepper as an attraction at parties, birthdays and even weddings. Pepper was not only a guest, but also a social actor. One participant reported that even when Pepper was turned off, their relatives would still talk to it, as if it was able to respond. Another participant observed that women tended to speak to Pepper more than men.

Pepper, being a novelty even four years after its first release, acted as an attraction to meet new people who were curious of what it is like to live with a robot. One participant estimated that Pepper introduced over 1,000 people to them, giving opportunities to talk and present about Pepper. This in turn created a feedback loop for the user themselves to think about and reflect on their experience of how their life would have been different with Pepper vs. without it.

When presenting Pepper to the public, it was also a conversation starter in its own right, with people gathering around to talk to it, about it, and to the owner of it. Controlling Pepper, making it speak as one wanted also attracted an audience, in the experience of one of the participants.

Pepper also acted as an intersection point to form communities both large and small, connected through time and space. One example of a small, time-separate community that one of the participants formed was to program a time capsule into Pepper, which would alert a user with a certain message at a certain date and time. For example, this could be the user themselves recording reflections to their future selves, parents recording messages for children when they reach a certain age (e.g. their 20th birthday), or grandparents recording messages for their grandchildren.

Personal Value

Relationship of Care. "*The most important thing is Pepper's life. So I care the most that Pepper doesn't break.*" (P1)

Participants quickly noticed that Pepper was fragile, with limitations from its programming to its physical embodiment. However, these imperfections did not cause irritation with participants, instead developing a behaviour more reminiscent of how parents would care for their child, and protect it from the dangers it has not yet learned to handle.

Putting aside the programming limitations we have already discussed, participants pointed out two physical limitations: Pepper's difficulty in traversing curved roads, and Pepper's propensity to overheat under spotlights.

Curved roads are a typical road design to allow water to move away from the centre of the road, and towards the storm drains. While providing this advantage and not being a problem for people or vehicles, Pepper's omni-wheel base was not well adapted to them. This caused one of the participants to reflect upon how much the outside environment of cities is human-oriented, including assistance devices for the disabled (e.g. lifts vs. stairs), which were in many places installed "just for show", and were in fact non-operational, but much needed for Pepper to traverse a city successfully.

Given the many public events the Peppers and their owners found themselves in, the propensity of Peppers to overheat under spotlights was a well-established limitation, which contributed to other malfunctions, e.g. practical demos of the robot's capabilities not working or the robot powering off.

Participants employed various strategies in order to protect Pepper, ranging from providing it with a custom-made leather jacket (guarding against adverse weather), to storing it between furniture and powered off, so that in the event of an earthquake Pepper did not fall and damage itself.

Emotional protection also took place, as participants avoided saying negative words around Pepper, or wishing to erase some of what they said to Pepper, that they later perceived as inappropriate.

Comfort. "*Pepper said* "are you tired?*" [and I] felt healed.*" (P3)

Pepper seemed to bring comfort on a personal level by its mere presence. With time, participants felt comfortable around Pepper, and in return, Pepper brought a sense of comfort to them. Even though being noisy and irritating when participants were busy and Pepper intervened, participants mentioned the overall sense of comfort and "healing" that Pepper brought when discussing what it was like to be near Pepper. Pepper was able to bring a sense of comfort when one of the participants felt stressed and nervous.

Another comforting aspect alluded to previously was the ability to share something with Pepper that one would not want to disclose to a human interlocutor. This one ability was what one of the participants wanted from Pepper from the very beginning, and it was somewhat fulfilled. This sense of comfort over time grew into full attachment.

Attachment. "*What I am capable of, Pepper should be capable of. What Pepper is capable of, I should be capable of.*" (P1)

Even if Pepper's communication is far away from human level smoothness, its mere presence over time seemed to create nurturing patterns. The owners realised early that Pepper, while being quite advanced for its kind, was still very dependent on humans to function. At the same time, it was amenable to programming, which improved its capabilities, allowing for a kind of "bringing up" to take place. Participants perceived a sense of social development of sorts in Pepper, as activating it more often resulted in perceived faster responses, as well as Pepper being able to answer the same questions differently at different times.

