"Adventures of Harvey" – Use, Acceptance of and Relationship Building with a Social Robot in a Domestic Environment

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Abstract. The goal of this study was to improve our understanding about how older people use social robots in domestic environments and in particular whether and how they build relationships with these robots. Three participants interacted with the Nabaztag, a social robot, for a 10-day period in their own home environment. Some of our findings are (1) utilitarian-, hedonic-, and social factors are important when accepting social robots, (2) utilitarian-, hedonic- and social factors are important for building a relationship with the Nabaztag, (3) there is a relationship between name-calling and relationship building and (4) there is a relationship between using non-verbal- and verbal communication and relationship building.

Keywords: Social robots, usage and acceptance of social robots, relationship-building, elderly people, domestic environments.

1 Introduction

It is often assumed that in the near future, social robots will be able to aid the elderly to live longer autonomously at their homes. For example, robots will do household tasks for them, monitor their health and be a social companion. Therefore it is important to study the acceptance/use of and relationship building with these robots, so that future social robots can be adapted to the wishes and demands of the elderly, which is important for their future diffusion and adoption. The study presented here, the first of three in total, aims to improve our understanding of how elderly people use social robots in domestic environments in general, and how elderly people build relationships with social robots in particular. The main research questions in this study are: (1) How are social robots used by elderly people in a domestic environment? (2) Which factors play a role in building and maintaining a relationship with social robots?

2 Related Work

In this section we provide an introduction to related work that was used in the analysis of the interactions that were analyzed in this paper.

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Acceptance and use. Acceptance of robots is assumed to differ from the acceptance of other technical innovations. On the one hand, social robots are utilitarian systems: they are able to perform household tasks for example. On the other hand, social robots are hedonic systems: they offer interaction possibilities to be able to build (long-term) relationships, e.g. friendship, with their users. Therefore it is important to study besides the utilitarian, productivity-oriented factors [1], also hedonic, pleasure oriented, factors [2], to get a more complete view of which factors play an important role in the acceptance and usage of social robots [3]. Research with social robots showed that enjoyment seems to influence the intention to use it. Furthermore, playfulness also seems to be an important factor regarding acceptance and use of robots [4, 5].

Interacting with social robots seems to be a social activity. When interacting with social robots for the first time, people approach the robots with other people instead of individually [6, 7]. When participants in the study of Shiomi et al. [6], tried to let the social robot call the participants' name using RFID tags, several other participants also tried to have their names called. During another study, each time someone tried to interact with a social robot via the touch screen, at least 10 other people were curious and tried to interact with the robot as well [7].

Robots also easily become a topic of conversation. People tend to talk with each other about the robots. For example, social robots were used to increase the communication between (autistic) children and others (e.g. carers, other children) and demented elders with others (e.g. researchers, care-givers and other residents) [8-11].

In general, personal interest in technology (PIIT) is an important factor for acceptance and usage of technologies [12]: there appears to be a relationship between PIIT and perceived enjoyment, suggesting that the more people are interested in new technologies, the more enjoyment they perceive while using new technologies [12].

In conclusion, several factors appear to play an important role in the acceptance and usage of social robots: (1) Utilitarian factors, such as ease of use and usefulness. (2) Hedonic factors such as enjoyment and playfulness. (3) Social factors such as approaching robots in groups and communicating about robots with family and friends. (4) Personal interest in technology. No studies were found that looked at the same combination of above factors. To fill this gap, this study will look at utilitarian-, hedonic- and social factors and PIIT.

