How Anthropomorphism Affects User Acceptance of a Robot Trainer in Physical Rehabilitation

Baisong Liu, Panos Markopoulos and Daniel Tetteroo
Department of Industrial Design, Eindhoven University of Technology, De Zaale, Eindhoven, The Netherlands

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Abstract: Developments in social robotics raise the prospect of robots coaching and interacting with patient during rehabilitation training assuming a role of a trainer. This raises questions regarding the acceptance of robots in this role and more specifically, to what extent the robot should be anthropomorphic. This paper presents the results of an online experiment designed to evaluate the user acceptance of Socially Assistive Robots (SARs) as rehabilitation trainers, and the effect of anthropomorphism on this matter. User attitudes were surveyed with regards to three variations of a scenario where the robot with varying levels of anthropomorphism acts as a trainer. The results show that 1) participants are accepting towards SAR-assisted rehabilitation therapies, 2) anthropomorphism influences patient's perceived self-efficacy and attitude towards the system. A second survey studied inventoried issues regarding patients' acceptance of such systems, pertaining to technology acceptance, patient needs for rehabilitation training and the effect of anthropomorphism. Based on the above findings we propose user-informed design implications for improving user acceptance is rehabilitation settings.

1 INTRODUCTION

The application of robotic technology in the domain of physical rehabilitation is an area of ongoing research (Laut *et al*., 2016). Projects have developed robotic technology to support physically impaired patients, such as mobility aids for aging and motor function impaired users, assisting users in loaded walking (Ding *et al*., 2017) and supporting rehabilitation training exercises (Feys *et al*., 2015; Popescu *et al*., 2016). Such projects have shown that robots can help to improve the quality and quantity of rehabilitation training. However, the current trend mostly concerns with physically supporting (parts of) the body (Cardona *et al*., 2017; Vitiello *et al*., 2017).

Socially Assistive Robotics (SAR) provides assistance to users through social interaction (Feil-Seifer and Mataric, 2005). The use of SAR in rehabilitation training has been considered and demonstrated as promising (Eriksson *et al.*, 2005). Taxonomies of components concerning socially interactive robots have been proposed (Fong *et al*., 2003; Feil-Seifer and Mataric, 2005), suggesting human-oriented perception is an important part of SAR interaction design. Thus far, this aspect is yet to be explored in the context of rehabilitation training.

We have taken a user-centered approach to this issue, exploring patients' acceptance towards the concept of a robot trainer for rehabilitation, and the effect anthropomorphism has on its acceptance. This paper provides insights for further design of utilizing SAR in the context of rehabilitation training.

2 RELATED WORK

2.1 Social Robot Acceptance

General robot acceptance studies have investigated the effects on acceptance of specific robotic traits, such as gender of the voice (Eyssel *et al*., 2012), facial expressions (Moosaei *et al*., 2017) and gestures (Zaga *et al*., 2017). Regarding SAR, (Fong *et al*., 2003) have identified the following factors to be of influence on acceptance: 1) the user's attitude towards the robot, 2) the robot's field performance, 3) robot-displayed emotions, 4) appearance and dialog, and 5) personality. These studies explore robot acceptance regardless of a specific context, and thus provide general conclusions and directions for further research.

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Another branch of social robot acceptance study focuses on specific contexts and user groups, typically children, elderly and autism patients. For example, the Almere Model has been proposed for testing and predicting elderly users' acceptance of assistive social agent technologies, suggesting 12 factors to be of influence (Heerink *et al.*, 2010). Another study employed a zoomorphic companion robot (Nabaztag) into an elderly user's home to gain insights on social robot acceptance, focusing on users building a long-term relationship with a social robot in domestic settings (Klamer and Allouch, 2010). The acceptance of SAR in the specific context of rehabilitation has not yet been investigated.

2.2 Anthropomorphism

Anthropomorphism of social robots is a powerful factor influencing the user's experience, including empathy (Moosaei *et al*., 2017), enjoyment, and other social emotions (Bartneck *et al*., 2010). Anthropomorphism is proposed to be expressed in appearance and behavior (Choi and Kim, 2008). So far studies have explored different factors of anthropomorphic appearance embodied in the design of robots, for example through facial expressions (Moosaei *et al*., 2017), voice (Siegel *et al*., 2009) and gesture (Salem *et al*., 2013). As it has been suggested that user responses to anthropomorphic robotics are context based (Epley *et al*., 2007), it is important to explore the effects of anthropomorphism for specific contexts and use cases, such as that of physical rehabilitation.