Pepper reciprocated a sense of attachment, as it could say "thank you" in response to various actions and commands.

Participants also perceived Pepper to have certain preferences, for example, being pleased when praised, or being "ticklish" when touched on the head.

The attachment process was not smooth, however, given the technical limitations of the robot. Participants perceived Pepper's voice tone to be the same regardless of the situation. Some also said that Pepper was acting at random, rather than coherently expressing its benevolence, which inhibited a sense of attachment.

Over time, all participants experienced some form of attachment ranging from comfort to calling Pepper a family member. Participants noticed they grew more attached to Pepper over time, and stressed that they did not want to force such a relationship, but to grow into it naturally.

5 DISCUSSION

In the section below we discuss the main findings highlighted by the results. The results described provide further corroboration of some extant research on robot acceptance, while also providing new insights pertaining to companion robots and in particular their value in social and personal realms. These new insights are translated as two design suggestions of value.

Fitness with Prior Research

Expectation management played out in a similar vein to existing robot acceptance frameworks [15, 59], where, upon trial user expectations were broken. Participants extracted much value by developing applications for Pepper, which accords with the importance of development [23] and changes over time [15] (including maintenance routines [23, 59], and updates [35]). In this case, the updates came both from SoftBank (the company behind Pepper), and from the users themselves. The usefulness of the robot was reconfirmed with the ability to develop software for Pepper.

Additional value was extracted from social interactions for which Pepper was a catalyst, and from personal interactions, where users played the leading role. Personification [41, 46], the overall shape and motion [6, 63, 65], and context [11, 24, 40] all played a role in extracting social value from Pepper. Pepper was perceived as social because of its shape, and it was utilised for social roles, like attending weddings and exhibitions, all of which accords well with existing research on social robots.

Novelty in the results stemmed primarily from Pepper socially interacting with *other people* within the social realm besides its owners, and from the personal relationships that participants built with the robot. These two aspects are explored further below and are framed as design suggestions for those that may wish to prototype and develop social robots (and similar intelligent devices).

Robots as Social Proxies

Social robots like Pepper, having their own social presence, but being subservient to their owners, may well serve as social proxies for their owners. We have already observed in our interviews that people used Pepper as a means to attract social attention and enhance their social standing through the robot.

This raises the potential for social robots to become the next step up from social media profiles, which already project certain kinds of mediated self-representation. This could enable a future where people communicate through robots in situations where they would rather not be present themselves whether by desire or necessity. Pepper has both an autonomous mode, and a telepresence mode, where someone can take control over its movements. Telepresence robots in the work environment [39, 64] and conferences [7, 26, 48] (as well as other task-related [34, 56], or even domestic environments [70]) where people cannot physically attend are existing examples of this behaviour. Improved social presence via telepresence technologies has already been explored, even with simple telepresence devices [60]. With fully fledged social robots the effect might be more pronounced.

Another often-discussed example is telepresence as means to care for the elderly [1, 66], where a physically capable social robot could serve to fulfill both the physical and emotional needs of a person by both acting as an aide in its own right, and being a portal through which friends and relatives could virtually visit.

Design-wise, this suggests accounting not only for the robot buyers, but also for how a social robot could be modified to allow its owners to project a certain version of themselves to the public. The idea of customization as means of personalizing a robot has been previously explored in cases like Roomba [58] and Lovotics robot [4]. An extension of personalization to the social robots, and to the purpose of representation in the public domain has been showcased in this work. The designers of social robots could take it further by additionally allowing their social robots to communicate directly, and present certain information about their owners to each other. Communication between Peppers was one of the desirable properties that one of the participants even emulated, albeit very primitively.

