Use of a Socially Assistive Robot to Promote Physical Activity of Older Adults at Home

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Abstract. Demographic change is leading to a higher proportion of older adults. The health and care sector must adapt because diseases and functional limitations increase with age. Strategies are required to promote and improve the functional capacity of older adults. A key factor in protecting health is regular physical activity. However, older adults do not move enough. It is therefore important to develop strategies to encourage older adults to be physically active. Regular motivation and guidance are helpful, but often not feasible due to staff shortages and high costs of personalized trainers. One solution is to use technology. Several studies have shown the positive effects of robots as instructors and motivators for physical activity. However, it has not been examined whether it is suitable in the private household. Therefore, the explorative user study investigated whether a socially assistive robot could be a practical solution to motivate older adults living independently to exercise regularly. Seven older adults participated. They trained one week with the robot as an instructor. The participants enjoyed the robot, but some technical difficulties such as slowness, communication, face recognition, stability, and acoustic problems occured. The participants experienced the robot as motivating, but they expected habituation effects. Even if the robot used was not suitable for autonomous training at home, this research can help find new ways to motivate older adults to engage in regular physical activity and improve technical solutions with the involvement of older adults.

Keyword: Robot · Physical activity · Older adults

1 Background

1.1 Societal Changes

Worldwide, the percentage of older adults is increasing [78]. In Europe, 19.4% of the population were aged over 65 in 2017. This percentage is expected to reach 28.5% in 2050 [21]. The percentage of older adults over 80 years will double to 13% from 2019 to 2070 [15]. In Switzerland, the percentage of people over 65 years is 18.9% in 2020 and is expected to rise to 25.6% until 2050 [24].

To deal with Europe's ageing society, health and care systems must adapt and provide a long-term vision for well-functioning and resilient public health systems, in particular

M. Ziefle et al. (Eds.): ICT4AWE 2020, CCIS 1387, pp. 78–95, 2021.
https://doi.org/10.1007/978-3-030-70807-8_5

by investing in disease prevention [16]. To be able to benefit from the prolonged life span, healthy aging is important, which includes good physical and mental health. Therefore, the ability to acquire and maintain skilled motor abilities to adapt to the challenges and requirements of the changes in daily life is highly relevant [30]. However, with increasing age, the incidence of diseases and functional limitations also increases. There is a substantial increase in physical problems that affect the performance of activities for daily living (ADLs) due to physical and medical problems associated with age [44], and the number of people with severe cognitive disabilities in 2050 will be three times larger than today [1, 87]. In Switzerland 5.7% of the 65 to 79-year-olds have problems in activities of daily living (ADL) and 15.9% of those over 80 [22]. 24.8% of the 65 to 79-year-olds have problems with instrumental activities of daily living (IADL) and 55.9% of those over 80 [23]. Aging societies must therefore develop effective strategies to promote and improve the functional capacity of older adults to maintain physical and cognitive health and therefore their participation in social life.

1.2 Physical Activity of Older Adults

It has been shown that physical activity is age-dependent: there is a decrease in physical activity with increasing age [5], and motivation for physical activity decreases with age [63], so many older adults do not move enough [38, 83]. Older adults living at home have a high incidence of falls, due to a sedentary lifestyle, deconditioning, and comorbidities [68]. The prevalence of pre-frail and frail syndrome is estimated high in older adults [8]. Further, older adults are found to be the population subgroup with the highest levels of sedentary time [91] and the lowest levels of physical activity [74]. This has various negative effects like reduction in (functional) everyday abilities [81], losses in health, self-confidence, and self-efficacy, reduced participation in social life, decrease of cognitive abilities, and increased loneliness [e.g. 5, 27, 31]. Therefore, there is a high need for healthcare systems to develop effective solutions to ensure the physical wellbeing of older adults [10]. Besides the positive effects of activity on physical health, Tully et al. [76] showed that replacing 30 min of sedentary behavior with light or moderate physical activity was associated with improved anxiety symptoms in older adults.

Physical exercises have a very positive impact on overall health status and cognitive health [90]. There is strong evidence that regular physical activity is associated with comprehensive benefits of older adults [2, 11] and also mental health [64, 65, 76].

