Applying persuasive design to support the elderly in home rehabilitation: Report on explorative studies

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Abstract. Persuasive design in the context of home rehabilitation of the elderly has been applied. Developing various prototypes based on persuasive features and behavioral changes helps to tune to more personalized solutions and serves as a valuable tool for implementing blended care in the practice.

Keywords. Home rehabilitation, elderly, persuasive design, eHealth

1 Introduction

This paper reports on applying principles of persuasive design and behavioral changes in order to support home rehabilitation of the elderly (> 65 years old). Osteoarthritis is common amongst the elderly population, the placement of joint prosthesis is often the outcome. The elderly population worldwide is growing, the occurrence of joint replacement therefore increases proportionally [1]. After being discharged from the hospital, rehabilitation is supported by a physical therapist. The aim is to improve mobility by exercises and information about doing these exercises. To recap the exercises after the therapy sessions the patients are often given folders or videos. Physical therapists experience a difference in the treatment in their practice and the exercise the patient performs at home.

The aim of the reported work was twofold: to explore the persuasive design principles which can be applied to support home rehabilitation of the elderly, and to gain educational insights by having students from different disciplines use persuasive design in order to develop a sustainable solution for this healthcare situation.

In the work reported here the following typical case was used: *Mrs. Smits (70) is single and lives independently. She has been suffering from severe pain in her hip and her mobility was reduced due to stiffness in the hip joint. Her general practitioner has referred her to a hospital and she had a hip replacement surgery. After a short stay in the hospital she was sent back home. The physical therapist has given her some exercises she has to do every day. He advised her an app on her tablet where she can see how the exercise needs to be done. She finds it difficult to perform the exercises, she doesn't know if she is doing it right and has little motivation to continue doing them.*

2 Method

2.1 Theoretical framework

In order to design adequate and personalized eHealth solutions targeted at the elderly for home rehabilitation, we use the CeHRes roadmap as the basic framework [2]. The roadmap guides planning, coordination and execution of the participatory development process of eHealth. It takes a holistic research and development approach and consists of iterative phases: starting from contextual inquiry, towards defining requirements and designing the application, and aiming at implementation in the practice. The work reported here is exploratory and does not include implementation. In the course of the different phases, persuasive elements from the model of Oinas-Kukkonen [3] and the behavioral model of Fogg [4] are being applied [5]. During the contextual enquiry phase, the persuasive context helps to acquire a deep understanding of the targeted user. In the context of home rehabilitation, the elderly person is the main user of the application engaging in the rehabilitation process. The physical therapist is there to assist at a distance and providing the necessary guidance. Important aspects such as living conditions (alone of with a partner), activities, preferences etc. are being gathered. The information collected helps to define personas, scenarios and requirements. During the design phase, persuasive design features from the design principles are scrutinized and selected for the eHealth solution, and prototypes are being developed. During the various phases of development, the user's level of motivation and his/her ability to carry out a task are identified. The behavior model of Fogg provides the conditions under which behavioral change is meant to occur.

2.2 Explorative studies

In order to explore how persuasive design principles can be applied in the case of elderly's home rehabilitation, we carried out three explorative studies. In each study, a group of students worked with our Medical Technology Group on eHealth solutions. The case of Mrs Smits (see section 1) was used for the assignment. Students were asked to develop an eHealth application that could support Mrs. Smits in her rehabilitation at home. This application should help/assist Mrs Smith in doing her exercises and should be based on the eHealth methodological approach using the CeHRes roadmap and the persuasive design aspects. There were no strict instructions on how to apply and use the persuasive design principles. Therefore, creativity of the students was encouraged.

Study #1 (group named InfoFysio): a group of three third year informatics students from Inholland University of Applied Sciences worked on this assignment for nine weeks as part of the Minor User Experience.

Study #2 (group named Stapp-app) and study #3 (group named Blue): Per study, a group of three to four fourth year students from Rotterdam University of Applied Sciences worked on this assignment for six months as part of the Minor Healthcare Technology. The groups were interdisciplinary with students from different educational programs (informatics, biomedical sciences, physical therapy, Occupational

therapy, health care). These student assignments were part of an exchange collaboration facilitated through our Vitale Delta Research Program (https://www.vitaledelta.nl/).

3 Results

3.1 Developing the prototypes

In the three studies, a prototype integrating persuasive features was developed. The level of prototyping depended on the programming related skills that students had within one group. Wire frames and mocks-up where used in study #1 and study #3. In study #2, the students provided a programmed app as one informatics student was involved. During the development of the prototypes, the targeted users were involved, namely during the contextual enquiry (see 3.2) and to test the final version of the prototype.

3.2 Contextual enquiry

In the three studies, the context was fully investigated, resulting in interviewing elderly people as well as healthcare professionals such physical therapists, nurses and general practitioners. This was complemented with a literature review about the targeted group, rehabilitation at home and the use of eHealth in this context.