2.3 Social Robots for Rehabilitation

SAR has been proposed as an alternative to the therapist for rehabilitation exercises, due to its potential benefits of cost reduction, privacy, improving engagement, and open up possibilities for home training scenarios (Winkle *et al*., 2018). A feasibility study has proven the potential of such application (Kyong Il Kang *et al*., 2005). A further study has suggested that even very simple robot behavior might benefit compliance in stroke rehabilitation exercises (Gockley and Mataric, 2006). A more recent study underlined the link between personalized robot behavior and user task performance in rehabilitation training (Tapus and Mataric, 2008.).

3 RESEARCH QUESTIONS

While the above-mentioned study by (Winkle *et al*., 2018) examined the design of SAR from a therapist perspective, this paper presents a study from the perspective of the patient. The aim of this paper is to explore patients' attitude towards having a social robot trainer to facilitate their rehabilitation training. Specifically, we are interested in:

RQ1) What is the patient' attitude towards having a robot trainer as facilitator of their rehabilitation training?

RQ2) How does the level of anthropomorphism in SAR form-design influence the patients' acceptance in the context of rehabilitation training?

RQ3) What are patients' preferences and concerns regarding SAR within the context of rehabilitation training?

4 METHOD

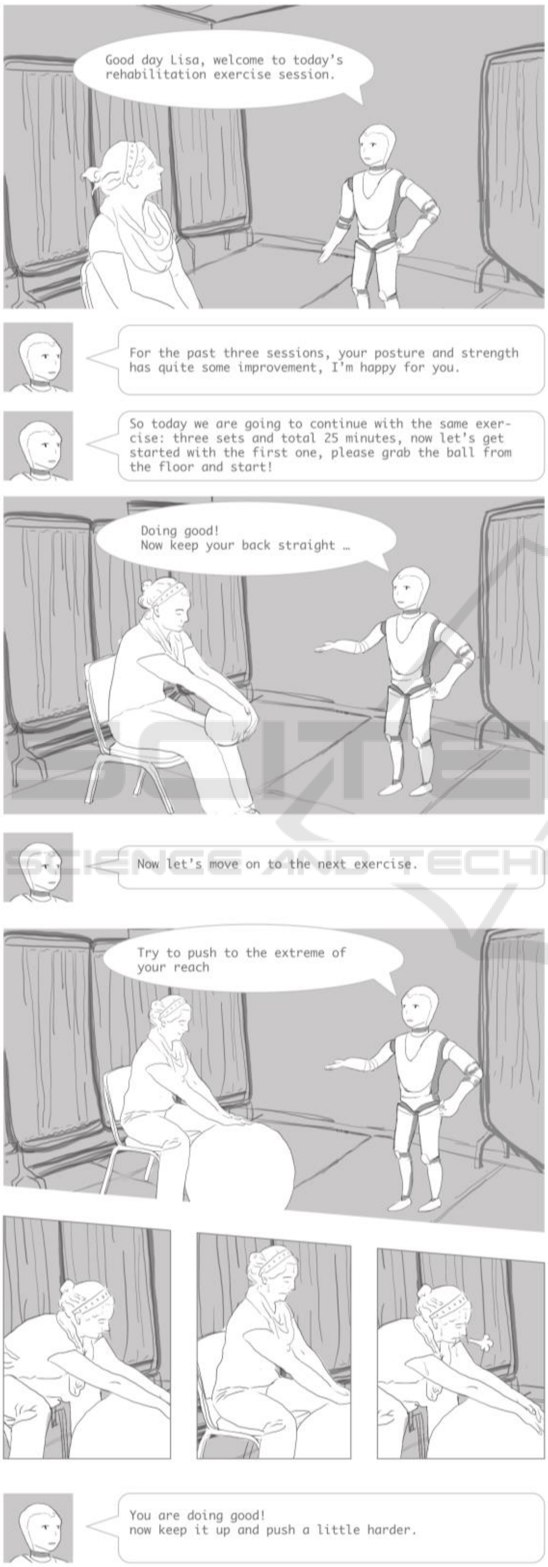
We conducted two studies to investigate our research questions. In both studies, we used an illustration of a fictional scenario with a patient performing her rehabilitation exercise with the help of a robot trainer (see figure 1), participants in the three conditions of study one were shown with three different robot trainer concepts presented in table 1.

In study one, aimed at answering RQ1 and RQ2, we have used standard questionnaires and open questions to collect the participants' general attitude towards social robotics, as well as their attitude regarding the application of SAR to the scenario.

Study two was aimed at answering RQ3, and to collect more in-depth information on some of the answers obtained by study one. This study was executed as a survey composed of mostly open questions regarding RQ3.