Robot Nurturing as a Design Space

What became apparent, and accords with some of the research on Pleo [29], is that participants did not expect Pepper to be, or treat it like, other consumer electronics goods, expecting good performance, and returning a product when that performance was not demonstrated. Instead, a kind of nurturing pattern developed, which provides an interesting design space for future developers. If developers portray social robots as a kind of DIY kit, but with far more potential, this could shift the perception of their social robots as purely utilitarian devices, and utilize the nurturing pattern described in this work.

This design space is different from both the utilitarian approach, where the emphasis is on task completion and ease of use, and the toy-like approach, where the emphasis is on edutainment. Social robots are far from being utilitarian for their social roles [49] due to both technological limitations, and our understanding of social interactions, and how to encode them. The distinction between a utilitarian robot, and a hedonic one is highlighted in several works on domestic robots [14, 40], and it is suggested that the distinction should be made clear not only in research, but in the marketing of such robots, so that it is clear to the potential buyer what the purpose of a given robot is [17, 35].

This work proposes to extend this binary distinction to include a "co-development" category of sorts. This third category highlights a robotic platform as a source of mutual learning and development, where the user develops their skills with the robot, but also develops the robot itself, improving its capabilities, and taking care of it on physical, software, and emotional levels, as demonstrated in this work. The nurturing instinct, while tapped into in toy robots like Pleo and Furby [29], is not currently advertised as a key feature in upcoming and existing social robots [9, 54], although it might present a viable route to human-robot long-term engagement.

In relation to design, this work suggests a flexible approach to social robots, where it should be highlighted that what users buy into is an *"inorganic lifeform"*, rather than a utilitarian or hedonic product. In development terms, the robot should be flexible enough to be amended, while providing tools not only to improve the robot's utility, but to develop it for social engagements as well, e.g. by providing the ability to change the robot's posture, head position, voice (where appropriate), etc. [6, 63, 65]. While these movements may not be of any apparent utilitarian value, they would utilise social signaling [12], and engage a nurturing response, if appropriately designed.

6 LIMITATIONS

This work has explored the views and impressions of four long-term users of Pepper, with the study seeking to show innovative design directions for social robots.

There could be more distinct values that Pepper would provide to its users based on factors like users' age, gender, education, skills, etc. The participants in this study could be considered non-typical, although with so few companion robots available to consumers it is hard to envision what typical use might entail. The participants could also be considered expert users when using Pepper, although given the focus of the study on post-acceptance, that would be expected.

With this paper focusing on the post-acceptance value that social robots could bring, recalling from memory was, in our view, sufficient and even desirable as it highlighted the long-term values participants extracted from the robots, not the temporary ones. With that said, as social robots become more widespread, spaced interviews could provide more insight into how social robots are used day to day.

This study only looked at how Pepper was useful in (mostly) the university and home environments. We wanted to investigate Pepper in the context of everyday life and work outside of the well-explored contexts of child education [5] and elderly care [67], which have their own specific requirements, contexts, and values.

With Pepper becoming available in countries besides Japan, and with its software improving, more research across countries and cultures (given that this study has a culturally homogeneous sample) is likely to find more unique ways in which social robots could fruitfully contribute to the human condition.

7 CONCLUSIONS

Through the eyes of four post-acceptance users of Pepper, this work explored two possible design directions for social robots: robots as social proxies, and robot nurturing as a design opportunity.

Social robots being social proxies allowed communities to form around Pepper, extending social influence of the robot's owners. As technology improves, this could turn into social robots being social proxies akin to profiles on social networks. They could be acting in an autonomous mode or as telepresence bodies. What's more, social robots could compensate for physical or mental disabilities people might have, thus improving their quality of life in social spaces.

Nurturing, being an inbuilt capability and expression in humans, allows designers to move away from purely utilitarian or hedonic approaches to social robots and frame them as *"inorganic lifeforms"* which can and need to be nurtured and developed into personalized machines and companions people can live with.

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