Across the three studies, similar problems experienced by the elderly emerged. This included for example anxiety to fall, not knowing how to do the exercises, having little motivation and support. Co-creation sessions were carried out to provide a better understanding of the context provided in the case. **Fig. 1** shows on the left an example from study #2 of paper based mocks-up which were shown to the users. In the middle, an experience map from study #1 and to the right a user testing the end solution from study #3.



Fig. 1. Examples of contextual enquiries

3.3 Applying persuasive design principles

Various persuasive design elements where incorporated in the three prototypes.

Primary tasks support: Self-monitoring was often used as a persuasive design principle**.** Self-monitoring was explicated in different ways: 1) monitoring the number of steps (see left screenshot in **Fig. 2** from study #2), 2) monitoring of pain score during particular exercises (see middle screenshot in **Fig. 2** from study #1) and 3) moni-

toring how easy or difficult was a particular exercise (see right screenshot in **Fig. 2** from study #1).



Fig. 2. Examples for primary support tasks

Two others principles to support doing exercising were also used namely rehearsal and simulation. **Fig. 3** and **Fig. 4** show examples used in study #3 and study #1 respectively. The user is given instructions on how to correctly perform an exercise. Videos were combined with text and photos to rehearse the targeted behaviors and provide enough information to the user.



Fig. 3. Examples of exercising from study #3

Tailoring and personalization were also taking in account. The exercises provided to the user are the exact exercises one needs to do in order to recover. Various ways to exercises were also provided to align with the user's preferences. For example in study #1 different sort of activities such as cycling, walking, or squat were introduced (see right screenshot in **Fig. 4**).

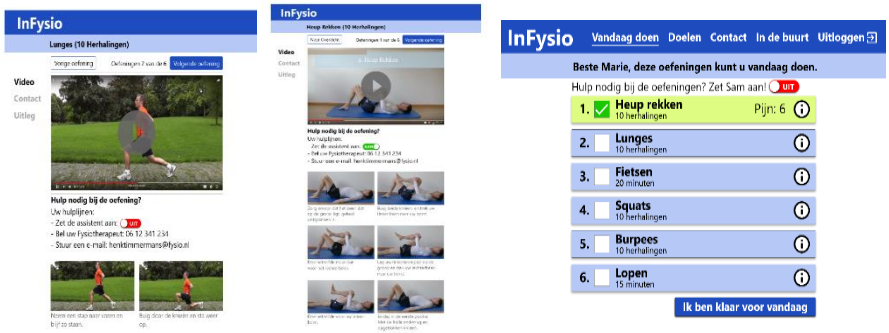


Fig. 4. Examples of exercising from study #1

In addition to the primary task “exercising”, goal setting is an important aspect of home rehabilitation. Achieving goals is not easy and requires not only knowledge from the client but also (intrinsic) motivation and support. In study #3 visual graphics were used to show progress of goal achievement (see left screenshot in **Fig. 5**) while in study #2 the metaphor of a flower with different colors was used (see right screenshot in **Fig. 5**).

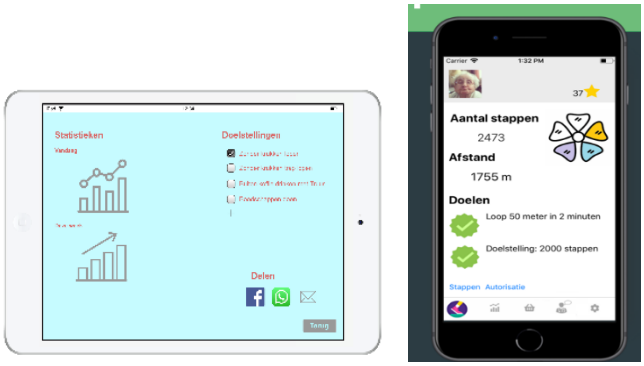


Fig. 5. Examples for goal setting

Dialogue support: Reminders were used for example to remind the user a) to perform some particular exercise at a given moment or b) of an appointment with his/her physical therapist (see left screenshot in **Fig. 6** from study #3). Dialogue support also incorporated an option to contact the healthcare provider via video, telephone or chat. Given that the targeted group includes elderly, providing more “traditional” ways of communication such as telephone contact was assumed appropriate (see middle screenshot in **Fig. 6** from study #3). A dialogue with an healthcare professional was also possible during exercises (See the green button in the right screenshot in **Fig. 6** from study #1). This was seen as a valuable option given that the elderly often feels insecure and uncertain about performing their exercises.

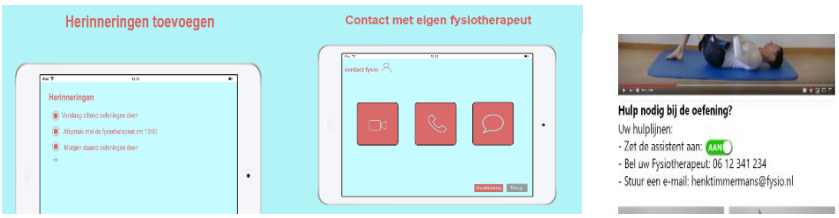


Fig. 6. Examples of dialogue support

Credibility support: This design principle is closely intertwined with the principles in the primary tasks support. For example, the exercises shown in **Fig. 3** and **Fig. 4** were validated by physical therapists, providing information which is trustworthy, credible and from experts.

