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Persuasive robotic assistant for health self-management of older adults: Design and evaluation of social behaviors

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Abstract

Daily health self-management, such as the harmonization of food, exercise and medication, is a major problem for a large group of older adults with obesity or diabetics. Computer-based personal assistance can help to behave healthy by persuading and guiding older adults. For effective persuasion, the assistant should express social behaviors (e.g., turn taking, emotional expressions) to be trustworthy and show empathy. From the motivational interviewing method and synthetic assistants' literature, we derived a set of social behaviors, and implemented a subset in a physical character, a virtual character and a text interface. The first behavior type concerns conversing with high-level dialogue (semantics, intentions), which could be implemented in all 3 assistants. The other behavior types could only be implemented in the characters: showing natural cues (e.g., gaze, posture), expressing emotions (e.g., compassionate face), and accommodating social conversations (e.g., turn taking). In an experiment, 24 older adults (45–65) interacted with the text interface and one of the characters, conform a ''one-week diabetics scenario''. They experienced the virtual and physical character as more empathic and trustworthy than the text-based assistant, and expressed more conversational behavior with the characters. However, it seems that the preference of interacting with the character or the text interface was influenced by the conscientiousness of the participant; more conscientious people liked the text interface better. Older adults responded more negative to the characters that lacked the social behaviors than to the text interface. Some differences between the virtual and physical character probably occurred due to the specific constraints of the physical character.

Keywords: Persuasive computing; Human–robot interaction; Health-care

1. Introduction

In the year 2000, one in ten individuals in the world was 60 years or older and one in fourteen was at least 65. It is expected that these numbers will increase to one in every five persons being 60 or older and nearly one in six people 65 or older in 2050 (United Nations, 2002). On top of that, the prevalence of chronic diseases is rising amongst older people because of urbanization and an unhealthy life-style (Wild et al., 2004) (e.g., diabetes, COPD, obesities). A major problem is that only 50% of the chronically ill adheres to their treatment advice (WHO, 2003). For older adults, this problem is particularly hard because of their health illiteracy and deep-rooted daily routines—or lifestyles.

Information and Communication Technology (ICT) might provide the required support to better cope with the personal health constraints, such as doing exercises (Kidd and Breazeal, 2006; Ruttkay et al., 2006; Bickmore et al., 2004; Goetz et al., 2003; Gockley and Mataric, 2006), giving social support (Kidd et al., 2006; Kriglstein and Wallner, 2005), and helping with lifestyle change (Bigelow et al., 2000; Looije et al., 2006). Research on persuasive technology (Fogg, 2002) and affective computing (Picard, 1997) is providing technological (partial) solutions for the development of this type of assistance, e.g., for the

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realization of social behavior, such as social talk and turn taking (Bickmore et al., 2004; Kidd et al., 2006; Goetz et al., 2003; Gockley and Mataric, 2006), and of empathic behavior, such as attentiveness and compliments (Kidd et al., 2006; Bigelow et al., 2000; Looije et al., 2006; Kriglstein and Wallner, 2005). In our view, psychological techniques for behavioral change, such as motivational interviewing, should be accommodated by this type of ICT support (e.g., Rogers, 1951; Looije et al., 2006; Miller and Rollnick, 1991). However, a concise and coherent set of behaviors – worked-out in specific user-interface behaviors – for such an accommodation is lacking. Derived from relevant literature of psychology, persuasive technology and affective computing, this paper presents a first set of behaviors (e.g., compassion) that map support objectives (motivating, educating, and supporting) on specific – *social* – user-interface behaviors for the intended ICT support. In an experiment, we tested how far these social behaviors help to make the interface more empathetic and trustworthy, which are preconditions for long-term use.

It should be noted that older adults experience specific hindrances to actually make use of ICT support, due to relatively limited computer skills (partly due to limited sensory, physical and cognitive abilities), and motivation to use a standard Windows, Icons, Menu and Pointing (WIMP) device (Czaja and Lee, 2007). An important question is how to realize user interfaces with which older adults feel at ease and which are pleasant in use (Czaja and Lee, 2007). Different user-interface types for older adults' health assistance have been developed, such as text or WIMP-based questionnaires and feedback providers (Blanson-Henkemans et al., 2007; Bigelow et al., 2000), and character educators and buddies (Looije et al., 2006; Kidd et al., 2006; Goetz et al., 2003; Gockley and Mataric, 2006; Kriglstein and Wallner, 2005). A speech interface may be more natural to use than a text interface for people who are not experienced with computer technology (Neerincx et al., 2008). A user interface with a character-like appearance (e.g., animal) could further improve the feeling of comfort of older adults with technology (Kidd et al., 2006; Kriglstein and Wallner, 2005). Social behavior increases when a character-like appearance is used (Kidd et al., 2006; Kriglstein and Wallner, 2005) and as a result the resistance towards the interface might decrease. However, empirical research on possible benefits of these types of user interfaces on older adults' appreciation and conversational behavior is lacking.

This paper presents an experiment, comparing a text-based interface with a – virtual and physical – character providing health assistance for older adults. For this comparison, we used the currently most common dialogue: written input and output (keyboard and window) for the text (WIMP) interface, and spoken input and output for the character. Overall, the expectation was that social behaviors improve users' appreciation and enriches their interaction behavior; i.e., more talking, looking, laughing will occur. Furthermore, it is expected that such user-interface behaviors can be best incorporated in characters in comparison with virtual characters and text interfaces. However, we assume that characters which do not show the required social behavior evoke relatively large negative responses of the users. Finally, we expect that the personality of the user influences his/her preference for a specific interface.

2. Research approach

Within the SuperAssist project, in which this experiment was performed, we apply a user-centered design approach, in which support concepts are being developed, tested and implemented incrementally (Neerincx and Lindenberg, 2008; Blanson-Henkemans et al., 2007). Within the SuperAssist project diabetes is taken as a case study for the development of personal assistants for older adults. The support content about diabetes is based on a thorough domain and task analysis with involvement of patients (e.g., interviews), medical experts (e.g., with respect to diet and lifestyle advice for people with obesity), and computer support experts (e.g., current e-health solutions); see Blanson Henkemans et al. (2009). Scenarios are derived from this analysis, getting the use context clear, and enabling assessments of the expected support effects and corresponding behaviors (Blanson-Henkemans et al., 2008; Rosson and Carroll, 2001). In the practice of medical research, the well-being of patients should remain central, and empirical foundation of computer support – such as a persuasive assistant – should burden this user group as little as possible (Coyle et al., 2007). To reduce this burden, general support characteristics can first be tested with healthy persons. The general characteristics of these persons that may affect support preferences, such as age, should be similar to the target group as far as possible. Scenarios help to address the effects of context-of-use in the evaluation. Furthermore, scenarios can help healthy participants empathize with the use of health assistants in complex and tedious patient situations during the evaluation. The evaluation may show positive and negative outcomes on core support characteristics, and recommendations for improvement. When the outcomes are mainly positive, the tests with patients should be started. This paper presents an experiment with healthy adults in the age group with a relatively high risk to acquire diabetes type II (i.e., age between 45 and 65). The experiment shows whether this user group in general appreciates the social behavior of virtual or physical characters, and responses well to the persuasion skills that are relevant for chronic diseases like diabetics. If the assistance works well on these aspects, we will test the support with older adults with diabetics in a subsequent experiment.

3. Social computer skills for persuasion

We aim at computer-based personal assistance that persuades and guides older adults to behave healthily.