As a central protective factor for health, regular physical activity shows the most stable evidence of benefits in terms of health and independence in old age [9]. It has positive effects on physical complaints [28], and can reduce the occurrence of falls [52, 70]. Frailty can be reduced by targeted physical training [e.g. 42], and quality of life and independence can be increased [e.g. 13].

The ability to walk safely in one’s environment facilitates a physically and socially active life and access to goods and services [60]. Furthermore, regular physical activity can reduce the risk of high blood pressure, stroke, diabetes, cancer, or depression [88, 90]. Besides positive effects on physical health, movement exercises also have measurable positive effects on cognitive performance [51]. Physical exercise is one of the possible treatments for depressive mood which is especially important in old age as there is a high prevalence of depression in older adults [32, 53, 61]. Therefore, one of the most important fields of action is the promotion of physical activity in old age [83] with direct positive effects for the older population and at the societal level by preventing a further increase in health costs due to illness and care.

To ensure and support active aging, many countries have invested in promoting activities. Via media platforms, they provide physical exercises for older adults that they can perform at home. The exercises are specifically designed to attend to age-related limitations and to improve the health of older adults. For example, Pro Senectute Switzerland [56] has designed sets of physical exercises that older adults may perform at home to improve their strength, flexibility, and balance [71].

However, the difficulty is to get older adults to integrate physical exercises into their daily lives. Information campaigns highlight the benefits of physical activity for older adults and various exercise programs are specifically designed to promote physical activity among older adults. But the problem often is to motivate older adults to perform the exercises regularly. Exercise programs are beneficial only when done regularly and over a longer period [28]. Regular invitation and guidance seem to be helpful [39] and to be more effective than unguided training [29].

There are possibilities to ensure regular training, for example with a homecare assistant which is quite costly, or going to a group training what requires traveling, what could be a barrier for some older adults living in rural areas or having to travel with public transportation. These solutions do not apply to the growing number of older adults that need assistance but still living in their own home. Older adults express the wish to be able to age independently in their familiar living environment for as long as possible [33], which is in line with the concept of "ageing in place" [43]. Older adults are nowadays living longer in their own homes [17] but at the same time, the lack of nursing staff is increasing [46, 47, 89]. Therefore, an alternative must be found.

1.3 Use of Technology as One Possible Solution

There is a lack of resources and personnel to meet these societal challenges. So, solutions that promote the health of older adults and support them to live independently at home are of considerable interest. The question is whether the use of technology can contribute to enhance independence and therefore reduce individual and societal costs of caring by preventing disability and frailty of older adults [77]. The technological advances could provide additional solutions to meet these social and individual challenges [66]. Amongst these, socially assistive robots could be used in everyday living environments and for example advise older adults in performing exercises at home and increase the motivation of older adults to do so. In this way, the autonomy of older adults could be maintained, and their well-being could be increased, carers could be relieved physically and psychologically, and costs could be saved.

Based on their application, robots can be divided into industrial robots (robots for manufacturing) and service robots (robots for services). In the case of service robots as a separate subclass of robots, the focus is on the direct benefit to humans. The International Organization for Standardization defines a service robot as a robot "that performs useful tasks for humans or equipment excluding industrial automation applications (ISO 8373)" [36].

In the field of assistive robotics, different types of robots have been developed that perform various activities with the aim to maintain healthy life habits of older adults by engaging their users to develop training activities in physical and mental activities and rehabilitation, including humanoid robots, exoskeletons, rehabilitation robots, service robots, and companion-type robots [55]. According to the categorization of assistive robots for elderly of Broekens, Heerink, and Rosendal [7], assistive robots can be divided into rehabilitation robots (e.g. wheelchairs and exoskeletons) and socially assistive robots, with the subcategories service robots and companion robots (p. 94 ff). In their review of robots supporting elderly people with no cognitive decline, Bedaf, Gelderblom & DeWitte [3] identified 107 robots for the elderly in their home situation to prolong independent living. Nowadays, commercially available robots focus on the physical support of self-care related activities. Most of the robots in the development phase claim to physically support mobility-related activities. Few robots in the development phase focus on providing physical support for self-care related activities.

In some studies, a robot was used as an exercise coach for older adults. The motivation of older adults was positively influenced by socially assistive robots [75] to stay active via social exercise encouragement [19, 37] and it was more motivating to perform physical activity with a robot than alone [86] or with a standard training plan [85] and the effort was boosted with a humanoid robotic partner compared to exercising alone [62]. Shen and Wu [69] even found a preference for robotic instructors over human instructors.