Social support: Some attention was given to social support principles. In study #1 (see left screenshot in **Fig. 7**), the user was given information to exercise with other people in his/her neighborhood, offering social contact but also stimulating motivation. The use of social media such as Facebook or WhatsApp as options to share results with other people was also introduced in study #3 (see left screenshot in **Fig. 5**). In addition, an avatar was introduced in study #1 to help the user to perform his/her exercise (see right screenshot in **Fig. 7**).



Fig. 7. Examples of social support

3.4 Interface design

Students from the three studies developed graphical user interfaces which could be suitable and match the needs and preferences of the targeted groups. Attention was given for example to the colors and choice of logos, and ways to provide overviews of the current status as seen in the right screenshot in **Fig. 5**).

4 Discussion

This paper reported on three studies carried out to explore eHealth solutions based on persuasive design principles in the context of home rehabilitation of the elderly. The studies were carried out by third year students in collaboration with our Medical Technology Research Group of the Inholland University of Applied Sciences. Students were supervised by members of the Medical Technology research group (authors 1 & 2), in addition to their tutors from their educational programs.

4.1 Research added value: applying the theories

Results from the developed prototypes show that various design principles were applied (from primary task support, dialogue support, credibility support and social support). Most attention was given to the primary tasks support, for exercising and goal setting. This is not surprising given that it was the central focus of the casus. In addition, one or more persuasive design features was used for all the support groups. Results also point out that there is more than one way to apply a specific persuasive feature. This is clearly shown for the task support in the way exercises were promoted in study #1 and in study #3 (see **Fig. 3** and **Fig. 4**). Further work is needed to investi-

gate which other persuasive design principles to support home rehabilitation could be applied and under which conditions. This is specifically relevant when it comes to motivation. Recent research [6] emphasizes the role of motivation for compliance in exercising. Another study [7] has shown that in the context of home rehabilitation, data registration is crucial. It helps the user to gain better insights in the exercises which are being done and to give the healthcare provider the right information for online guidance and feedback. Solutions for this aspect developed in the three prototypes were kept simple. However, they provide good examples, and can help to further explore the application of design principles to reinforce this task of data registration.

4.2 Educational added values

Students were new to persuasive design. A workshop was given by two researchers (authors 1 & 2) of the Medical Technology Research Group to explain the models of persuasive design and behavioral change as well as introducing the casus. In addition students came from different disciplines, allowing them to address a problem from different perspectives. For most of the students, this was an eye opener. This is a valuable learning aspect of the assignment. Students had a restricted number of weeks to develop the eHealth solutions (9 to 24 weeks). During this period of time, they had to comprehend not only the theoretical models and but also how to apply those. In addition, they needed to decide how much time was spent for each phase to develop the application. Despite these constraints, each group produced an interesting and workable eHealth solutions. The composition of the groups may also have affected how their approached the problem and ended up with a solution. Informatics students in study #1 had no healthcare background, taking a user experience perspective relying on the knowledge of healthcare professionals. In study #2 the students had a technical and health sciences background, they spent time not only on the healthcare aspect (exercises) but also on software development. Group #3 did not include technical students and focused mainly on the healthcare issue.

4.3 Added value for the practice

Home rehabilitation after a hip or knee operation often remains a challenge for a growing number of elderly and limits participation and self-management. At the same time, recent research [8] indicates that healthcare professionals such as physical therapists faced a number of barriers in implementing eHealth applications. This includes for instance knowledge about using technology as well financial aspects. Nevertheless, physical therapists are nowadays more open to use eHealth based solution to support their clients. The Covid-19 crisis has amplified the urgency of using blended care for home rehabilitation with the elderly. One area which is of great concern for the physical therapists is promoting and stimulating behavioural changes of their clients. We are currently working together with physical therapy practices in The Hague area in the Netherlands in order to develop appropriate eHealth solutions based on persuasive design principles. Persuasive technology based on persuasive design prin-

ciples is new to the majority of healthcare professionals. The developed prototypes reported here can provide (in addition to other tools) means in engaging in the co-creation of dedicated eHealth solutions. Home rehabilitation often presents practical obstacles. For example, the elderly experience problems performing General Daily Life Operations (ADL) and they experience psychosocial problems such as loneliness and depression [9]. Rehabilitation at home involves often a long term process, new behaviours need to be learned and lifestyle needs to be changed. In this context, persuasive eHealth based application provides an adequate means for sustaining long term behavioural changes.

5 Conclusions

Home rehabilitation for the elderly presents a number of challenges and limits participation and self-management. Developing various prototypes based on persuasive features and behavioral changes helps to tune to more personalized solutions and works as a tool for blended care interventions.

Acknowledgements

We would like to thank the students from the Inholland University of Applied Sciences (Minor User Experience), and from Rotterdam University of Applied Sciences (Minor Healthcare Technology) for their work in developing the eHealth solutions.

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