
SCIENCE • TECHNOLOGY • RESEARCH HIGHLIGHTS • VISIONS •

Dissertation
68

# On the development of persuasive systems

## A framework for designing and evaluating behavior change support systems and its applicability for e-Health

Marja Harjumaa

VTT

VTT SCIENCE 68

# On the development of persuasive systems

## A framework for designing and evaluating behaviour change support systems and its applicability for e-Health

Marja Harjumaa

VTT

*Thesis for the degree of Doctor of Philosophy to be presented with due permission for public examination and criticism in Auditorium IT115, at University of Oulu, on the November 14th at 12 noon.*

ISBN 978-951-38-8169-6 (Soft back ed.)
ISBN 978-951-38-8170-2 (URL: http://www.vtt.fi/publications/index.jsp)

VTT Science 68

ISSN-L 2242-119X
ISSN 2242-119X (Print)
ISSN 2242-1203 (Online)



JULKAISIJA – UTGIVARE – PUBLISHER

VTT
PL 1000 (Tekniikantie 4 A, Espoo)
02044 VTT
Puh. 020 722 111, faksi 020 722 7001

VTT
PB 1000 (Teknikvägen 4 A, Esbo)
FI-02044 VTT
Tfn +358 20 722 111, telefax +358 20 722 7001

VTT Technical Research Centre of Finland
P.O. Box 1000 (Tekniikantie 4 A, Espoo)
FI-02044 VTT, Finland
Tel. +358 20 722 111, fax +358 20 722 7001

Cover image: iStockphoto

Grano Oy, Kuopio 2014

# Preface

This piece of work has a long history. It all started in 2005 when I was working at the Department of Information Processing Science, University of Oulu, and gained a position in the Infotech graduate school. I was fortunate in being able to continue with the topic at VTT Technical Research Centre of Finland later on, after I started there in 2010. Even though many interesting projects came along and attracted my attention for a couple of years, I am happy to finally wrap everything up.

Firstly, I would like to express my gratitude to my supervisor, Professor Harri Oinas-Kukkonen, who introduced me to behaviour change support systems and encouraged me to carry on with my research work year after year. Besides his contribution to the main construct of this doctoral dissertation, the PSD model, I would also like to thank him from applying funding for many young researchers who have been able to build expertise on information systems and, thus, success in their careers later on.

The reviewers of my thesis, Professor Susanna (Shuk Ying) Ho and Professor Ola Henfridsson, have provided me very constructive feedback on my research. Their comments were really helpful for finalizing this thesis, so I am really grateful for their time and effort.

I wish to thank all the co-authors who have contributed to the articles and thus, helped me to accomplish this thesis. Thank you, Professor Harri Oinas-Kukkonen, Professor Minna Isomursu, Dr Katarina Segerståhl, Mh.Sc. Salla Muuraiskangas, Director Igone Idigoras and Dr Ainara Garzo.

I would like to express my gratitude to the University of Oulu Graduate School, Tauno Tönning Foundation and Infotech Oulu for funding this work. I am also grateful for all the industrial and research partners involved in the related research projects RichWeb, SalWe SHOK, HearMeFeelMe, and Ageing in Balance. Furthermore, I would like to thank VTT and especially Head of Research Area Eero Punkka and Team Manager Johan Plomp for making this possible. I would like to thank also our Key Account Manager Kari Kohtamäki who has introduced me to some really interesting customer cases in the area of BCSSs and thus motivated to me to carry on with this research area also in the future.

Special thanks go to Professor Minna Isomursu. I cannot thank you enough for hiring me for my Master's thesis project at the university and later for VTT. It has been a privilege to work with you. You have taught me so much and provided

encouragement and support during this journey. I would also like to thank Professor Ilkka Tervonen who has always had time to listen to my doubts and worries. As has been said, there is a lot of difference between listening and hearing.