Although several studies found positive effects of socially assistive robots as instructors and motivators for physical exercise for older adults, it is not yet tested if a robot as a fitness coach is suitable in private households, where physical exercises have to be performed independently with the robot.

Therefore, the question of this project was whether a socially assistive robot that acts as a training coach could be a practical solution to motivate older adults living independently at home to exercise regularly. It was analyzed in an explorative user study.

2 Methods

2.1 Participants

Older adults were recruited via the network of senior citizens of the institute. For inclusion, the participants had to be over 65 years, with no physical or cognitive restrictions, living in private homes in Switzerland, and German-speaking. Eight older adults could be enrolled in the study.

2.2 Exercise Program

In a program called "Walk safely, stand safely" Pro Senectute Switzerland [56] compiled exercises for daily exercises, consisting of three strength exercises, three standing balance exercises, and three walking balance exercises with each exercise having an easier and a harder version [71]. For the present study, three strength exercises and three balance exercises were selected out of the original nine exercises. The selection was made based on the capabilities of the socially assistive robot. The six exercises were presented in three versions: (1) a programmed humanoid robot (NAO V6, 6th version) that performed the exercises as an autonomous fitness coach; (2) written instructions and pictures of the exercises based on the official booklet of the campaign from Pro Senectute Switzerland; (3) a video tutorial based on the official video of the campaign. The version of the exercise program shown by the socially assistive robot, with an introduction and six exercises with verbal instructions lasted 36 min (for details see [6]).

2.3 Questionnaire

To examine whether a socially assistive robot is practical to be a training coach and motivate older adults to exercise, a questionnaire was compiled consisting of the items shown in Table 1.

Table 1. Overview of used variables.

Variable	Item	Source
Sociodemographic	Age in years Gender Marital status Type of housing Former professional activities Level of education Residential area	Self-developed with recommendations from Flandorfer [25]
Health status	General Health	Short Form Health Survey, SF-36 [82]
Current physical activity	Frequency in one week Duration of one session Social aspect (alone/group)	Self-developed
Self-efficacy	Rely on own skills Mastering problems by myself Solving complicated tasks	Allgemeine Selbstwirksamkeit Kurzskala (ASKU) [4]
Technical affinity	Interest in technology Interest in new technology	Adopted questions from Seifert and Meidert [67]
Socially assistive robot as an exercise coach in older adult's homes	Regularity Difficulties Fun Motivation Operation Own experience Recommendations	See Table 2 [based on 18–20, 75, 85, 86]

At the end of the study, all participants were asked seven questions in a qualitative semi-structured interview about the exercises with the socially assistive robot (see Table 2). We used qualitative methods to identify important issues and understand subjective opinions and problems in-depth [49].

Table 2. Questions in the qualitative semi-structured interview.

Questions
(1) Were you able to exercise regularly (3 times a week) with the robot NAO?
(2) Were there any difficulties during training? What did not work?
(3) Was it fun to train with the robot?
(4) Was it motivating for you to train with the robot NAO?
(5) How was the operation of the robot for you? Were there any difficulties?
(6) If you look at your own experiences, do you think the use of NAO for older adults to activate movement is possible in principle?
(7) Would you like to tell us anything else about your experience with the robot?

2.4 Procedure

The study ran for 12–14 weeks for each participant from June 2019 to December 2019. The participants first had an individual introduction at the study center where they signed the informed consent form. Questions (T0) about sociodemographic factors, physical training, state of health and self-efficacy were asked before the participant was introduced to all three conditions (robot, booklet, video). After this first training with the socially assistive robot to get used to the handling, commands, etc. (see Fig. 1) the participants were asked questions about the robot as a fitness coach (T1). The participant was instructed to place the robot on the floor and not on a table due to its instability to avoid a fall and thus damage to the robot. Figure 2 shows the survey dates and used instruments.

Fig. 1. First contact of an older adult with the robot in the study center. Image source [6] (published in [58]).

