



Sharing a life with Harvey: Exploring the acceptance of and relationship-building with a social robot



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ABSTRACT

Social robots will become ubiquitous in our everyday environments. These robots could potentially extend life expectancy, and improve the health and quality of life of an aging population. A long-term explorative study has been conducted by installing a social robot for health promotion in elderly people's own homes. Content analysis of interviews provided an in-depth understanding of the factors that influence the acceptance of and relationship-building with social robots in domestic environments. The permanent presence of a robot in users' own homes yields the vital challenges social robots encounter to be successfully accepted by their users. These vital acceptance challenges are unlikely to be revealed in one-day laboratory human-robot interaction studies or even in multiple observations of short interactions between humans and robots.

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1. Introduction

Social robots are expected to increasingly enter our everyday environments. Social robots are characterized by understanding and communicating in a humanlike way, allowing them to behave as social actors and be understood as such by their users (Breazeal, 2002). Triggered by aging populations in many advanced economies, artificial companions in the form of social robots are gradually becoming part of people's environments. Social robots are hypothesized to aid the elderly to live in their homes autonomously for longer and therefore to decrease the burden on our social and healthcare systems. Helping people to live independently and in good health for longer will enable them to extend their active and positive contributions to society (World Health Organization, 2010). Social robots potentially hold the promise of extending life expectancies and improving health and quality of life for all people as they age by: (1) letting elderly people live autonomously for longer in their own homes; (2) helping elderly people feel less lonely; and (3) helping elderly people to stay fit, thus improving their health (Broadbent, Stafford, & MacDonald, 2009). To profit from these positive outcomes of social robot use, elderly people need to accept these robots into their home

environments. Moreover, it is important to study the user acceptance of these types of robots at an early stage of their development process, so that future social robots can be adapted to the desires and requirements of elderly people. For a successful introduction of social robots, underlying reasons need to be revealed where upon people their perceptions of use these robots.

One way of understanding how people perceive social robots is by studying the reasons why people accept or reject such robots in their natural environments (Young, Hawkins, Sharlin, & Igarashi, 2009), for example in their own homes. Although previous research studying the user acceptance of social robots have used various methods, long-term studies are still scarce as almost all studies are usually no longer than one day (e.g. Bartneck, Reichenbach, & Carpenter, 2008; Bartneck, van der Hoek, Mubin, & Al Mahmud, 2007; Heerink, Kröse, Evers, & Wielinga, 2007; Nomura, Kanda, Suzuki, & Kato, 2008; Wada & Shibata, 2006). As a consequence, not much is yet known about the factors that influence the acceptance and continued use of social robots in everyday life (Oydele, Hong, & Minor, 2007). Yet, people's perceptions of technologies are likely to change over time as they develop experiences with that technologies and their usage skills develop (Fink, Bauwens, Kaplan, & Dillenbourg, 2013; Sung, Christensen, & Grinter, 2009; Venkatesh & Davis, 2000). Thus, longitudinal studies are necessary to investigate how users' perceptions towards robots, their behaviors and their experiences change over time. Although domestic uses in long-term studies are recently starting to receive more attention in robotics research (Leite, Martinho, & Paiva, 2013), still, more insight is necessary to fully understand why and how people are

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willing to continue to use a robot after initial interactions. The goal of this paper is to explore the acceptance of social robots in domestic environments by observing how older adults use and perceive a social robot for health purposes.

2. Theoretical background

2.1. Robots as social actors

The acceptance of social robots is presumed to differ from the acceptance of other technical innovations, because these robots are not always perceived by their users as technologies (Lee, Park, & Song, 2005; Young et al., 2009). It might be that the interaction of social robots is more in line with the principles of human–human communication than with human–machine communication (Heerink et al., 2007; Krämer, von der Pütten, & Eimler, 2012). Just as humans and other living beings differ from each other in terms of internal and external characteristics, social robots also have their autonomous individuality displayed through their design and behavioral configuration (Libin & Libin, 2003). With a minimum of social cues, technological objects can be evaluated as social entities; a theory known as the media equation (Reeves & Nass, 1996), which has also been successfully applied to the field of robotics (Kahn et al., 2007; Lee et al., 2005). Although a study on behavioral analysis suggests that the robotic dog AIBO is a poor substitute for a living dog, nonetheless, all children and adults from that study did engage with the robotic dog as if it were a social partner to some extent (Kerepesi, Kubinyi, Jonsson, Magnusson, & Miklosi, 2006). Another study on the evaluation online forum posts (Melson, Kahn, Beck, & Friedman, 2009) shows that both children and adults recognize AIBO as a product or technology. However, they still grant the robotic dog with many attributes of a living dog, by regarding it as having a mental life and treating it as a social companion. More recently, a study revealed that people show increased physiological arousal, report more negative and less positive emotions and expressed empathic concern when watching a video in which the baby dinosaur robot Pleo is being tortured (Rosenthal-von der Pütten, Krämer, Hoffmann, Sobieraj, & Eimler, 2013). However, these social effects might decrease when the novelty effect wears off. Fernaeus, Håkansson, Jacobsson, and Ljungblad (2010) reported on a study evaluating the robotic baby dinosaur Pleo with six families over two to six months (each family was allowed to stop using the robot at their own terms). Initially the families regarded the robot as a real pet (e.g., petting it, giving it a name and displaying emotions towards it), but the disappointing interaction capabilities of the robot resulted in it being treated as a regular pet. Still, when investigating the user acceptance of social robots in the home, it is important to consider the effect of these possible social reaction towards the technology and how this might affect the process of long-term acceptance.

