

# Robots to Motivate Elderly People: Present and Future Challenges\*

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**Abstract**—In this paper we argue for the development of new methodological approaches to create and evaluate robots for elderly-care, which offer support for the psychological determinants of the quality of life of elderly people. Relevant determinants, such as mood, self-efficacy and happiness are discussed in this paper in relation to older people. We offer an overview of previous work on robots offering psychological support and analyse the various methodological challenges in studying the effects of motivational and psycho-therapeutic robots on elderly people’s psychological well-being.

## I. INTRODUCTION

Much of the current research regarding elderly people centres around their Activities of Daily Living (ADLs) and the factors that impact independent living [1]. An increasing number of elderly people need help on a regular basis. In the U.S., 20% of non-institutionalized elderly aged 70 or older need help in performing at least one ADL [2]. Common unmet needs elderly people have for physical assistance are related to eyesight/hearing, mobility, self-care activities and incontinence ([3],[4]). Other needs concern cognitive support to deal with memory loss, early phase dementia and cognitive decline [5]. However, emotional and social difficulties, such as isolation, low self-esteem, lack of emotional support and psychological distress also burden the lives of older people ([3],[4],[6],[7]).

This paper advocates the importance of psychological support in the lives of elderly people as determinant of their wellbeing. The following section discusses psychological constructs that are relevant for the wellbeing of older people. Thereafter, an overview is provided of previous studies where robots were used to offer emotional and psychological support. We then offer two scenarios where robotic psychological assistance is envisioned and use these to discuss the methodological challenges for human-robot interaction research in this setting.

## II. PSYCHOLOGICAL CONSTRUCTS INFLUENCING ELDERLY PEOPLE’S WELLBEING

### *Motivation*

Although finding consensus on a definition of motivation remains a challenge [8], we will focus on motivation as an internal state or as a way to increase the occurrence of certain behaviours (persuasion).

*Self-determination theory* offers a framework to understand the types of motivations behind people’s

behaviours. Self-determination refers to “true choice” when carrying out an action and can be represented on a continuum of motivations. The two main types of motivations are *intrinsic motivation* and *extrinsic motivation*. Intrinsic motivation refers to performing an action for itself, in order to obtain satisfaction or pleasure from it, whereas extrinsic motivation is present in actions where the goals are beyond the realization of the action itself [9]. Understanding these two types of motivation is relevant as they influence behaviour in different ways. For instance, Ryan et al. [10]. showed that the adherence of participants to exercise programs is higher when they are intrinsically motivated.

Many studies focus on motivational strategies to increase people’s compliance to exercise programs, e.g. [10–12]. Phillips et al. [11] offer an overview of strategies to increase the chances of success for exercise programs. Some of these methods are: educating; goal-orienting; gradually progressing; addressing costs (such as effort); addressing safety; adapting activities and equipment; treating concurrent disabilities; facilitating empowerment; focusing on accessibility and affordability; promoting socialization; and providing physical and occupational therapy.

In the healthcare domain, Friedrich et al. [12] employed several motivational strategies (interventions) in an exercise program for chronic low back pain patients. The program started by making the instructions clear and emphasizing the importance of the treatment as well as the patients dependence on themselves for the success of the program. Reinforcement techniques were applied, such as receiving positive feedback after the patients succeeded. Also, a “treatment contract” was made whereby the patients committed themselves to comply with exercise schedules, as well as with rewards and punishments. These treatment contracts would remain in their homes where they would see them often, so as to be constantly reminded. Finally, all the activities would be reported in an exercise diary.

Therefore, we can classify elderly people’s motivations as intrinsic or extrinsic, and also different motivational strategies are available that will influence their behaviour.

### *Mood and Depression*

Mood and depression are two related concepts commonly discussed in psychology. Mood could be defined as “a general, reactive and acute feeling state” [13] whereas depression refers to the persistent and pervasive low mood together with loss of pleasure in usual activities [14]. Regarding elderly people, controversy remains as to whether they are more prone to depression and negative moods with age or not. This may be due to the fact that most studies have been small and in clinical settings [15]. Also, results

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vary depending on how the problem is defined and what criteria are used to assess depression [16]. Some studies show that mood and anxiety disorders tend to decline with age, although the prevalence of these disorders remains high, especially in women [15]. However, when we consider depressive symptoms that do not meet all the criteria to diagnose a depression, older people appear to show a higher prevalence [17]. In addition, the rate of suicide in elderly people is the highest compared to other age sectors [17].

In either case, depression seems to have a high prevalence among elderly people. About 3% have severe depression and 10 to 15% suffer from mild to moderate depression [18], [19]. According to Steffens et al. [20], 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. As Arent et al. indicate in a meta-analysis [21], it seems that people older than 60 tend to show more mood disturbance (more negative affect and less positive affect). In particular, aged people that live in nursing homes appear more likely to be depressed than community-dwelling elderly [22]. Thus, treatments to improve mood and decrease depression in elderly seem to be of very high relevance.