According to a predetermined schedule, each participant then carried out the training independently at home. The participant exercised one week with each version of instruction (with robot (Condition Robot; CR), with booklet (Condition Booklet; CB), with video (Condition Video; CV)). In the training week, the participant should perform the six movement exercises three times. After each training week, the participant had to fulfill a study protocol. Between the one-week training in each condition the participants had a two-week break (B) in which they were not allowed to perform the six exercises.

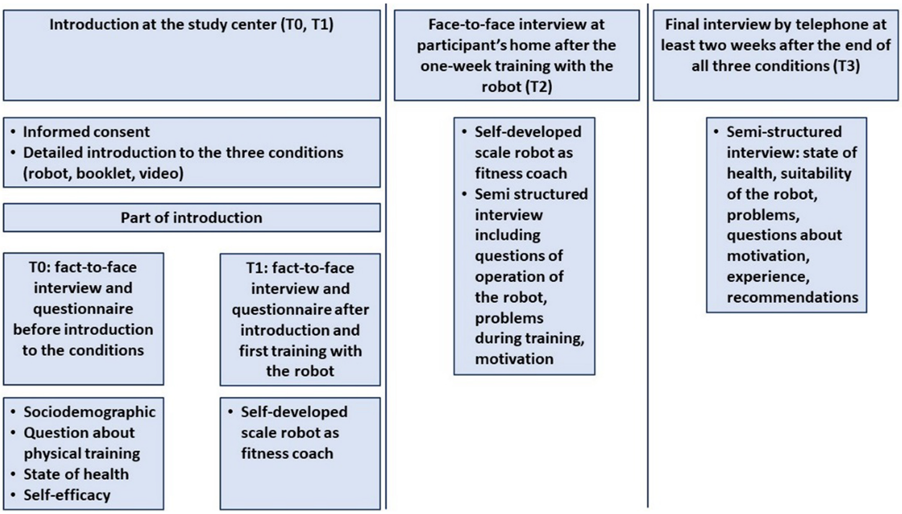

Fig. 2. Survey dates and used instruments.

Figure 3 summarizes the procedure of the study. A face-to-face interview was conducted immediately after the one-week training with the robot at the participants' private home (T2). The final interview was conducted by phone (T3) two weeks after the last training week (see Figs. 2 and 3). The sequence in which the participants went through the three conditions varied to avoid order effects. Due to a technical failure of the robot and the fact that the repair took longer than the planned break, it was not possible to realize the same break time between the conditions for all participants.

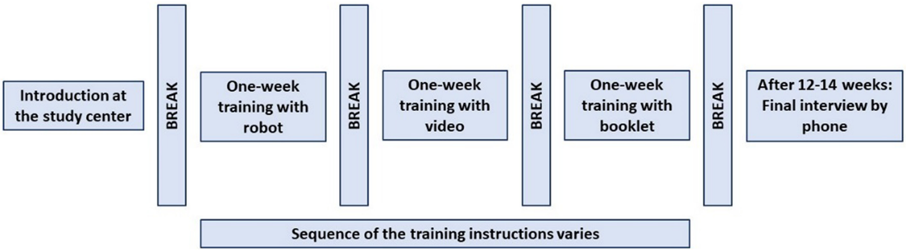

Fig. 3. Procedure of the study.

2.5 Analyses

To analyze the quantitative data from the questionnaires IBM SPSS 26 was used. The sample and questions were characterized with descriptive statistics (mean, standard deviation, frequencies). To compare the motivation to train with the robot at the introduction in the study center (T1) and after the training week with the humanoid robot (T2) the

Wilcoxon signed-rank test [35] was used, as non-parametric tests do not require a normal distribution of data and apply to small sample sizes.

The semi-structured telephone and face-to-face interviews (T2, T3) were recorded in writing, the statements were summarized and reported. No further qualitative content analysis [45] was performed due to the sample size and the explorative character of the study.

3 Results

3.1 Study Population

Eight older adults were recruited to participate. Due to acute physical impairment one participant was excluded. Five men and two women remained in the study population. Table 3 summarizes the characteristics of the study population.

Table 3. Characteristics of the study population.

