Robots for the psychological wellbeing of the elderly

Jorge Gallego-Perez
University of Twente
Enschede, AE 7500
the Netherlands
+31 53 489 3194
j.gallegoperez@utwente.nl

Manja Lohse
University of Twente
Enschede, AE 7500
the Netherlands
+31 53 489 2954
m.lohse@utwente.nl

Vanessa Evers
University of Twente
Enschede, AE 7500
the Netherlands
+31 53 489 3686
v.evers@utwente.nl

ABSTRACT

The present paper examines the potential robots may have to motivate and support elderly people psychologically. Two short- and long-term research scenarios are proposed where a robot interacts with an elderly person offering psychological support. We describe one experiment that was carried out probing the short-term scenario. Another study currently under development is also presented, which is based on the long-term scenario. The two scenarios have advantages and disadvantages and appear as complementary to each other.

Categories and Subject Descriptors

H.m [**Information systems**]: Miscellaneous

General Terms

Experimentation

Keywords

Interaction scenarios of socially assistive robots for older adults; requirements and constraints of socially assistive robots for older adults.

1. INTRODUCTION AND BACKGROUND

Older people might experience a greater need of psychological attention than people of other age groups. According to Steffens et al. [1], depression is one common cause of disability in elderly people. It has been shown to reduce life satisfaction, lead to loneliness, increase the use of medical services, reduce cognitive capacity, etc.

Despite the tendency in studies to consider robot roles that involve physical tasks, other studies have focused on various types of psychological influence that robots could potentially exert on humans. The most prominent example is the use of robots and virtual agents as coaches, typically as motivators to lose weight or do more exercise. For example, Kidd and Breazeal investigated the effects of a robot that had the role of a weight loss coach. Its effectiveness was measured and compared to the effects of using a computer or a paper log. The results showed that even though only minimal differences were found in weight loss across the three conditions, the participants used the robot for a longer time and reported a closer alliance with it [2].

Many studies have specifically focussed on robots to motivate older persons or alleviate their depressive symptoms. In a study by Fasola and Matarić [3], a socially assistive robot played with elderly people through a series of interactive activities. Their results indicated strong user preferences when the robot implemented behaviors that are known to improve one´s intrinsic motivation, such as praising the user upon completion of an exercise.

An example of robots to improve elderly people's mood is Paro, the seal robot. In studies, Paro is typically brought to nursing homes where older people hold the robot and interact with it. Some of the reported positive effects of interacting with Paro are general improvement in feelings and reduction in depression [4].

After this brief overview, two short- and long-term scenarios will be presented with their advantages and disadvantages, where a social robot would offer psychological support to elderly participants. Finally, two studies that correspond to the proposed scenarios will be described and followed by a conclusion.

2. TWO POSSIBLE SCENARIOS

Among the various ways to facilitate psychological support through a robot, a distinction arises in the timing or scheduling of the interaction with the robot. Studies, as well as interventions, can be *short-term* or *long-term* depending on whether they take place in only one session or over a prolonged period of time, respectively. In this section we describe the challenges that we expect robotic psychological support may bring with a short-term and a long-term scenario. These scenarios are useful to illustrate methodological caveats that might arise. Also, novel methods are proposed that might contribute to future experiments. The applicability of relevant indicators of psychological wellbeing is discussed for each scenario. These psychological indicators are *motivation*, *mood and affection*, and *self-efficacy and coping* [5].

2.1 Short-Term Scenario

A robot in a lab interacts in single sessions with elderly participants with the aim to improve their psychological wellbeing. The first question that might arise is: what joint activity is relevant to study improvement in wellbeing influenced by a robot? And secondly: in what way can increased psychological wellbeing be measured in short-term interactions?

When we think of motivation as techniques to influence the users´ long-term behaviours, as in the context of rehabilitation, e.g. [6], or weight-loss programs, e.g. [2], these motivational techniques appear as less applicable for this scenario due to their *progressive* nature. These motivational (persuasive) strategies are usually part of long-term programs.

