
Applying Behavior Change Theories For A Cardiac Rehabilitation Application

Supraja Sankaran

Hasselt University-tUL-iMinds
Expertise Centre for Digital Media
Wetenschapspark 2,
3590 Diepenbeek
supraja.sankaran@uhasselt.be

Kris Luyten

Hasselt University-tUL-iMinds
Expertise Centre for Digital Media
Wetenschapspark 2,
3590 Diepenbeek
kris.luyten@uhasselt.be

Paul Dendale

Hasselt University-Faculty of
Medicine & Life Sciences,
Agoralaan, 3590 Diepenbeek
Jessa Hospital- Department of
Cardiology, Stadsomvaart,
3500 Hasselt
paul.dendale@uhasselt.be

Karin Coninx

Hasselt University-tUL-iMinds
Expertise Centre for Digital Media
Wetenschapspark 2,
3590 Diepenbeek
karin.coninx@uhasselt.be

Abstract

Telemonitoring and tele-rehabilitation show tremendous potential to be effective approaches for secondary prevention and rehabilitation in heart patients, such as Coronary Artery Disease (CAD) patients. However, studies show a gradual decline of interest, lack of motivation and resistance to modify behavioral patterns among patients over a period of time, resulting in a lack of therapy adherence. Adopting persuasive technology in tele-rehabilitation applications contributes to solve these issues. In this paper, we highlight various theoretical frameworks related to persuasion, which aid in designing mobile applications supporting long-term behavior change and keeping patients motivated for the tele-rehabilitation program.

Introduction

Coronary Artery Disease (CAD) patients are initiated into a rehabilitation program at hospitals or specialized centers by medical staff and are informed about various risk factors and need for behavior change. However, geographical distance to rehabilitation centers, lack of motivation, psychological barriers and lack of time [3, 4] lead to decline in interest, motivation and a resistance to change behavioral habits [1, 2]. To overcome such setbacks, medical research has

Copyright statement

Persuasion target zone	Design patterns
Cognition	Illusion of control
	Need for closure
	Status quo bias
Perception and Memory	Reminders and Suggestions
	Tunneling
	Reduction
Game mechanics	Praise and Rewards
	Completeness meter
	Prolonged play
Social role	Credibility
	Coaching
	Interaction with caregivers
Feedback	Kairos
	Feedback loops

Table 1. Persuasive Design Patterns to influence behavior change in a personalized tele-rehabilitation application.

identified great potential in using telemonitoring systems for CAD patients [5]. Some studies also prove the effectiveness of motivation-oriented mobile applications to deliver personalized healthcare and achieve a better alignment with the individual needs of patients[6].

In our approach to realize a comprehensive tele-rehabilitation application, mobile devices play a vital role in delivering personalized interventions effectively. They provide guidance for patients’ behavior change in their daily life environment, besides communicating monitored parameters (such as blood pressure, physical exercise level etc.) to the telemonitoring unit. Furthermore, there is preliminary evidence that persuasive systems modelling may assist in identifying key behavioral patterns that may foster behavioral maintenance[7]. King et al. [8] suggest that the integration of behavioral science theory with an iterative user-oriented design process may enhance the potential of mobile applications aimed at promoting behavior change in key health areas such as promoting physical activity.

This is exactly the approach we are exploring while designing and developing a comprehensive tele-rehabilitation application for CAD patients.

Theories and Models

While designing the tele-rehabilitation application, we identified various persuasive design patterns that need consideration, and are presented in Table 1. These patterns were assessed to be in line with the findings of a recent medical review that consolidates the results of various studies and identified some core features for applications related to cardiovascular disease [9].

Fogg Behavior Model

The Fogg Behavior Model (FBM) [10] states that for a target behavior to happen, a person must have sufficient motivation, sufficient ability, and an effective trigger. All three factors must be present at the same instant for the behavior to occur. With respect to tele-rehabilitation, patients need to be able to sustain their motivation and abilities over a prolonged period. We therefore classified the selected design patterns as motivators, abilities and triggers to apply FBM in our design approach (Figure 1).

Persuasive Systems Design Model

The Persuasive Systems Design (PSD) Model is a conceptual framework that suggests three phases for persuasive systems development that lead to behavior change:- (1) understanding key issues behind persuasive systems, (2) analyzing the persuasion context and (3) design of system qualities [11]. Having thoroughly evaluated the issues in conventional rehabilitation practices (through the involvement of cardiologists, physiotherapists and other medical staff in the project team) and the need for persuasion, we have clearly established the first two phases of PSD. As for phase three of designing system qualities, we mapped the identified persuasive design patterns (Table 1) to the suggested design patterns in PSD.