#### *Self-Efficacy and Coping*

Psychology offers a wide range of concepts that relate to attitudes and abilities to confront situations in life. Rotter [23] defines *locus of control* as “the degree to which individuals view themselves as controlling their own environment”. Similarly, Bandura [24] defines *self-efficacy* as the “degree of confidence persons have in their ability to successfully perform specific behaviours”. Another related concept, *coping*, is defined by Folkman and Lazarus [25] as “cognitive and behavioural efforts to manage specific demands that are appraised as taxing or exceeding the resources of the person”.

Greenglass et al. [26] measured proactive coping in a study with community-residing older people and found that coping was significantly associated with lower levels of disability. They also found an association between proactive coping and lower depression. Similar conclusions were reached in longitudinal studies by Mendes de Leon et al. [24] and Rejeski et al. [27], where they found that high self-efficacy becomes especially protective when aged people’s physical condition is challenged.

Some studies indicate that it is possible to intervene and motivate elderly persons to take control and to enable self-efficacy. Langer and Rodin carried out a field study in a nursing home [28]. The residents from the experimental group received communication that emphasized the responsibility they had for themselves, their freedom to make choices, and their active role in caring for a plant. The residents from the comparison group were told that the nursing staff would take care of them and the plant. After only three weeks, 71% of the residents from the comparison group were rated as having become weaker, whereas 93% of the people from the experimental group showed overall

improvement. Furthermore, the residents from the experimental group that took more responsibility became happier, more active and more mentally alert [28]. In a previous study [29] results from interviews suggest that feelings of self-efficacy are important indicators of well-being for elderly and we feel that increased self-efficacy needs to be one of the core goals of assistive technology.

#### *Wellbeing and Happiness, the Field of Positive Psychology*

In an attempt to broaden the focus of psychology, Seligman and Csikszentmihalyi have coined the field known as *positive psychology* to refer to studies that tackle valued subjective experiences (e.g. contentment, hope and optimism), positive individual traits (e.g. perseverance and originality) and civic and institutional virtues (e.g. responsibility and altruism) [30]. Within this framework, exercises have been proposed and empirically tested that can foster psychological wellbeing and combat depression. For instance, Seligman et al. carried out an Internet study where participants could perform five different exercises for a period of one week. The authors compared the effectiveness of the exercises in increasing levels of happiness and reducing depressive symptoms [31]. One of the most successful techniques was the so-called “Three good things in life”, which consisted in writing down three things that went well on that day and their causes. Its benign effects progressively increased even after six months from the intervention, due to the fact that some participants spontaneously decided to carry on with the exercise after the one-week experiment [31].

We argue that feelings of self-efficacy and a positive outlook on life are important, measurable goals of elderly people’s well-being. When designing assistive robots for elderly care, these psychological goals will need to be considered just as important or arguably, more important than the physical goals the robot has. The following section offers an overview of the extent to which robots have been successfully applied to offer similar psycho-emotional support and motivation for elderly people as described above.

### III. DOES ROBOTIC TECHNOLOGY RISE TO THE OCCASION?

#### *Motivation*

Most studies with robots that motivate elderly people (or other users) are not based on specific psychological frameworks of motivation. One exception is the work by Fasola and Matarić who employed motivational methods to increase participants’ intrinsic motivation ([32],[33]). They carried out experiments where elderly performed physical activities in the context of playing a game with a robot. The motivational strategies that they applied were *praise*, *encouragement*, *indirect competition*, *optimal challenge* and *offer of choice* [32], [33]. Among other results, the authors found that adapting the difficulty level of the task online increased user enjoyment more than praise alone [32].

Other studies report on robots or related technologies that aim to motivate users to engage in certain tasks. For

instance, in the context of rehabilitation robotics, Colombo et al. [34] implemented motivational methods to increase patients compliance to a rehabilitation program. Like Phillips et al. [11], they adapted the difficulty level of a motor task by increasing it steadily. Feedback was offered through dials and other devices so that patients could see how well they were performing their exercises. This feedback was found to improve the motivation (interest) in the rehabilitation program.

Johnson et al. [35] discussed how the robot system they used to rehabilitate arm-impaired users could effectively be motivating. They considered the relationship between patient, therapy provider, and rehabilitation system to be very important. Teleconference was expected to facilitate the social interaction between therapists and users. A personalized rehabilitation interface, meaning a system that was tailored to the user's capabilities, would also improve motivation. In addition, patients had the opportunity to choose among several input devices (e.g. joystick or driving wheel). Finally, patients could engage in fun video game activities that were not just enjoyable but also possessed a therapeutic value.

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 [36].

These examples gave an indication of how robots could motivate elderly people to change their behaviors. The next subsections address the issue of how technology in general, and robots in particular, could offer psychological interventions to increase happiness and well-being.