Regarding affective states, it seems reasonable to expect that short-term affective states can be assessed in just one therapeutic session. Curing depression or assuring long-lasting happiness in a one-session intervention appears beyond possibility. We therefore assume that the more transient affective and motivational states, like mood and intrinsic motivation, are more easily influenced in a short-term setting.

Self-efficacy and coping are addressed mostly in long-term interventions by psychotherapists, commonly lasting several weeks or months, e.g. [7], [8]. Thus, it may appear unpractical to include self-efficacy techniques in this scenario. We wonder, however, whether some self-efficacy techniques may have a small but significant effect after just one session. For example, in a setting where an aged person performs a physical exercise with a robot and he/she is convinced of having performed well, would the exercise self-efficacy of the participant increase? If yes, how lasting would this effect be?

Robots seem able to influence certain aspects of the wellbeing of elderly people. However, there are a few caveats that we should bear in mind. Firstly, one-session scenarios make it difficult to separate the effect of the intervention from the effect of *novelty*. For instance, if a robot employs strategies to improve the affective state of participants and this indeed improves, how can we know if the cause is the treatment or the enthusiasm of the users because of participating? Even though Kidd and Breazeal propose to briefly expose participants to the robot before the experiment so as to reduce the novelty effect [9], we should remain cautious as previous research has shown that the novelty effect might last as long as several weeks [10].

Another caveat has to do with the way robot-coaching or psychological treatment is administered. When a participant knows he/she is being subjected to psychological interventions, this may trigger *hopes* regarding success, which potentiate the effects of interventions [11]. Thus, hopes may add even more uncertainty about the sources that influence our measures. A possible approach to avoid these effects (which might be desired or undesired by the experimenter, depending on the goals of the experiment) would be to embed the motivational or coaching strategies into seemingly unrelated activities with the robot, so as to avoid the awareness in the participant that a treatment is taking place (see Section 3.1).

To summarize, most psychological wellbeing aspects would be difficult to influence in this scenario, with the exception of intrinsic motivation and mood.

2.1 Long-Term Scenario

In the long-term scenario envisioned here, the elderly participant of the experiment has a socially interactive robot at home, with which he/she interacts on a daily basis. As in the short-term scenario, the aim of the robot is to improve the user's psychological wellbeing.

One question we should consider in both scenarios is to what extent, and how, we can translate motivating and psychotherapeutic techniques to human-robot interaction. Psychological techniques that work in human-to-human interaction might not work when administered by a robot because of a lack of humanness, trust, social desirability or social presence. In theory however, it seems possible that any of the psychological constructs described above could be addressed in this scenario. For example, promising results have been obtained in studies with robots that motivate participants in rehabilitation contexts, e.g. [6], and also the seal robot Paro was found to reduce depressive symptoms for elderly participants, e.g. [4].

The long-term study involves multiple interactions and the possibility to study changes in responses and attitudes which eliminates many of the concerns of the short-term scenario. Treatments might extend in time as long as considered necessary.

Also, there would be no effects due to the artificiality of a lab setting and the novelty effect by having a robot at home for a long period of time. Ideally, the amount of visits from experimenters should be kept to a minimum to ensure that the effects on psychological measures are independent from this social contact.

Another challenge can be derived from studies with health-promoting technology, which show that adherence of participants is usually high at the beginning of the intervention programs but declines rapidly, e.g. [12]. Some solutions proposed are customization and avoiding low levels of self-efficacy regarding the tasks for which the program is designed [12].

A very relevant aspect to consider in both scenarios regards the population group, namely elderly people. Interactions with the robot should be tailored to meet the specific particularities of aged persons. For example, regarding memory loss, Heerink et al. found in a pilot experiment that some elderly participants forgot what the experiment was about during its execution [13].

3. SHORT- AND LONG-TERM STUDIES

In this section two studies are discussed where robots facilitate exercises to improve one's psychological wellbeing. The first study was carried out in a lab and would correspond to the short-term scenario proposed above. We then describe the setting of a study in preparation, which will take place in the home of an elderly person and would correspond to the long-term scenario.