My colleagues and friends from the university and VTT – You are amazing. I have had so much support and inspiration from you that you cannot even imagine. I would like to thank the University of Oulu's OASIS group and especially Katarina Segerståhl, Tuomas Lehto, Teppo Räisänen, Agnis Stibe, Pasi Karppinen and Sitwat Langrial. I would also like to thank VTT's Digital health team and especially Salla Muuraiskangas, Kirsikka Kaipainen, Miikka Ermes, Milla Immonen, Elina Mattila, Aino Ahtinen and Toni Vanhala. I have also been privileged to meet some people outside my research area who have offered insightful discussions, helped me to position my research and been good friends. Thank you, Mari Ervasti, Erkki Siira, Vili Törmänen, Kaisa Still, Katri Kallio, Arto Wallin, Tiia Ojanperä and Marja-Liisa Liedes.

I wish to thank my family; my sister Mari and brother Vesa and their families, parents-in-law Eila and Kauko and brother-in-law Teemu. Thank you for just being there. I am also grateful to my closest friends and neighbours who have given me the energy to keep on going.

Above all, I would like to thank my loved ones, my husband Lasse and children Sami and Emmi, for the invaluable support that you have given me during these years. This would be meaningless without you.

Oulu, September 2014

## Academic dissertation

Supervisor
Professor Harri Oinas-Kukkonen
Department of Information Processing Science
University of Oulu

Reviewers
Professor Susanna (Shuk Ying) Ho
Australian National University
ANU College of Business & Economics
CBE Building 26C
Acton, Canberra ACT, 0200 Australia

Professor Ola Henfridsson
University of Warwick
Warwick Business School
Coventry, CV4 7AL, United Kingdom

Opponent
Professor Marko Turpeinen
Helsinki Institute for Information Technology (HIIT)
Otaniementie 19B, Espoo
P.O. Box 19215
FI-00076 Aalto, Finland

# List of publications

This doctoral thesis is based on the following original publications which are referred to in the text as I–VI. The publications are reproduced with kind permission from the publishers.

I Harjumaa, M. and Oinas-Kukkonen, H. (2007) An Analysis of the Persuasiveness of Smoking Cessation Web Sites. In: Proceedings of the Second International Symposium on Medical Information and Communication Technology (ISMICT 2007). December 11–13, Oulu, Finland.

II Oinas-Kukkonen, H. and Harjumaa, M. (2008) Towards Deeper Understanding of Persuasion in Software and Information Systems. In: Proceedings of the First International Conference on Advances in Human-Computer Interaction (ACHI 2008). February 10–15, Sainte Luce, Martinique, pp. 200–205.

III Oinas-Kukkonen, H. and Harjumaa, M. (2009) Persuasive Systems Design: Key Issues, Process Model, and System Features. Communications of the Association for Information Systems, Vol. 24, Article 28, pp. 485–500.

IV Harjumaa, M. and Muuraiskangas, S. (2014) Building Persuasiveness into Information Systems. Electronic Journal of Information Systems Evaluation (EJISE), Vol. 17, Issue 1, pp. 023–035.

V Harjumaa, M., Segerståhl, K. and Oinas-Kukkonen, H. (2009) Understanding Persuasive System Functionality in Practice: a Field Trial of Polar FT60. In: Proceedings of the Fourth International Conference on Persuasive Technology. April 26–29, Claremont, CA, USA.

VI Harjumaa, M. Idigoras, I. Isomursu, M. and Garzo, A. (2014) Expectations and user experience of a multimodal medicine management system for older users. Journal of Assistive Technologies, Vol. 8, Issue 2, pp. 51–63.