	7 Participants
Age	74 (SD = 5.63, Range 67–84)
Nationality	Swiss
Canton	4 St.Gallen, 2 Thurgau, 1 Zurich
Residential area	5 more rural, 2 more urban
General state of health	1 excellent, 4 very good, 2 good
Activity per week	1 7-times, 1 6-times, 1 4-times, 1 3-times, 1 2-times, 2 1-time
Duration of activity	20 to 90 min
Activity in group or alone	3 in group, 3 both, 1 alone
Education	5 tertiary level education, 2 secondary level education
Household size	5 two-person household, 2 one-person household
Interested in technology	4 very interested, 3 interested
Contact with a robot before	2 at home, 1 at work, 1 somewhere else, 3 no contact before

3.2 Experiences of Older Adults Performing Exercises with the Robot at Home

All participants enjoyed the robot and they emphasized the joy in experiencing something new. They liked the humanoid appearance of the robot. Although there were some problems, all participants were able to exercise with the instruction of the socially assistive robot. But there were some difficulties that all participants had. From a technical point of view, there were five main difficulties. (1) When the participant started the robot, it took a very long time until the robot was ready for operation and the older adult could start with the training under the guidance of the robot. (2) The communication with the robot takes a long time because the robot was not ready to receive instructions or did not react immediately to instructions. (3) To receive instructions, the robot must recognize the face of a human being and then switch to “receive mode”. However, the socially assistive robot used had problems recognizing the face of older adults and was therefore often not ready to receive instructions. This meant that the older adults had to bend down to the robot so that it could recognize them better. (4) The participants were instructed to put the robot on the floor because the robot was not very stable while demonstrating the exercises to the older adults. When the robot showed the exercises, it fell backward with six participants during at least one exercise. Partially it was able to stand up again on its own. (5) There were also acoustic problems, so the voice of the robot was perceived as an unpleasant computer voice, was not optimally understandable, and was sometimes perceived as strenuous.

3.3 Motivation

The humanoid looking socially assistive robot was experienced as motivating to be physically active. The training with the robot was judged as interesting and the exercises attractive. However, the participants could not rule out the possibility that over time, habituation effects may develop, and the robot may lose its attractiveness as a training coach. They often mentioned that they might lose interest in training with the robot over time. Due to the short training period of one week, this could not be verified. Also, the rigid instructions contribute to the decrease in the attractiveness of the robot as a training coach. For example, the instructions were often too long, were always repeated without variability, and therefore boring. In addition, there were too many and too long breaks (see Sect. 3.2), which unnecessarily lengthened the training program. Moreover, the older adults did not know whether the breaks were intended or whether the robot was defect.

The participants assessed the ability of the robot as a fitness coach with eight items. They were asked the questions after the instruction and first training with the robot at the study center (T1) and after the one-week training with the robot at home (T2). They could indicate their agreement from “1 = not at all” to “5 = very much”. Table 4 shows the means and standard deviations. The Wilcoxon-tests show no significant results. So, there was no significant influence of the one-week training on the assessment of the robot as a training coach.

3.4 Comparison of the Three Types of Instructions

The video instruction was rated as good as the instruction by the robot. One participant found the video instruction better than the robot. Another participant preferred the robot because it is something new and therefore automatically has a certain attraction. Two participants pointed out that they have no space at home in front of their computer to exercise. One person found the video instructions more understandable. Other participants did not see a big difference between the video and the robot instructions. However, both the video and the robot instructions are experienced as more motivating than the written instructions. Whereby with the robot it is additionally mentioned that a relationship can be established with it. The written training instructions were rated worst. The

Table 4. Change in the self-developed assessment of the robot [58].

Question	T1 M (SD)	T2 M (SD)	Wilcoxon-test, exact significance, one-sided
How much did you enjoy training with NAO?	4.0 (0.82)	4.43 (0.98)	Z = −.828, p = .281, n = 7
Would you recommend NAO as a training coach to your friends?	2.17 (1.60)	2.50 (1.64)	Z = .000, p = .750, n = 6
How much would you like to train with NAO in the future?	3.14 (1.46)	2.29 (1.38)	Z = −1.857, P = .063, n = 7
Do you find NAO a good training coach?	3.43 (1.40)	2.71 (1.60)	Z = −1.089, p = .188, n = 7
How well could NAO motivate you for the training?	4.00 (1.41)	4.00 (1.73)	Z = −.378, p = .500, n = 7
Do you think NAO is more motivating than a human training coach?	1.43 (0.79)	1.29 (0.49)	Z = −1.000, p = .500, n = 7
Do you think NAO is more motivating than a training plan with video instructions?	3.57 (1.27)	2.57 (1.40)	Z = −1.382, p = .109, n = 7
Do you think NAO is more motivating than a written training plan?	4.71 (0.49)	3.57 (1.62)	Z = −1.857, p = .063, n = 7

T1: after introduction to robot training, T2: after one-week training with the robot, M: mean value, SD: standard deviation. 1 = not at all, 5 = very much

participants stated that they did not want to read while exercising. However, there are also individual exercises that are more comprehensible through the written instructions than just through the explanation of the robot.