3.1 Short-Term Study

We conducted a study with a Giraff robot [14] that would aim to improve the current affective state or mood of the participants. This experiment presented two experimental conditions. In one condition a positive psychology exercise was facilitated directly (the robot was presented as a coach with the intention to perform a psychological exercise), whereas in the other condition this exercise was implemented indirectly (the robot was presented as a conversation partner having a chat with the participant). The experiment was carried out individually and in a lab. After the introduction by the experimenter and filling in various questionnaires, the participant would interact alone with the robot, remaining seated, with the robot static and in front of the participant. In both role conditions, the interaction with the robot consisted in having a conversation which served as basis for the psychological exercise. This intervention from positive psychology was based on the so-called "three good things in life" exercise, whereby the participant writes down three things that went well on that day and their causes [15]. After the interaction with the robot, participants completed more questionnaires and were interviewed. Two days after the experiment, participants received a survey questionnaire by email to report on longer-term effects. We employed questionnaires and performed interviews and surveys because we believe that combining quantitative and qualitative measures makes the results more robust.

We analysed the data of 37 participants. Two subgroups were considered as part of the sample: non-elderly and elderly participants. The non-elderly subgroup was composed of 29 participants, with ages ranging from 20 to 55 (M = 30.48, SD = 7.49; 11 male, 18 female). 11 of the non-elderly participants were students of Bachelor or Master's degrees and 10 were researchers at PhD or Post-Doctoral level. The remaining had professions related to the university. The elderly group was composed of 8 individuals, 5 male and 3 female. Their ages ranged between 62

and 83 (M = 70.38, SD = 7.84). 3 elderly participants were retired and the remaining 5 worked at the university, in education or related.

The results of our analysis of the Positive Affect Scale, which is part of the Positive and Negative Affect Scale (PANAS) developed by Watson and colleagues [16], showed that the mood of the participants actually improved only after the direct treatment (m_{direct_post} = 31.15, sd_{direct_post} = 4.58; in a possible range of 10 to 50 resulting from 10 items on a 5-point

scale) compared to the same measure taken before the interaction (m_{direct_pre} = 28.95, sd_{direct_pre} = 4.78); $T(20)$ = 1.971, p = .032, one-tailed. In fact, the mood even seemed to have decreased after the indirect treatment ($m_{indirect\_post}$ = 26.41, $sd_{indirect\_post}$ = 6.51) compared to before the interaction ($m_{indirect\_pre}$ = 29.00, $sd_{indirect\_pre}$ = 4.89); $T(17)$ = 2.053, p = .057, two-tailed (see Figure 1).

One week after the trials, all participants rated their mood the same as before the experiment ($m_{indirect\_followup}$ = 28.71, $sd_{indirect\_followup}$ = 6.75; $m_{direct\_followup}$ = 28.31, $sd_{direct\_followup}$ = 5.84; see Figure 1).

In the interviews the participants tended to focus more on aspects about the interaction, such as talking with the robot, rather than their mood or the robot itself. The elderly participants reported communication problems with the robot (due to their lower understanding of English language and lower ability to understand a robotic voice). Also, elderly participants felt less confident during the experiment than younger participants, perhaps because it involved the use of new technologies.

This experiment presented the drawback of novelty discussed above: how can we separate the effect of the positive exercise from the effect caused by the first exposure to the robot, place and experimenter? The only certainty we can have is that the two conditions yielded different results.

