Applying Human-Centered Design to Develop Motivating Exergames

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Abstract

Lifestyle diseases like unspecific back pain affect a large percentage of the population, especially in the age group 55 and older. Physiotherapy exercises are often perceived as dull and boring and many patients are not motivated to perform them regularly. Exergames can motivate patients to perform their exercise through playing a game, however, designing motivating game elements that generalize well to a variety of exercises is challenging. We report on our development process, on how we employ human-centered design in order to create motivating exergames, and on how we developed the concept of Living backgrounds as the result of this design process.

1 Introduction

In modern society lifestyle diseases are affecting a large percentage of the population and have become a major challenge for health care systems. Further pressure is added through demographic change. Besides a generally increased level of healthcare requirements for older adults and obesity related diseases, back pain is one of the most common issues. Prominent causes include a general lack of physical fitness in combination with sitting for extended periods during the day. While more and more people already suffer from back pain at a young age, typically the chance of getting problems increases over time, especially in the age group 55 and older.

Many patients with clinically reported nonspecific back pain undergo a form of physiotherapy either to treat the pain directly or for rehabilitation after surgical interventions. In addition to manual treatments such as massages that are applied by the therapists, active physical exercises are the most important part of a successful therapy. However, maintaining a high level of motivation to regularly perform repetitive exercises can be challenging and a lack of motivation can endanger the success of the therapy. Additionally, the time that is available for therapists to provide detailed guidance is very limited and the patients are therefore often unsure whether they perform the exercises correctly.

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As several works over the past years have indicated, game elements can potentially increase motivation and offer helpful feedback and analysis to patients and to therapists (Gerling et al. 2012; Herrlich et al. 2014; Smeddinck et al. 2015). Exergames are digital games designed with the goal to engage players in performing physical exercises while playing the game. These can either be general exercises for increasing the player's general fitness and health or exercises for treating specific diseases or health problems. Exergames usually track the player's movements by an appropriate sensor device, e.g., a special camera or with sensors that are attached to the player's body.

A major challenge in exergame development is the design of motivating game elements and reward structures. These elements should motivate the players while also supporting them with performing the correct (and often very specific set) of exercises at the right exertion level. In this regard, dynamically adapting the difficulty and exertion levels as well as providing accurate and on-time feedback to the patient are important considerations as well (Göbel et al. 2010; Hardy et al. 2013; Smeddinck et al. 2013).

In this work, we discuss the concept and first phase of implementation for an exergame intended to motivate patients to perform exercises as part of physiotherapy for nonspecific back pain. It is part of the BMBF funded project Adaptify[1]. We present first results from applying a human-centered design methodology to investigate possible motivational game elements.

2 System Overview

The main goal of our approach is to develop exergames as effective and usable therapy tools that can be integrated into the daily routine of patients and therapists. Therefore, both the patients' and the therapists' requirements and perspectives have to be considered. Our system features three key components working together to achieve this goal: (1) motivating exergame frontends, (2) a powerful but usable settings interface for therapists, and (3) an intelligent adaptation backend.

The game frontends present the exercises in a motivating manner and they also represent the main interface to provide important real-time feedback to the patients. Additionally, they collect rich movement and other data, e.g., game scores, needed to improve the adaptation and personalization. In this way, they can offer guidance on how exercises should be performed during a session and immediately afterwards. Furthermore, the system can also offer objective analyses for therapy support regarding the medium- and long-term development of patients.

The exergames are parametrized through the settings interface that is mainly intended for the therapists in order to plan the therapy and follow the patients' progress. But it is also available in a reduced version to the patients themselves in order to provide more detailed analysis and to allow them to follow their own progress in an empowering, more self-directed manner.

[1] https://www.adaptify.de/, last viewed 2016-06-25

The third important component is the adaptation service that is based on heuristics and rules which are developed together with therapists. Machine learning techniques employing the collected (anonymized) exercise data with the goal to adapt the exercise selection and other parameters like exercise intensity, number of repetitions, the difficulty but also game parameters such as the reward calculation.