Relationships with robots. Relationships between humans and robots are assumed to be very important predictors of acceptance and use of robots. Many studies investigated relationships with social robots, studying robots such as (1) AIBO, a robot resembling a dog [13], (2) Robovie, a humanlike robot [14], and (3) Paro, a seal robot used for animal assisted therapy with elderly people suffering from dementia, [9, 10]. One of the studies showed that it was possible to build a relationship with AIBO: 70-80 percent of AIBO owners felt a strong attachment to AIBO [11]. Another example of a relationship with AIBO is described in [13], where a girl nurtured an AIBO all the time and saw AIBO as a living being [13]. The same study also indicated that there are two types of relationships humans have with robots: either humans love and nurture social robots and built relationships with them, or humans see social robots as artificial, as a machine [13]. For example, one elderly man treated a robotic doll as if it was his ex-wife and loved and nurtured the robotic doll, while another elderly man saw the robotic doll as an interesting artefact and he slapped it

just to see what would happen. Another interesting difference observed was that humans either talked to the robot or about the robot. The elderly man who saw the robotic doll as an artefact talked about the robot when interacting with the researchers, while the elderly man who saw the robotic doll as if it was its ex-wife talked directly to the robot itself [13].

Research with Robovie showed that not every participant was able to build a relationship with the robot, but there were also examples found of children who were indeed able to build a relationship with it [14].

Elderly people were also able to build a relationship with Paro [10] [15]. For example, elderly people stated that they felt better after Paro was introduced in their nursing home. They felt as if they had a new playmate and felt less lonely [15]. Another example: *"Some residents expressed a special attachment to Paro. They spoke to it like it was a pet, gave it names and engaged it in (one-sided) conversations[..] These users generally began a relationship with Paro in which they saw it as dependent of them. Very often they are/were pet owners."* [10, pp. 3]

In conclusion, people's interactions with robots should be studied long-term to establish whether relationships with social robots occur. Indicators from the literature for the presence of a relationship are (1) whether people love and nurture social robots instead of seeing it as artificial and (2) whether people talk to the robot instead of talking about the robot. Until now, most studies with robots studied interaction with social robots in controlled experiments. Only few studies looked at the use of social robots over a long period of time in domestic environments (e.g. [23] [25], where participants were studied in a domestic environment for 3-6 weeks and [29] where participants were studied in a domestic environment for a period of six months.) We believe that observation over a long time period is necessary to study whether people can build (long-term) relationships with social robots [3]. Therefore, this study will look at usage of robots in three different studies with an interaction period of 10 days per study, over a period of one year. The number of participants will grow during time: three during the first study, six during the second study (the three first participants and three new participants), and nine during the third study (the six participants that participated in study 1 and 2 and three new participants). In this paper the first study is reported.

Research questions. The purpose of this study is to gain insight into how people use social robots for health-promotion at home and, in particular, whether people are able to build relationships with contemporary social robots. Consequently, the main research questions of this study are:

(1) "How are social robots used by elderly people in a domestic environment?"
(2) "Which factors play a role in building and maintaining a relationship with social robots?"

3 Methods

Artifacts. The social robot used in this study is the Violet´s Nabaztag, type Nabaztag:tag: a rabbit-shaped Wi-Fi enabled ambient electronic device (www. nabaztag.com). The Nabaztag has no mechanisms of learning or memory. The Nabaztag is able to receive pre-defined spoken commands, but it is not able to understand natural

language. However, through its ability to be programmed, the Nabaztag can serve as a robotic user interface to intelligent applications that make use of external sensors and program. Personalized activity plans provided by the participants were used as input for personalized heath related conversations provided by the Nabaztag Participants could respond to these programmed conversations and messages via yes- and no-buttons that were added to the set-up of the Nabaztag.

Fig. 1. Set-up of the Nabaztag

Procedures. The Nabaztag was installed for 10 days at the participants' homes. The goal for participants was to improve their overall health condition. Conversations regarding health activity were initiated at four different times of the day and participants also received a daily weather report and messages from the researchers, e.g. "*did you have a good time at the town market*?" All conversations regarding health activities ended with closed questions. Participants could respond to the Nabaztag via the yes- and no-buttons. All conversations between the social robot and the participants were video recorded. Participants received a compensation of £20 for energy costs made during the study.