3.2 Long-Term Study

A long-term study is under preparation which will evaluate the responses of an elderly participant to a robot in his home. The robot will offer psychological support by doing Heart Rate Variability (HRV) exercises to reduce stress and depression.
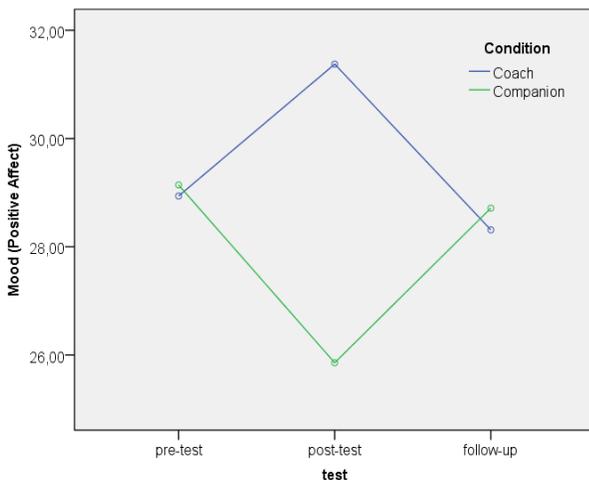
Heart rate variability (HRV) is the physiological phenomenon of variation in the time interval between heartbeats. Low HRV is associated, among others, with cardiovascular disease and high physiological arousal, as well as with negative psychological burdens such as duration of worrying [17]. It is possible to train HRV through biofeedback techniques, which have proven to reduce stress and depression levels [18].

For this study we adapted a Magabot robot [19] so that it would have bigger dimensions and present an arm. The robot can drive autonomously on three wheels and possesses various types of sensors for navigation, such as sonar sensors (see Figure 2).

The study will be "in the wild" (at someone's home), including one elderly participant. He will carry out the HRV exercise every day, following a schedule. When it is time for the exercise, the robot will localize the participant and bring him the sensor set so that the exercise can begin. The robot will also proactively try to *persuade* the participant to carry out the HRV exercise, for example by bringing the HRV exercise material to the participant.

We aim to learn about the evolution of the attitudes and responses toward a home assistive robot over a long-period of time. Also, we wonder how a participant's daily routines are altered when an assistive robot stays in his/her home. Finally, we also want to know whether a home assistive robot can be effective at providing psychological support.

The data collection will be of the ethnographic type, performed through interviews and diary keeping. One of our goals is to create explanatory theory on how the attitudes and responses toward a robot evolve over a prolonged period of time, for which the ethnographic data collection and grounded theory analysis will be employed. Additionally, quantitative measures will be taken of the acceptance toward the robot and effectiveness of the exercise.

In this long-term study we hope to reduce some of the disadvantages of short-term experiments. For instance, since the interaction between experimenter and participant will be kept to a minimum, we expect this to have a negligible effect on the

Figure 1: level of mood of participants at pre-test, post-test and follow-up, depending on condition.

Figure 2: adaptation of the Magabot robot.

participant. Also, we expect the novelty effect to be lower compared to short-term settings. Finally, having a robot at home greatly reduces the effects caused by the artificiality of lab settings.

4. DISCUSSION

This paper proposes two short-term and long-term scenarios, respectively, where a robot offers psychological support to elderly participants. Both types of scenarios pose advantages as well as disadvantages and could be considered as complementary. Whereas a short-term scenario can facilitate more experimental control (e.g. lab setting and easier to recruit more participants) it also presents a great artificiality, which would not allow the results to be easily generalized to contexts such as home or elderly residences. Thus, our short-term scenario would be characterized by high internal and external validity, with a very low ecological validity. On the other hand, a long-term scenario that involves relatively sophisticated robots would imply the participation of very few individuals. Also, we cannot control everything that happens in the homes of the elderly participants. Therefore, long-term scenarios would be characterized by high ecological validity, but low internal and external validity.

All in all, current robot technology lies far from achieving the performance of human psychotherapists and coaches. Elderly people could greatly benefit from the use of these robots, since they often suffer from loneliness and low mood. Future work will hopefully develop more advanced robots that will be able to provide more effective psychological support to elderly people.

5. ACKNOWLEDMENTS

6. REFERENCES

[1] D. C. Steffens, I. Skoog, M. C. Norton, A. D. Hart, J. T. Tschanz, B. L. Plassman, B. W. Wyse, K. A. Welsh-Bohmer, and J. C. S. Breitner, "Prevalence of Depression and Its Treatment in an Elderly Population," *Arch. Gen. Psychiatry*, vol. 57, no. June 2000, pp. 14–18, 2012.

[2] C. D. Kidd and C. Breazeal, "Robots at home: Understanding long-term human-robot interaction," in *2008 IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2008, pp. 3230–3235.