#### *Mood, Depression and Loneliness*

The robot that has been probably most widely employed to interact with elderly people is Paro, the seal robot. In studies, Paro is typically brought to nursing homes where older people hold the robot and interact with it. Paro's benign appearance and pleasantness to touch facilitates the user's attachment to the robot. It has often been used in nursing homes in long-term experiments. Some of the reported positive effects of interacting with Paro are general improvement in feelings [37–39] and reduction in depression [39].

Also the virtual agent community has researched the effects of technology on mood and depression. Bickmore et al. define *relational agents* (RA's) as "animated conversational agents designed to establish trust and therapeutic alliance with users over time" [40], where therapeutic alliance is commonly defined as the "collaborative bond between therapist and patient" [41]. In one study, an RA talked with patients at a hospital to provide them with information about their own discharge plan. Even though the system was neither specifically developed for depressed people nor designed as a therapeutic aid, the

authors aimed to ascertain whether patients with more depressive symptoms would accept the RA differently than patients without depression. Interestingly, they found that depressed patients rated the RA higher in therapeutic alliance than non-depressed patients. This indicates a stronger emotional bond between the RA and patients with depressive symptoms [40].

Another interesting effect has been found for loneliness instead of depression. It seems that, when interacting with agents or robots at a given task, users usually prefer robots to virtual agents [33], [42–44]. The positive effects of the robot's embodiment appear to be due to its higher social presence [42]. When interacting with social agents or robots, the persons that feel lonely perceive a higher social presence compared to those that do not feel lonely. This suggests that employing social agents or robots as companions might provide valuable emotional support especially for people more prone to loneliness [42].

Thus far, robots and virtual agents seem able to reduce negative affective states of users, including elderly people.

#### *Self-Efficacy and Coping*

In a study with activity monitoring systems, Achterkamp and Vollenbroek-Hutten argue that health-promoting technology appears effective only in the beginning because the adherence of users decreases fast. They found that users with average to high levels of self-efficacy were more active than users with low self-efficacy. The authors stress the need of health-promoting systems to be outfitted with tailored feedback possibilities in order to enhance the self-efficacy of users [45].

Several studies have focused on the design of virtual agents that aim to teach users certain skills while improving their corresponding self-efficacy beliefs. For instance, Silvervarg and Jönsson proposed the design of a virtual agent that improves the user's mathematical skills and increases the positive attitudes towards math and math self-efficacy [46].

There appears to be a lack of studies with robots to improve self-efficacy and coping. Future research should fill this void given the relevance of these constructs, especially regarding older people.

#### *Wellbeing and Happiness*

Although many studies have proposed the use of diverse technologies to foster wellness (e.g., [33],[47–49]) few have focused on psychological wellbeing from the approach of positive psychology (e.g., [50]). Some of the therapeutic interventions that improve psychological well-being seem more applicable for robots than others. For instance, Seligman's "gratitude visit" exercise, which involves writing and personally delivering a letter of gratitude to another person, is not so applicable for a robot in this context [31]. On the contrary, treatments like "reminiscence" or "life review", where participants (usually elderly people) are encouraged to remember and share memories from their past

[51], might appear as easier to implement in a robotics setting.

#### IV. SHORTCOMINGS AND CHALLENGES

Based on the previous work introduced above, 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 arise from studies such as the ones described in the previous section. Also, novel methods are proposed that might contribute to future experiments.

##### *A 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. [34], or weight-loss programs, e.g. [36], 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. [52], [53]. 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 [54], we should

remain cautious as previous research has shown that the novelty effect might last as long as several weeks [55].

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 [56]. Benedetti et al. also provide evidence that a *placebo* effect greatly influences the success of interventions as well [57]. Thus, hopes and placebo effects 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.

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

##### *A 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. [34], and also the seal robot Paro was found to reduce depressive symptoms for elderly participants, e.g. [39].

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. [45]. Some solutions proposed are customization and avoiding low

levels of self-efficacy regarding the tasks for which the program is designed [45].

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 [58].

## V. CONCLUSION

When robots interact with participants in short-term scenarios, intrinsic motivation appears as a relevant psychological aspect that can be effectively influenced. However, longer term psychological constructs such as other forms of motivation, depression, self-efficacy and happiness, might require long-term scenarios to allow robots to provide effective interventions.

Long-term scenarios are preferred for studies where robots have a psychological support role. The main challenges surrounding long-term experiments where robots provide therapeutic interventions to improve self-efficacy and well-being are thought to be: the translation of therapeutic interventions to Human-Robot Interaction scenarios with elderly users; controlling the robot's behaviour in real-time, on location, for extended periods of time; eliminating the effect of researcher influence; controlling for the novelty effect of the robot as well as the treatment; and developing measures that reliably measure self-efficacy and happiness over time.

Future research will show the extent to which robotic technology can be designed to support elderly people physically, reduce their psychological distress and improve their life satisfaction.

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