4.1 Scenarios

Both studies utilized illustrated scenarios describing a fictional interaction between a patient and a robot trainer. To focus on only the social interaction aspects, the robot in this scenario does not support or enforce movements with the patient, as one might expect in rehabilitation robotics, but takes only the role of a coach who provides the patient with information on the overall progress of the therapy, instructions for the exercise and encouragement when the patient is experiencing physical challenges. The story of the scenario is based on observations of clinical treatment and was further improved by consulting experienced physical therapists.



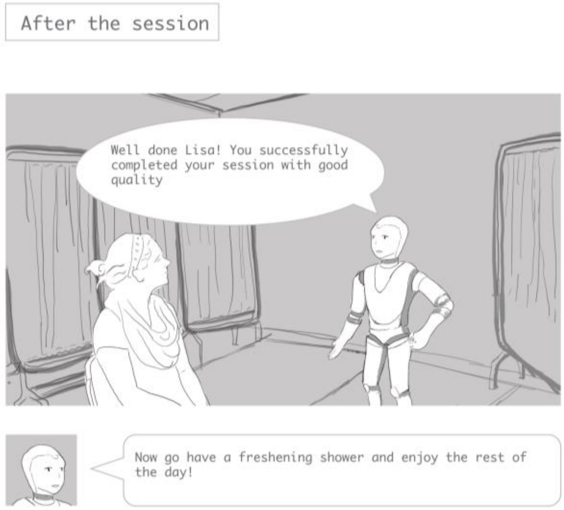


Figure 1: Scenario Used in the Survey.

The scenarios featured three versions of the robot trainer, differing in their level of anthropomorphic appearances. In the studies discussed above, robotic anthropomorphism is expressed mainly through facial expressions and gestures. Therefore, the three versions of the robot trainer included one with human-like body structure and expressions, one with only expressions, and one with none of the two factors, to represent high, medium and low levels of anthropomorphism in robot form design (See Table 1). A small survey was conducted as a manipulation check, to verify whether participants experienced the three representations as differing. in terms of anthropomorphism.

Table 1: Robot trainer designs.

			
Human-like body structure	√	x	x
Human-like expression	√	√	x
Level of anthropomorphism	High	Medium	Low

4.2 Study One Set-up

We first conducted a between subject study. Three groups of participants were presented a survey containing the scenario on rehabilitation training, each with a different form design for the robot trainer.

We used the Negative Attitude towards Robot Scale (NARS) questionnaire (Nomura *et al*., 2004) at the beginning of the survey to acquire participants' general attitude towards social robots and to check whether these were distributed equally over the three groups. Then, the participants were presented the scenario. After having experienced the scenario, we took the Credibility/ Expectancy questionnaire (Devilly and Borkovec, 2000) and the Technology Acceptance Model (TAM) questionnaire to evaluate the participants' acceptance of the robot assisted therapy and the robot trainer. At the end of the survey, we asked the user to rate the look of the robot trainer on a 10-point Machine-like to Human-like scale for a manipulation check. The structure of the study is presented in Table 2.

Table 2: Structure of Study One.

Screening questions
General attitude towards social robots
NARS questionnaire Open question regarding attitude towards working with social robots
Scenario "Lisa's Rehabilitation Training Session with Robot Trainer"
Attitude towards robot-assisted Rehabilitation therapy
Credibility/Expectancy questionnaire Open question regarding attitude towards robot-assisted rehabilitation therapy
Attitude towards robot trainer in rehabilitation therapy
TAM questionnaire Open question regarding attitude towards robot trainer in rehabilitation therapy
Manipulation check
Rate Robot Trainer's look on a scale from Machine-like to Human-like Open question regarding attitude towards robot-assisted rehabilitation therapy

4.3 Study Two Set-up

Study two was conducted with a within-subject design. It presented the same scenario as study one, but replaced the robot trainer with a blank box. After participants read through the scenario, we presented all three robot trainer concepts as available options and ask them to pick the one they preferred, assuming they were the patient in the scenario. We then provided open questions for the participants to give feedback on the reason of their choice and possible improvements for the concept of their choice. Finally, we asked participants to rate all three concepts of the robot trainer on a ten-point rating scale from "Machine-like" to "Human-like". The detailed structure is of study two is presented in Table 3.

Table 3: Structure of Study Two.