Participants. An announcement was placed at a website aimed at people older than 50 years old, living in the United Kingdom. Three participants volunteered to take part in this study. The participants (n=3) were all female and between 50-65 years old. The education of the participants differed, from formal education until 16 years old, to a Bachelor degree and a Master degree. One participant was retired, the other participants had a job.

Material. After the 10-day interaction period, experiences of participants were evaluated via a semi-structured interview (Table 1).

Table 1. Used topics/categories during the interviews

Topics	Categories
General use of Nabaztag	Intention to usage [16] Usefulness [16] Usage [16] Expectations Health exercises Evaluation of the possibilities of the Nabaztag (usefulness of design)
Communication with the Nabaztag	Perceived enjoyment [1] [12] Perceived playfulness [17] [18]
Relationship development with the Nabaztag	Trust [19] Likeability [19] Source credibility [19] Appearance (and the uncanny valley) Relationship building Novelty effect
Social factors	Subjective norm [16] Self-identity [16]
Personal interest in technology	Personal interest in technology [12]

Coding and reliability. Linear- and cross-sectional analysis was used to analyze the interview data [20]. After the interviews, the audio recordings of the interviews were transcribed verbatim. The transcriptions were categorized via the used categories of Table 1. After analyzing the interview data, the video data was analyzed [21]. First, the videos were watched. No coding system was designed due to the explorative nature of this study. After watching the videos, the researchers discussed the findings with each other via the visual images. After analyzing the video data, the results of the video data were used to verify/disconfirm the results of the interviews and vice versa.

4 Results

Utilitarian Factors. We refer to participants as A, B, and C. Participants A and B stated in the interviews that they did not find the Nabaztag a useful device because of technical problems and the limited conversation abilities. An indication was found that Participant C found the Nabaztag useful, because she stated in the interviews that she did find the goal of the Nabaztag, for research purposes, useful. All participants found the Nabaztag easy to use.

Hedonic Factors. Participant A and B stated in the interviews that they did not perceive such factors. Participant C stated in the interviews that it was fun to use the rabbit. All participants stated in the interviews that they did not perceive playfulness.

Social Factors. (1) All participants stated in the interviews that they discussed the Nabaztag with others. (2) The videos showed that Participants A and C did not show the Nabaztag to family and friends, but they stated in the interviews that they did show photographs of the Nabaztag to them. The videos showed that Participant B showed the Nabaztag to family and friends. (3) The videos showed that Participants A and C interacted alone with the Nabaztag when interacting with it for the first time and that Participant B interacted with her partner when interacting with the Nabaztag for the first time.

General Usage. The videos showed that Participant C seemed to have embedded the Nabaztag into everyday life, e.g. combining household tasks and interaction. The videos also showed that Participant C experimented with the Nabaztag and found ways to trick the Nabaztag, e.g. by using spare keys when leaving the house for groceries or pushing the no-button when the Nabaztag asked whether participant C had a good time when doing exercises.

Interaction. When communicating with the Nabaztag, the videos showed that Participant A used verbal communication, Participant B used non-verbal communication and Participant C used both verbal- and non-verbal communication. Examples of used non-verbal communication of Participants B and C were mimicking the rabbit and waving to it when leaving the house.

Personal Interest in Technology. The interview data showed that Participants A and B could be categorized as early adopters and that Participant C could be categorized as belonging to the majority regarding adoption of technology [22].

Relationships. Participant C stated in the interviews that she did build a relationship with the Nabaztag: she gave it a name, "Harvey"; she found the rabbit enjoyable to use and interacted with it via both verbal and non-verbal behaviour. The relationship was described in the interview as: *"He asked, the questions, I answered them."* Participant C stated in the interviews that she did not see the Nabaztag as a friend. *"[…] He's a man-made presence or even a women-made presence, in my kitchen […]".*

5 Discussion

The findings of this study showed that Participants A and B did not perceive a lot of utilitarian factors and that Participant C did show some hedonic factors when using the social robot and was able to built a relationship with the Nabaztag. It is assumed that there is a relationship between showing hedonic factors by participants when using a social robot and being able to build a relationship with these robots.