Behavior Wizard

The Behavior Wizard provides a method to match types of target behaviors with solutions for achieving them [12]. In cardiac tele-rehabilitation, it is also important to personalize the target behaviors based on patient-specific pathologies [4]. Therefore, using the Behavior Wizard we categorized patients into different behavior modalities based on pathologies to design a more

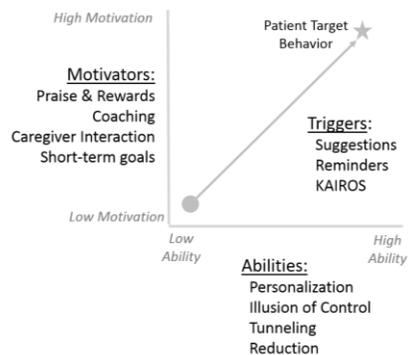


Figure 1. Selected persuasive design patterns classified as motivators, abilities and triggers in FBM.

tailored tele-rehabilitation application. For example, a CAD patient who has suffered from cardiomyopathy is classified into the modality that targets decreasing behavior intensity (such as physical exercise intensity) for a specific span of time.

Perspectives

In an attempt to realize a comprehensive tele-rehabilitation application for CAD patients, we started from the Fogg Behavior Model, Persuasive Systems Design Model and Behavior Wizard and applied some persuasive design patterns and behavior modalities. Reflecting in terms of FBM, PSD model and Behavior Wizard, facilitated eliciting user requirements. These requirements will be elaborated upon in the following stages of our iterative user-centered design process. We strongly believe that this approach to design will help motivate patients and increase therapy adherence.

References

- [1] K. I. Turk-Adawi, N. B. Oldridge, S. S. Tarima, W. B. Stason, and D. S. Shepard, "Cardiac rehabilitation patient and organizational factors: what keeps patients in programs?," *J. Am. Heart Assoc.*, vol. 2, no. 5, p. e000418, 2013.
- [2] W. M. Mampuya, "Cardiac rehabilitation past, present and future: an overview.," *Cardiovasc. Diagn. Ther.*, vol. 2, no. 1, pp. 38–49, 2012.
- [3] K. Patrick D. Savage, Bonnie K. Sanderson, Todd M. Brown and P. A. A. Berra, "Clinical Research in Cardiac Rehabilitation and Secondary Prevention: Looking Back and Moving Forward," vol. 31, no. 6, pp. 333–341, 2012.
- [4] D. Hansen, P. Dendale, A. Raskin, A. Schoonis, J. Berger, I. Vlassak, and R. Meeusen, "Long-term effect of rehabilitation in coronary artery disease patients: randomized clinical trial of the impact of

- exercise volume.," *Clin. Rehabil.*, vol. 24, no. 4, pp. 319–327, 2010.
- [5] I. Frederix, N. Van Driessche, D. Hansen, J. Berger, K. Bonne, T. Alders, and P. Dendale, "Increasing the medium-term clinical benefits of hospital-based cardiac rehabilitation by physical activity telemonitoring in coronary artery disease patients.," *Eur. J. Prev. Cardiol.*, 2013.
- [6] A. Emrich, A. Theobalt, D. Werth, and P. Loos, "Motivation-oriented Mobile Training: A Novel Concept for Rehabilitation and Personal Fitness," *Int. J. Eng. Innov. Technol.*, vol. 3, no. 1, pp. 1–10, 2013.
- [7] E. B. Hekler, M. P. Buman, N. Pothakandiyil, D. E. Rivera, J. M. Dzierzewski, A. A. Morgan, C. S. McCrae, B. L. Roberts, M. Marsiske, and P. R. Giacobbi, "Exploring behavioral markers of long-term physical activity maintenance: a case study of system identification modeling within a behavioral intervention.," *Health Educ. Behav.*, vol. 40, p. 51S–62S, 2013.
- [8] A. C. King, E. B. Hekler, L. a. Grieco, S. J. Winter, J. L. Sheats, M. P. Buman, B. Banerjee, T. N. Robinson, and J. Cirimele, "Harnessing Different Motivational Frames via Mobile Phones to Promote Daily Physical Activity and Reduce Sedentary Behavior in Aging Adults," *PLoS One*, vol. 8, no. 4, pp. 2–9, 2013.
- [9] L. Neubeck, N. Lowres, E. J. Benjamin, S. Ben Freedman, G. Coorey, and J. Redfern, "The mobile revolution—using smartphone apps to prevent cardiovascular disease," *Nat. Rev. Cardiol.*, 2015.
- [10] B. Fogg, "A behavior model for persuasive design," *Proc. 4th Int. Conf. Persuas. Technol. - Persuas. '09*, p. 1, 2009.
- [11] H. Oinas-Kukkonen and M. Harjumaa, "Persuasive systems design: Key issues, process model, and system features," *Commun. Assoc. Inf. Syst.*, vol. 24, pp. 485–500, 2009.
- [12] B. J. Fogg and J. Hreha, "Behavior Wizard : A Method for Matching Target Behaviors with Solutions."