Screening Questions
Scenario "Lisa's Rehabilitation Training Session with Robot Trainer" with the trainer left blank
User preference for the given concept
Choose the desired robot trainer from the three given concepts Open questions regarding the choice Open questions about further improvements for the therapy and the robot trainer
Manipulation check
Rate three Robot Trainers' look on a scale from Machine-like to Human-like respectively

4.4 Participants

Participants were recruited through a crowdsourcing platform for both studies. Participants were expected to have been (formerly) involved in physical rehabilitation training. The study involved four groups of participants (total pool N = 103 after screening, average age 37). Detailed numbers of participants and group allocations are listed in Table 4. Study one and two were published on Amazon Mechanical Turk on July 12, 2018 and lasted 14 days. Each participant spent around 10 minutes on the study. Based on the minimum hourly wage, the reward was set at 1.5 USD.

To ensure the quality of the answers collected, we set a three-step screening scheme. Firstly, workers on Amazon Mechanical Turk had to answer three questions, proving that they had experience in physical rehabilitation, to access the survey. Secondly, four reverse questions (changing positive statements into negative ones, e.g. "*I found the robot trainer easy to interact with*" into "*I found the robot trainer difficult to interact with*") were also planted

Table 4: Study participants.

Study	Conditions	Participants
Study One	HA (High Anthropomorphism)	28 (HA1 - HA28)
	MA (Medium Anthropomorphism)	24 (MA1 - HA24)
	LA (Low Anthropomorphism)	20 (LA1 - LA20)
Study Two	-	31 (ST1 - ST31)

within the survey to check for satisficing behavior in answering the survey. Lastly, we put an eight-digit password at the end of the survey for claiming the reward, only visible to participants who finished the survey. We set the survey to be only available to workers with approval rate higher than 97% percent and job experience less than 5000 to further ensure the quality of the answer.

4.5 Analysis

Quantitative data were analyzed through mean scores for all conditions as an indicator of general acceptance. Additionally, through one-way ANOVA tests, we analyzed the effect of anthropomorphism on the patient's acceptance for SAR assisted rehabilitation therapy and robot trainer technology.

We conducted a closed coding and an open coding analysis on the qualitative data. The closed coding scheme was applied to the data from Study One, and consisted of the factors from the Credibility/Expectancy and TAM questionnaires, namely: Credibility, Expectancy, Perceived Ease of Use (PEU), Perceived Usefulness (PU), Behavioral Intention (BI), Attitude (A), Self-Efficacy (SE) and Subjective Norm (SN).

Next, we combined the qualitative data from Study One and Study Two and conducted an inductive open coding analysis to generalize more insights.

5 FINDINGS

We present our findings regarding three topics: 1) general attitude towards SARs, 2) Acceptance of SAR assisted rehabilitation therapy and robot trainer, and 3) effects of anthropomorphism on the acceptance of SAR assisted rehabilitation therapy and robot trainer.

5.1 General Attitude towards Socially Assistive Robots

With the NARS questionnaire, we tested Study One's participants' negative attitude towards situations of interaction with robots, social influence of robots and emotional interaction with robots. One-way ANOVA analysis showed that there are no significant differences among the three groups for Factor 1 (Negative Attitude towards Situations of Interaction with Robots) ($F(2,68) = 2.83$, ns), Factor 2 (Negative Attitude towards Social Influence of Robots) ($F(2,68) = .69$, ns), and Factor 3 (Negative Attitude towards Emotions in Interaction with Robots) ($F(2,68) = 2.97$, ns). This suggests that the three groups have a similar attitude towards socially assistive robots. The mean scores for the three groups and for all three factors are under 3. Since NARS is a negative attitude questionnaire, these lower scores suggest a rather positive attitude towards the factors (see Figure 2).

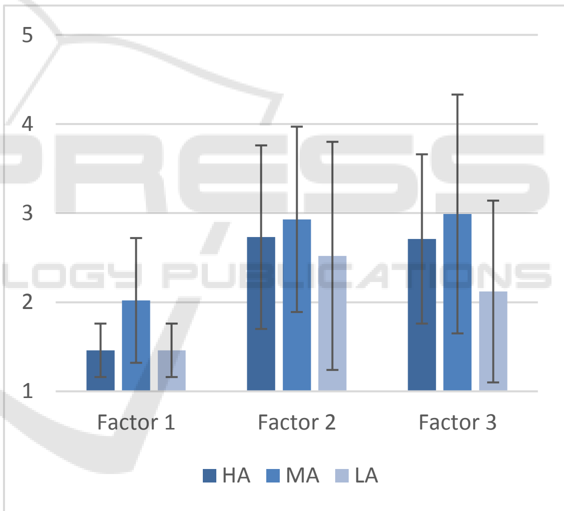


Figure 2: Mean score of the three groups from Study One for the three NARS factors.