The older adults would most likely wish to train together with a professional (sports teacher/therapist) who can give direct feedback, correct mistakes in the execution, and help in case of accidents, but this option was not offered in the study.

3.5 Recommendations

The study participants gave some recommendations on how to improve the training with the robot:

Features of the Robot: (1) The robot should be taller or elevated because it was rated to be too small. Since the robot was only allowed to be placed on the floor due to its instability, the older adults always had to bend down to communicate with the robot. (2) The communication with the robot should be easier. The participants did not want to wait to be recognized by the robot first. (3) It should be possible to adapt the sequence spontaneously by simple voice commands (e.g. "Stop", "Continue"). (4) The robot should not have any faults.

Other Desired Functions of the Robot: (1) The robot should have a reminder function integrated so that the participants can be reminded to train regularly. (2) Hearing aids should be compatible with the robot. (3) Breaks should be announced with their exact duration. (4) Feedback was required as to whether the exercises were being done correctly and the robot should correct incorrect movements.

Personalization: (1) Based on the feedback of the participating older adults, the training program of the robot should be individually adaptable and personalizable.

Variability: (1) The training program, but also the sentences, both in terms of content and structure, should have a greater variability to avoid boredom.

Environmental Factors: (1) The robot did not work on all floor coverings so environmental factors should be considered before implementation. For example, the robot worked worse on high carpets, but on smooth floors there was a risk that the robot would slip away.

Social Aspect: (1) Although the use of a robot as a training coach could motivate people to be physically active, the social aspect of the activities is just as important, especially for older adults, which is why a training group would be preferred.

4 Discussion

This study investigates whether a robot is motivating and practical for older people at home to perform physical exercises.

The study participants were well educated, interested in technology and four out of seven had previous experience with a robot. As only seven participants were included in the study, the sample is not representative. It was a highly selected study population which characteristics do not map the general population and therefore, results should not be generalized to other groups or the general population, although important points certainly apply in principle, and could be shown based on this group. The phenomenon that mainly well-educated seniors participate in studies about use of technology is known from other studies [e.g. 12, 73]. The number of participants who were interested in technology is in line with studies based on larger populations [e.g. 48, 72]. Regarding the percentage of people who already had experience with robots, findings for Germany values from 26% [26] and 27% [54] and for European countries 14% [14]. A recent survey showed 42% for Switzerland [41].

The participants emphasized that the experience with this new technical possibility was joyful. Also in the Technology Acceptance Model (TAM) 3 by Venkatesh and Bala [79] or in the Almere Model by Heerink, Kröse, Evers and Wielinga [34] "Perceived Enjoyment" is seen as a factor for the intention to use a technology. However, it should be considered that although the perceived enjoyment can influence acceptance, habituation effects should also be considered. It is known that after the novelty effect vanishes the interest in continuing to use the new technology decreases rapidly [57]. This circumstance could not be investigated in this study due to the short duration of the study. However, from the statements of the participants in the semi-structured interviews, it is clear that the robot's motivational factor quickly diminished when the novelty effect was exhausted and they doubt a long-term motivating effect, because already during the training week the always same and rigid exercises and instructions were perceived as not very entertaining.

The cute appearance of the robot was also positively highlighted. The positive evaluation of the humanoid appearance was mentioned, even if not specifically asked for it, also fits to the theory of the "uncanny valley" [50], according to which the acceptance of a robot increases the more human-like its appearance is. But there is a turning point where acceptance turns into rejection. A recent survey in Switzerland found that a quarter preferring a machine-like appearance and over a fifth preferring a human-like appearance [41]. Although the appearance was rated as cute, a larger robot was desired. This is mainly because the robot must recognize the face of the older adult to take orders. This could only be achieved if the older adult bent down toward the robot, which is probably why the wish for a larger robot was expressed.