Regarding the social factors of usage of social robots (1) All participants discussed the Nabaztag with family and friends; (2) Participant B also tended to show the Nabaztag to family and friends, similar to [23] where Roomba, a vacuuming robot,

was used to show off. This could imply that Participant B was showing off. Participants A and C showed photographs of the Nabaztag to family and friends. All these results implied that all participants did not see the Nabaztag as a simple piece of technology [24]. (3) Participants A and C interacted individually with the Nabaztag the first time. This finding differs from [6], probably due to the fact that the data of the earlier mentioned studies were gathered in a public area instead of the domestic area. Participant B did not interact alone with the Nabaztag the first time. This could be due to the fact that Participant B did not live alone like the other participants. Furthermore, when looking at Personal Interest in Technology. Participants A and B, early adopters, did not perceive utilitarian and hedonic factors when interacting with the Nabaztag. Participant C, belonging to the majority in adoption of technology, did perceive utilitarian and hedonic factors. This could imply that Participants A and B had higher expectations than Participant C regarding the Nabaztag, and that that expectations were not realized for Participant A and B.

Regarding the usage of social robots in general, Participant C seemed to have embedded the Nabaztag into everyday life. This could be due to the physical place where the Nabaztag was situated in the participant's house. Participant C also experimented with the Nabaztag by tricking it. Similar results were found when studying usage of Roomba in domestic environments [25]. Experimentation with new technology can be an indication for the appropriation of technology [26]. Furthermore, when observing the interaction, Participants used verbal and non-verbal communication when interacting with the Nabaztag, e.g. waving to the Nabaztag when leaving the house. This could imply that human-human communication was used when interacting with the Nabaztag, like was argued in [27] [28], namely that social rules guiding human-human interaction can be applied to human-computer interaction.

With respect to building a relationship with social robots, Participant C stated that she was able to build a relationship with the Nabaztag. This could indicate that relationship building with robots is related to acceptance of the robots. The results showed that relationship building seemed to be related to (1) naming the Nabaztag, also shown in [25], (2) perceiving utilitarian- and hedonic factors and (3) using both verbal and non-verbal behaviour when interacting with the Nabaztag. Participant C showed all these behaviors, while Participants A and B did not show any of these behaviors.

6 Conclusion, Limitations and Future Research

The goal of this study was to get more insight in how elderly people use social robots in domestic settings in general and particularly whether elderly people are able to build relationships with these robots. This study yielded interesting insights such as (1) utilitarian-, hedonic-, and social factors seem important reasons for participants to accept social robots in their domestic environments, (2) the physical location where a social robot is situated in a home is of importance for the ease of acceptance and use, (3) utilitarian-, hedonic- and social factors are important for building a relationship with social robots, (4) there seems to be a relationship between name-calling and relationship building with social robots and (5) there seems to be a relationship between the use of non-verbal and verbal communication of participants and relationship building with social robots.

Since this was only the first, explorative study in a series of studies, the conclusions will be further explored in studies which are currently being undertaken. Our main goals in these studies are: (1) to establish whether utilitarian-, hedonic- and social factors are important in accepting social robots, (2) to explore whether utilitarian-, hedonic and social factors are important for building a relationship with social robots, (3) to explore the relationship between name-calling and relationship-building and (4) to explore the relationship between the usage of non-verbal and verbal communication and relationship-building.

A limitation of this study was that the participants did not find the Nabaztag useful, because it did not help participants to improve their overall health due to technological problems and a limited activity plan. These problems should be solved before the next iteration. Another limitation was the small number of participants. But small, qualitative studies are an essential step to provide in-depth insight into this phenomenon. Although there are still many interesting questions unanswered about which factors are important for the acceptance and usage of social robots, this study did provide a rich, first understanding of how people use social robots in domestic environments.

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