Open coding analysis highlighted that robotic technology is desired for its precision, being objective, convenience, efficiency, opening up possibilities for more privacy and eliminating negative social encounters. Negative opinions clustered around technological possibilities, and cultural and ethical concerns. Below are the two factors concerning acceptance for SARs.

5.1.1 Technological Status-quo

"I think it has the potential to be very interesting and constructive, but hasn't been fully developed" (HA7)

"I might feel alone working with robot as robots don't have cognitive behavior" (MA12)

7 quotes suggested robots are best suited for the kind of jobs that are simple, repetitive and do not need complicated judgment. In the participants' opinions, current robotic-related technologies still lack flexibility to handle emergencies and lack proper judgement for complex situations. Such technological reality proposed a limitation for participants in terms of the tasks assumed possible for robots to take on.

5.1.2 Issues of Technology-related Attitude and Beliefs

"Not comfortable. Humans are losing the ability to think and react without assistance." (HA21)

"Not a fan, I can see the appeal, but I'm sure if there is a living person who needs the money." (LA6)

This refers to current cultural opinions about the relationship between people and technology. Participants regard certain human characteristics as irreplaceable (e.g., empathy, social perception, etc.), and worry that humans will be weakened and end up in an inferior position compared to technology in the future. The scenarios evoked a sense of anxiety about human identity among respondents. A recent study suggested that the anthropomorphic appearances of a social robot can pose a threat to human distinctiveness (Ferrari *et al.*, 2016). In this sense, anthropomorphism can trigger these negative emotions, and should thus be considered in design decisions.

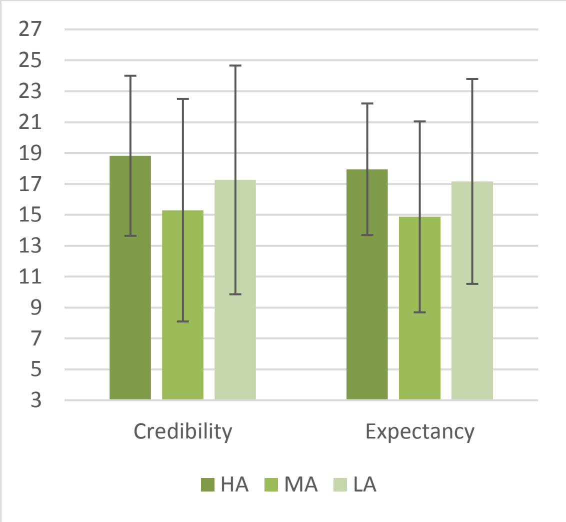


Figure 3: Mean scores of three groups for Credibility and Expectancy.

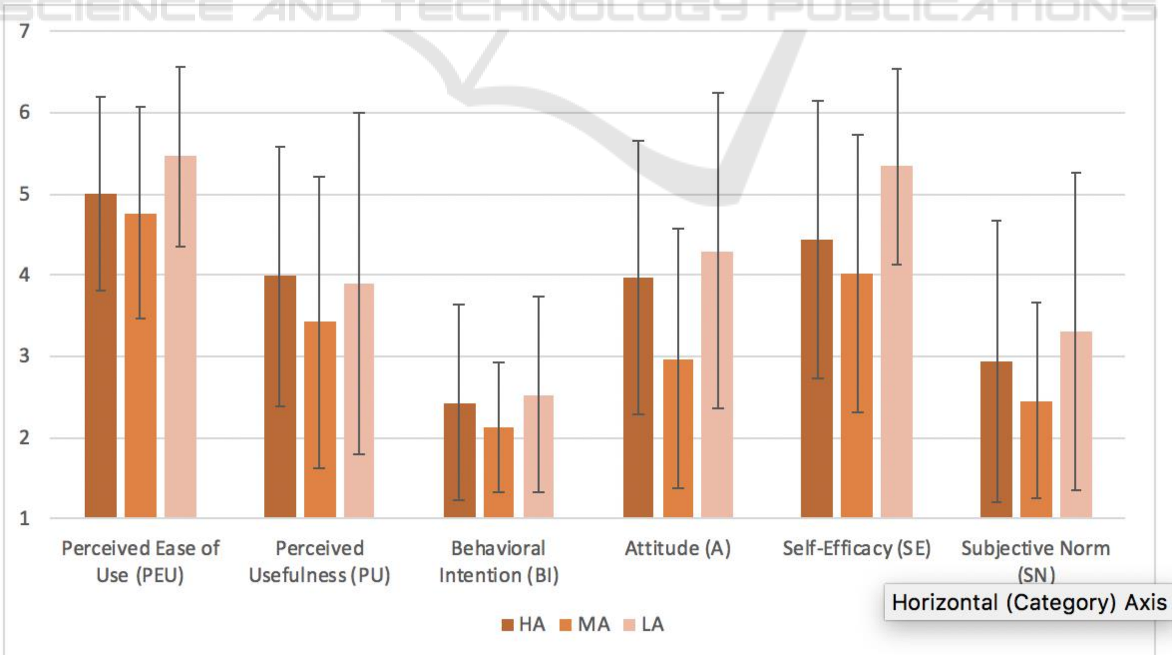


Figure 4: Means scores of TAM questionnaire.