[3] J. Fasola and M. J. Matarić, "Using Socially Assistive Human-Robot Interaction to Motivate Physical Exercise for Older Adults," in *Proceedings of the IEEE, Special Issue on Quality of Life Technology*, 2012.

[4] K. Wada, T. Shibata, T. Saito, K. Sakamoto, and K. Tanie, "Psychological and Social Effects of One Year Robot Assisted Activity on Elderly People at a Health Service Facility for the Aged," in *Science And Technology*, 2005, no. April, pp. 2785–2790.

[5] J. Gallego-Perez, M. Lohse, and V. Evers, "Robots to Motivate Elderly People : Present and Future Challenges," in *RO-MAN, 2013 IEEE*, 2013.

[6] R. Colombo, F. Pisano, A. Mazzone, C. Delconte, S. Micera, M. C. Carrozza, P. Dario, and G. Minuco, "Design strategies to improve patient motivation during robot-aided rehabilitation.," *J. Neuroeng. Rehabil.*, vol. 4, p. 3, Jan. 2007.

[7] M. J. Allison and C. Keller, "Self-efficacy intervention effect on physical activity in older adults.," *West. J. Nurs. Res.*, vol. 26, no. 1, pp. 31–46; discussion 47–58, Feb. 2004.

[8] C. Bode, D. T. D. de Ridder, and J. M. Bensing, "Preparing for aging: development, feasibility and preliminary results of an educational program for midlife and older based on proactive coping theory.," *Patient Educ. Couns.*, vol. 61, no. 2, pp. 272–8, May 2006.

[9] C. D. Kidd and C. Breazeal, "Human-Robot Interaction Experiments : Lessons learned," in *Proceeding of AISB'05 Symposium Robot Companions: Hard Problems and Open Challenges in Robot-Human Interaction*, 2005, pp. 141–142.

[10] R. Gockley, A. Bruce, J. Forlizzi, M. Michalowski, A. Mundell, S. Rosenthal, B. Sellner, R. Simmons, K. Snipes, A. C. Schultz, and J. Wang, "Designing Robots for Long-Term Social Interaction," in *2005 IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2005, pp. 2199–2204.

[11] D. J. Larsen and R. Stege, "Hope-focused practices during early psychotherapy sessions: Part I: Implicit approaches.," *J. Psychother. Integr.*, vol. 20, no. 3, pp. 271–292, 2010.

[12] R. Achterkamp, "Promoting a healthy life style : how to improve long term adherence," in *DIS 2012 Workshop Designing Wellbeing*, 2012, pp. 1–2.

[13] M. Heerink, B. Kröse, B. Wielinga, and V. Evers, "Human-Robot User Studies in Eldercare : Lessons Learned," in *4th International Conference on Smart Homes and Beyond: ICOST*, 2006, pp. 31–38.

[14] "Giraff." [Online]. Available: http://www.giraff.org/?lang=en. [Accessed: 13-Jan-2014].

[15] M. E. P. Seligman, T. A. Steen, N. Park, and C. Peterson, "Positive Psychology Progress: Empirical Validation of Interventions," *Am. Psychol.*, vol. 60, no. 5, pp. 410–421, 2005.

[16] D. Watson, L. a Clark, and a Tellegen, "Development and validation of brief measures of positive and negative affect: the PANAS scales.," *J. Pers. Soc. Psychol.*, vol. 54, no. 6, pp. 1063–70, Jun. 1988.

[17] F. C. M. Geisler, N. Vennewald, T. Kubiak, and H. Weber, "The impact of heart rate variability on subjective well-being is mediated by emotion regulation," *Pers. Individ. Dif.*, vol. 49, no. 7, pp. 723–728, Nov. 2010.

[18] P. M. Lehrer, "Biofeedback Training to Increase Heart Rate Variability," in *Principles and practice of stress management*, vol. 23, no. 2, P. M. Lehrer, R. L. Woolfolk, and W. E. Sime, Eds. New York, NY: The Guilford Press, 2007, pp. 227–248.

[19] "Magabot." [Online]. Available: http://magabot.cc/. [Accessed: 14-Jan-2014].