3 Human-Centered Design for Increased Motivation

We follow a human-centered design methodology that is in principle based on different stages of prototyping and quick iterations. This is an established practice in general game development and interaction design (Fullerton et al. 2004). However, the serious purpose of games for health requires that both the game experience and therapeutic efficiency are considered as important outcomes. Our design "toolbox" therefore consists of the following elements: lab internal design sessions, design sessions together with therapists and other domain experts, formative focus groups, and evaluation sessions with patients and therapists separately and together. Additionally, summative studies are employed to validate design choices after important milestones.

The first step in our design process consists of formative and open sessions together with domain experts. Here we identify general requirements, constraints and ideas. This stage is also important to get a better feel for aspects relating to the work, culture and language of the specific domain. In our concrete case it quickly became evident that the exergame concept and design should be playful but not overloaded with game aspects, in order to provide a professional appearance in line with the serious purpose of supporting therapy. The domain experts emphasized qualities like "seriousness" and a visual design that should be realistic, clear and calming. This initial very rough characterization was further iterated in expert rounds, e.g., by employing lists of exergame specific design choices (Mueller et al. 2011), game mechanics, and gamification techniques (Deterding et al. 2011). We also created non-interactive visual prototypes, e.g., using image layers with different alternatives that could be switched on and off during a design session.

In parallel to iterating the game design and motivational aspects, we conduct formative studies and focus groups to evaluate and select exercises based on a large library of existing training programs provided by the domain experts. These studies focus on technical aspects but they also include important motivational factors as the motions themselves can be perceived very differently by participants, e.g., some might find them "awkward", boring or making them look ridiculous. Bringing together these different aspects and impressions we conducted two one-day workshops including 2 therapists and 12 patients (6 older adults in the first workshop that was situated in a meeting center for older adults; 4 older adults, 2 middle-aged adults, and 2 therapists in the second workshop that was situated in a physiotherapy practice) in order to collect more detailed feedback on our design concepts and ideas. After an introduction to familiarize the participants with the general topic and showing examples of exergames, we let the participants form small groups in which they were asked to collect and arrange game elements they found important or interesting, allowing them to create their own game screens.

We supported them by providing a large range of game elements, e.g., avatars, typical elements like leader boards, different backgrounds, printed on paper and cut out so they could then select and arrange them as they liked on a paper-based game screen. Afterwards, the paper game screen and its elements were discussed together with the groups and rated according to their importance and emotional qualities. We conducted additional semi-structured interviews and recorded the session on video for later analysis.

4 Resulting Motivational Game Elements

Generally, the target group reacted very differently (either very positively or very negatively) to common game concepts like leaderboards or comparison/competition with other players or themselves. Younger participants favored competition oriented elements, while older participants preferred nature-oriented designs, and the therapists added elements intended for adjusting the exercises.

Taking the heterogeneous feedback into account, we developed the concept of "living backgrounds". Living backgrounds are intended to provide soft rewards, i.e., rewards that are optional to the progress in the game but that motivate players by triggering their curiosity, stimulating them visually and also address a passion for collecting and ordering things that motivates many people. The basic idea is to provide realistic and visually interesting backgrounds according to the preferences of the target group. Many participants agreed on a preference for nature-oriented scenarios like beaches or the sea, woods, or mountains. At the beginning of the game or exercise session these backgrounds start out in a very simple version, which is then enriched as the player progresses by successfully performing exercises. The background "grows" in a way, hence the term "Living background". This effect can be achieved in different ways, e.g. the background can be populated with interesting objects or parts of the background can be occluded or provided in a low detail version at first and then the missing parts of the background or details are added in bit by bit.

Participants generally agreed on a preference for a direct representation of themselves and the instructor inside the virtual game as a realistic human avatar. When using living backgrounds, this can be easily achieved by fitting a video stream of the player and a video recording of an instructor into the backgrounds. Additionally, living backgrounds will be complemented by simple and easy to process in-game and more detailed reflective post-game feedback on the player's performance and progress, however, in a manner that emphasizes the therapeutic aspects and not competition.

5 Conclusion

In this work, we presented our approach of developing adaptable exergames for physiotherapy. We provided a brief system overview of the key components and discussed how we employ a human-centered design methodology and what tools we are using in order to include our target

group into the development process. We reported on one exemplary workshop that lead to the concept of living backgrounds for motivating players while providing great flexibility and generalizability independent from the actual exercise program.

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