5.2 Acceptance of SAR in Rehabilitation Therapy and as Robot Trainer

The Credibility/Expectancy questionnaire was used in Study One to evaluate how much patients believe and how much they feel that the social robot can be an effective aid during rehabilitation training. This questionnaire has a two-factored structure, three items are used for each, two of them are nine-point Likert scales, and the third is a scale from 0 to 100. The latter is converted to a nine-point scale by dividing by 12,5 and adding 1. The subscale items are added resulting in two aggregate scores ranging between from 3-27 for credibility and for expectancy respectively, with 15 as the midpoint of the scale. The mean scores for the three groups show that participants for conditions HA and LA have positive opinions on the credibility (HA: M=18.82, SD=5.18, LA: M=17.26, SD=7.4) and expectancy (HA: M=17.95, SD=4.26, LA: M=17.16, SD=6.64) of the training, and participants for condition MA have neutral scores for credibility (M=15.30, SD=7.21) and expectancy (M=14.87, SD=6.18), as visible in Figure 3.

The TAM questionnaire was used to measure the acceptance of the robot trainer. The results suggest that participants perceive the robot trainer as easy-to-use (PEU & SE), have a neutral attitude towards the concept (A) and are neutral with regards to its

Table 5: Patient Needs for SAR-Assisted Rehabilitation Therapy.

Pre-session		
Plan Making		Planning for short/ long term rehabilitative training plan
Therapy Informing		Information about the session including exercises, time, sporting facilities, goal, key points etc.
During Session		
Exercise Guidance	Demonstration	Step by step instruction about the exercise being practiced, with sufficient information for self-evaluation for the quality of the exercise.
	Guiding information	Counts of the movements, breathing techniques, breaks, next exercise etc.
Performance evaluation and correction		Therapist need to have an on-going evaluation of patients physical and mental state, exercise performance, then provide them with correction information, reminder of key considerations of the exercise, motivational prompts as they deem as needed.
Hands-on Assistance and Therapies	Posture correction	Hands-on correction for posture when the correction information is not well understood.
	Hands-on therapies	Massages etc.
Safety Supports	Case of emergencies	Possible situations might occur during the session like broken sporting facilities, physical instabilities and other factors that can potentially interfere with the session.
	Sports injuries	Dealing with spots injuries with physical and informational support.
Emotional Interaction	Social interaction	Patients suggest that social interactions with the therapist can help them to be calm and relax, mentally getting ready for the exercises.
	Motivational support	Providing timely motivational support when the patient is experiencing physical difficulties.
After session		
Progress Summary		Summarizing the session, helping the patient to reflect on his/her progress.
Plan for Next Session		Information about short/ long-term sessions later.

perceived usefulness (PU). Finally, participants have a below average mean score for the factors behavioural intention (BI) and subjective norm (SN) (see Figure 4).

5.2.1 Patients' Needs for SAR-assisted Rehabilitation Training

From analyzing the qualitative data, a section labeled "Patient Needs" emerged. Due to the limited contents of the scenario provided, participants were left with doubts about services they considered important in their own rehabilitation therapies, but which were not shown in the scenario. Over 100 quotes were collected and summarized into 9 categories of needs presented in Table 5.

5.2.2 Perceived Benefits of SAR-assisted Rehabilitation Training

"My own rehabilitation therapy was with a human, but it accomplished the same purpose." (HA17)

Mean scores of Credibility/Expectancy questionnaire show that participants have above average expectations from the rehabilitation therapy provided by a robot trainer.