The study clearly showed that technical defects, such as taking too long, not reacting, not recognizing, not being stable and acoustic problems, had a negative influence on the motivation to use the socially assistive robot. However, the participants did not rate these technical deficiencies of the robot as bad, because it was a well-educated sample with an affinity for technology, which was aware of the technical difficulties of new technologies, used to test technical systems and give critical feedback due to other studies at the institute. Differentiated feedback with error reports was not unusual for them.

The participants rated the socially assistive robot as motivating for physical activity, which gives a very positive image of this technical possibility. However, it should be considered that the participants only had the robot for one week during the study and had to train under its guidance three times. During this time, they were in a special test situation and were willing to comply with the study requirements. In addition, the study participants were already active before the training and perform sports exercises at least once a week. It is unclear how motivating the robot instruction can be over a longer period of several months and whether training would be carried out regularly. It is known that the acceptance of end users should be investigated over a longer period in their familiar environment in order to be able to make statements [40]. Even the non-significant differences in the assessment of the robot as a fitness coach are not surprising and should be repeated with a longer training period in between.

Improvements must be primarily of a technical nature, and here both features of the robot that need improvement and other desired functions of the robot have been mentioned several times. However, the individual adaptability and personalization are important too. Weidner, Redlich and Wulfsberg [84] do not see technical possibilities or economic considerations in the foreground for acceptance, but rather what is individually perceived as adequate. Also, Sankowski, Wollesen and Krause [59] indicate the optimal fit.

But also facilitating conditions from the Unified Theory of Acceptance and Use Technology (UTAUT) model [80] are discussed by noting in this concrete case that the robot does not work on all floor surfaces.

The study participants missed the social aspect of physical activity. Only one person carried out their previous physical activities alone, all other participants were used to being active in a group. So, on the one hand, it was mentioned that the supervision and control of the exercises were missing, but on the other hand, social control was missing. Social control is possible in the group so that even when people are living alone others would notice if they did not appear for training. A good application for a socially assistive robot would be the support of a human trainer. A human trainer should supervise the performance and assist, but the robot can motivate to be more active [10].

Overall, the participants found a socially assistive robot not useful for already active people, but for people who are not yet active. But they would not recommend the tested socially assistive robot mainly due to the technical problems and question of cost-benefit arises.

There are some limitations to the study that should be noted. The study was conducted as a real-life testing and therefore no lab conditions were present. There were technical problems of the robot and challenges to arrange personal appointments, so not all study participants went through the study in the same time span, and variation of the three conditions could not be balanced optimally. Since only one robot was available for all participants, it was not possible to test in parallel and the testing time had to be kept relatively short. However, the study was also conducted to get to know exactly these challenges in everyday life and what needs to be considered when using a socially assistive robot as a motivator for physical activity. Due to the short duration of the study, no long-term effects, no habituation effects and no effects on physical activity or other parameters such as the number of falls could be investigated. And no statement can be made whether the exercises would have been performed consistently over a longer period.

Furthermore, as already mentioned above, the study sample was not representative and even the meaningfulness of the mean value comparisons calculated is restricted because of the sample size.

An essential difference in the three conditions was that in the booklet and the video older adults showed the exercises. Furthermore, the influence of a reinforcer was not investigated, so in contrast to the written and video instructions, participants have been praised by the robot during the training.

5 Conclusions

The used socially assistive robot with a humanoid appearance was appreciated by the study participants and judged as motivating but not suitable because of its abilities and the strict sequence of the programmed movement exercises. Therefore, the older adults would not recommend this robot to their friends. It became clear, that this special robot is not suitable for autonomous exercise training for older adults at home. The study participants were highly motivated and interested in technology so it can be expected other less interested persons would rate the motivating effect less. Even if the study sample was small and explorative some factors from technology acceptance models like “perceived enjoyment”, “facilitating conditions” or “social aspects” are mentioned, it became clear that they are important for further investigation. This research can help to try different ways to help older adults to be regularly active and to improve and adapt technical possibilities with the participation of older adults.

Acknowledgements. We thank all study participants and Zoe Brack, who programmed the robot as part of her master thesis.

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