For the acceptance of social robots, the above described differences in the user's perception of social robots need to be taken into account and the dual perception by their users need to be acknowledged. On the one hand, social robots can be perceived as utilitarian systems; they are able to perform tasks such as housekeeping. On the other hand, social robots are recognized as hedonic systems; they offer sociable interaction opportunities to be able to build long-term relationships with their users (Kidd, Taggart, & Turkle, 2006; Reeves & Nass, 1996; Shibata, Wada, Ikeda, & Sabanovic, 2008). Previous research thus indicates that in addition to the utilitarian factors of usefulness and ease of use (Davis, Bagozzi, & Warshaw, 1992), the hedonic factors of enjoyment (Heerink, Kröse, Evers, & Wielinga, 2010) and anthropomorphism (Bartneck, van der Hoek, et al., 2007; Ben Allouch, Klamer, & de

Graaf, 2011; de Graaf & Ben Allouch, 2013; Friedman, Kahn, & Hagman, 2003; Klamer, Ben Allouch, & Heylen, 2010) also seem to play a role in the user evaluations and acceptance of social robots. People who perceive higher levels of anthropomorphism tend to be more positive in the general evaluation of a social robot, perceive higher enjoyment when engaging with it and are more likely to see the robot as a companion (Lee, Jung, Kim, & Kim, 2006). People, who enjoy the use of a robot, also think that robot is more easy to use (Heerink et al., 2010). This effect becomes stronger when users gain more direct experience with a technological system (Venkatesh, 2000), indicating that previous experiences mediate and strengthen the effect of enjoyment on ease of use. Elderly people tend to accept social robots more readily because they enjoy the interactions more than younger people (Heerink et al., 2010). Thus, our study will incorporate both the utilitarian and hedonic usage aspects of social robots into account.

In addition to the general usage factors, the social reactions social robots evoke from their users, we will also investigate the possible relationships people might build with these robotic systems. As computer technology interacts with us through increasingly complex and humanlike interfaces, the psychological aspects of our relationships with them comprise an ever more important role (Bickmore, 2005). Moreover, it is expected that the media equation effect (Reeves & Nass, 1996) may even magnify with embodied agents that interact socially using natural language and non-verbal behaviors. Indeed, many studies show the existence of relationships between humans and social robots (Fujita, 2004; Kanda, Sata, Saiwaki, & Ishiguro, 2007; Kidd et al., 2006; Robins, Dautenhahn, Boekhorst, & Billard, 2004; Turkle, 2011), whether this occurs consciously or subconsciously. Users who feel involved when interacting with a social robot tend to conceptualize it in terms of agency, social standing and life-like attributes (Friedman et al., 2003). People seem to respond to robots in one of two ways: either humans love and nurture social robots and build relationships with them, or humans see social robots as artificial, as machines. In the studies of Turkle (2011), an elderly man interacted with 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. Using imagination and empathy, people are able to anthropomorphize the objects in the world. This reasoning makes it plausible for people to develop a relationship with a social robot even when its cognitive, behavioral and interactive capabilities are simpler than those of other living creatures. When users perceive social robots as companions and build a relationship with them, they are more likely to continue interacting with these robots. However, not establishing a relationship with these robots results in discontinuing the use of social robots (Kanda et al., 2007). The ability to build a relationship with a robot will thus have an effect on the long-term process of user acceptance and will therefore be included in this study as a factor of technology acceptance.

Together, the utilitarian and hedonic usage aspects provide a more holistic view on the user acceptance of social robots in domestic environments. However, these aspects originate from static models of technology adoption, such as the technology acceptance model (Davis, 1989), and do not include the social context of technology use which becomes more important when technology is used for a longer period of time. In the next section, we will introduce the social context of the home in which the technology use and long-term acceptance process of the robot will be investigated.

2.2. Domestic use of robots

An alternative view on user acceptance to the commonly used adoption models in the technology acceptance literature is pro-

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