Self-directed practice is considered to be an important component in rehabilitation therapy (Winkle *et al*., 2018). Quotes from the questionnaire confirmed that the process is mostly done by the patient him- or herself, and demands consistency and certain quantity. To this end, participants have confidence in having a robot trainer providing guidance, feedback and motivational prompts. Participants also mentioned the following additional benefits a robot trainer could bring about:

1. Providing Stable and Basic Services and Eliminating Human Errors and Interference.

"The facility I used insisted their doctor see me. He (the therapist) ignored my doctor's orders. This (robot trainer) would prevent that from happening." (MA19)

"I wouldn't feel judged while doing it. It seems positive and reassuring." (HA15)

Some participants mentioned their rehabilitation experience, during which, there were moments that they felt neglected, misdiagnosed or given the wrong instructions and being interrupted by inappropriate social interactions. These participants believed a robot trainer to be more goal-oriented, therefore enabling them to better focus on the training exercise and eliminating possible human errors.

2. Financial Benefits and Cost Effectiveness.

"My experience was that they were interested in what they could get from insurance, my needs were not." (HA18)

"Development of at-home exercises that can be performed without purchasing expensive equipment needed" (LA9)

Cost efficiency and flexibility brought by a robot trainer were expected by the participants, suggesting tele-rehabilitation is one of the most promising usage cases that can be developed for robot trainer.

5.2.3 Concerns about SAR-assisted Rehabilitation Therapy

Concerns primarily focused on 1) how the robot will make up for the loss of human specific values in rehabilitation therapy e.g. empathy, perceptions on the patients and the overall rehabilitation training based on experience and expertise, and capability of dealing with emergencies, 2) the normally included/expected therapies that are not shown in the scenario, e.g. massages, hands-on corrections, real-time demonstrations and exercise walk-through, and 3) the loss of social and emotional interactions. When it comes to evaluating patients' training performance, providing emotional support and dealing with emergencies and safety issues, participants remained concerned. The concerns centered on the participants' lack of trust in the robot trainer, since it does not have empathy towards the patient. Furthermore, patients doubted whether the motivational prompts would be perceived as sincere, or just pre-programmed prompts.

5.3 Anthropomorphism and Acceptance

Participants were asked to rate the look of the robot on a ten-point rating scale (0 = machine-like, 9 = human-like), as a manipulation check to ensure the independent variable — in this case the anthropomorphism level of the robot trainer — was perceived as intended. The scores in both studies turned out to be as intended. For study one, a one-way ANOVA analysis showed the perceived human-likeliness of the high anthropomorphic concept (M=4.28, SD=1.77), medium anthropomorphic concept (M=2.96, SD=2.33) and low anthropomorphic concept (M=.70, SD=1.03) were significantly different, F (2-70) =22.79, p<.001. In study two the three concepts were all shown to every participant at the same time. Participants were asked to rate all three concepts on anthropomorphism. One-way ANOVA analysis also shows a significant difference between the ratings of human-likeliness (F (2,89) = 121.34, p<.001) between the three versions (HA:M=6.67, SD=1.79, MA:M=3.1, SD=1.4, LA:M=.48, SD=1.46).

A one-way ANOVA analysis showed no significant effect of anthropomorphism on the credibility (F (2,68) = 1.89, ns) and expectancy (F (2,68) = 2.02, ns) of the SAR-assisted rehabilitation therapy.

A similar analysis on the outcomes of the TAM questionnaire found a significant preference for the low anthropomorphic concept (M = 5.34, SD = 1.2), over the high anthropomorphic (M = 4.43, SD = 1.71) and the medium anthropomorphic concept (M = 4.02, SD = 1.7) on the factor Self-Efficacy (SE), F (2,68) = 3.8, p < .05. No significant effects of anthropomorphism were found for the factors Perceived Ease of Use (PEU, F (2,68) = 1.84, ns), Perceived Usefulness (PU, F (2,68) = .7, ns), Behavioural Intention (BI, F (2,68) = .27, ns), Attitude (A, F (2,68) = 3.03, ns) and Subjective Norm (SN, F (2,68) = 1.15, ns).

In Study Two, participants were asked to choose their preferred version of the robot trainer. Participants preferred the high anthropomorphic concept (17 out of 31), followed by the medium anthropomorphic concept (9/31) and low anthropomorphic concept (5/31). 13 quotes indicated that the human-likeliness was the reason for choosing the high anthropomorphic concept, 7 quotes because it looks warm and feels personal, and 6 quotes because it seems most able to provide a better and more varied service. Reason for participants who chose one of the other two concepts were 1) participants feel safe around them, 2) participants are unfamiliar with the high anthropomorphic concept, not knowing what to expect, and 3) a robot trainer with high anthropomorphic appearance, but only voice interaction, is considered unintelligent. A low anthropomorphic robot trainer offering the same interaction was deemed realistic within the current situation. In line with this reasoning, a unique group of quotes appeared for the high anthropomorphism concept. These 15 quotes inquired whether the robot would provide hands-on training assistance. This highlights a potential link between the robot's appearance and users' expectations about its functionality.

All three concepts got quotes suggesting to make the robot trainer more human-like rather than machinelike, which indicates a preference for high anthropomorphic SARs for rehabilitation training (see Figure 5). Interestingly, most of these quotes were proposed in relation to the most anthropomorphic concept.

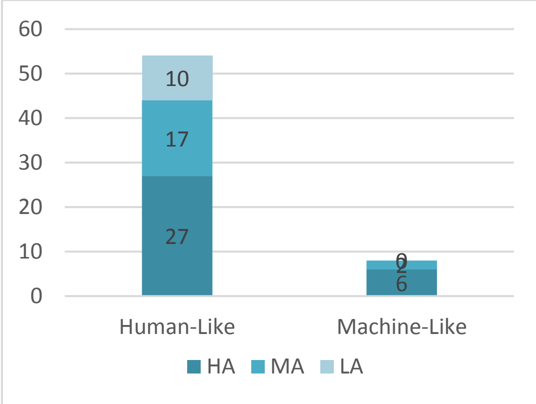


Figure 5: Number of Quotes for Desired Anthropomorphism Level.

6 DESIGN IMPLICATIONS

6.1 Managing Form Factor and Patient's Expectations

Patient's expectations are related to their impressions of the robot trainer, and were found to affect patients perceived self-efficacy toward the robot trainer. The form design of the should fit the task that will be performed, as the form factor of the trainer is indicative for the patients to assume the service that will be offered. Therefore, the form design of the robot trainer should be referred to the task assigned to it, and made easy for patients to have a realistic expectation and a positive opinion.

6.2 Connecting to Wearable Technologies

One of the participants' major concerns is the quality of the feedback given by the robot trainer. Also, trust is a crucial issue in a medical context. The use of wearable technologies has the potential for dealing with both issues. Data like heart rate, perspiration, body posture, speed, muscle tension and more can provide a more comprehensive understanding of the training condition of the patient (Beckerle *et al.*, 2017), giving a more accrete and timely understanding of the situation in progress. Furthermore, being able to see the instrument of measuring would help in explaining and specifying the process and content of user data collection, therefore facilitating better trust in SAR-assisted rehabilitation therapy.

6.3 Allowing Emotional Input for Tailored Experience

A physiotherapist is always able to pick up emotional conditions of the patient, therefore can select the suitable motivational prompts accordingly. Being able to acquire and respond appropriately to a patient's emotional condition can better help to tailor the experience offered, and can help to fast-forward the adaptation phase, where the robot trainer has to learn about the patient.

7 LIMITATIONS OF CURRENT STUDY

The main limitations pertain to the nature of the materials presented to participants (sketches and scenarios) and the sampling approach (crowdsourcing). The attitudes expressed are based on imagined experiences based on very limited stimuli. More extensive and realistic exposure to a robot acting as a coach in rehabilitation therapy would provide higher confidence in the results found, and further study will also shift focus to elder groups which fits better with rehabilitation context. Second, with crowdsourcing one is constrained to the crowdsourcing platform as a sampling frame. This allows surveys that cover different geographical areas, but the sample may be skewed to people very familiar with internet technology. Further, there could be potential for more satisficing behaviors from crowd workers interested to earn the reward rather than provide good data. On the upside, methodological research has shown that crowdsourcing can be effective and valid approach for accessing participants and that crowd workers can actually be more motivated to provide good quality answers(Stewart *et al.*, 2017). Moreover, suitable checks were made to check on the quality of the data in accordance to the screening process and verifying reversed questions.

8 CONCLUSION

This work explores of patients' acceptance for socially assistive robot in rehabilitation settings, and the use anthropomorphic form factor in robotic design in this context. We discovered that 1) participants have a neutral to positive attitude towards SARs and it's use in rehabilitation therapy as trainer, 2) the SAR technology in therapies is regarded easy to use but participants generally lack intention for using the system, which is possibly due to unfamiliarity with SARs and lack of trust for them, 3) the level of anthropomorphism has an effect on patients' self-efficacy and attitude for the robot trainer, a potential link exists between SAR form factor and user expectation for its service, 4) high anthropomorphic concept is generally preferred. As we found out, to bring SAR into rehabilitation therapies, much work is yet to be done in solving patient concerns, improving the quality of the therapy and developing detailed personalized motivational strategies. Further studies should replicate and elaborate these results while exposing patients to more realistic experiences of social-robot assisted rehabilitation therapy and include proximal (non-crowdsourced) studies with actual patients.

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