With regards to Publication I Harri Oinas-Kukkonen designed and managed the study presented, and in his thesis Master's student Jukka Peltoperä conducted a general overview of the smoking cessation web portals. Marja Harjumaa took the lead in heuristic evaluation of the persuasiveness of the smoking cessation web portals. She also studied the suitability of the Functional triad (Fogg, 2003) to the

evaluation of persuasive systems, and had the main responsibility for authoring the article. With regards to Publication II, Harri Oinas-Kukkonen designed and managed the study presented and ensured its relevance for the big picture, whereas Marja Harjumaa was the key contributor to the conceptual review of persuasion theories. With regards to Publication III, Harri Oinas-Kukkonen was the key contributor to the framework presented. Marja Harjumaa participated actively in the process and contributed especially on the demonstration of the feasibility of the model. With regards to Publication IV, Marja Harjumaa took the lead in designing and managing the study presented, and as the first author she took the lead in authoring the article. Salla Muuraiskangas participated in managing the study and was the key contributor to the review section of the article. With regards to Publication V, Marja Harjumaa as the first author took the lead in authoring the article, whereas the study was designed, implemented and reported together with Katarina Segerståhl and Harri Oinas-Kukkonen. With regards to Publication VI, Marja Harjumaa as the first author took the lead in authoring the article and analysing how persuasive functionalities of the system addressed patient-centric factors influencing non-adherence. Igone Idigoras and Minna Isomursu took the lead in designing and managing the study, whereas Ainara Garzo participated in analysis and reporting the study presented.

# Contents

# List of abbreviations

| | |
|---|---|
| ACT | Acceptance and Commitment Therapy |
| BCSS | Behaviour Change Support System |
| BCT | Behaviour Change Technique |
| DS | Design Science |
| DSR | Design Science Research |
| EHR | Electronic Health Record |
| ELM | Elaboration Likelihood Model |
| HRM | Heart Rate Monitor |
| HSM | Heuristic Systematic Model |
| ICT | Information and Communication Technology |
| IS | Information Systems |
| MMS | Medication Management System |
| NFC | Near Field Communication |
| OECD | Organisation for Economic Co-operation and Development |
| PMA | Personal Medicine Assistant |
| PSD | Persuasive Systems Design |
| SCT | Social Cognitive Theory |
| TAM | Technology Acceptance Model |
| TPB | Theory of Planned Behaviour |
| TRA | Theory of Reasoned Action |
| UI | User Interface |
| UTAUT | United Theory of Acceptance and Use of Technology |

# 1. Introduction

Information and communication technology (ICT) has become part of people's everyday lives. It is no longer used only at work to enhance job performance, but is an enabler for new service offerings, which do not recognise boundaries between digital and physical user experiences – ICT is everywhere. In recent years, data processing has moved from computers to smartphones and tablet devices, and various personal health and wellbeing technologies, such as activity monitors, heart rate monitors, and home blood pressure monitors have also become popular. The generalization of personal ICT and advancements in technology's capabilities has also opened up new possibilities for influencing people's attitudes and behaviour.

People are influenced all the time when they communicate with other people or receive information through mass communication, such as newspapers, television and radio. Persuasion can be defined as "human communication designed to influence the autonomous judgments and actions of others" (Simons et al., 2001). In persuasive communication, people intend to persuade someone to change their attitudes or the way they behave (McGuire, 1973). Besides traditional interpersonal persuasion, there can also be computer-mediated or human-computer persuasion (Harjumaa and Oinas-Kukkonen, 2007). Computer-mediated persuasion means that people intend to change the attitudes and/or behaviours of others through social media, e-mail, instant messages, or other means of computer-mediated communication. Human-computer persuasion means that there is no other person communicating or sending the persuasive message, but the attitude or behaviour change happens in interaction between human and computer. Persuasive technology is a computing system, device or application intentionally designed to change a person's attitude or behaviour in a predetermined way (Fogg, 2003).

As no communication is persuasive by nature, any new technology is not inherently persuasive. Persuasive technology does not focus on any attitude or behaviour change that has emerged as a side effect, but it is interested in the planned effects. Thus, there is always intentionality involved in the development, distribution or adoption of persuasive technology (Fogg, 1998). Too often, systems are developed from functional viewpoints – how they meet the functional requirements of the customer, how they fit into the existing processes, or they are designed in order to be easy to use and adopt. In order to be successful, they should also be

designed to be driven by user values (Ervasti, 2013; Isomursu et al., 2011; Van Gemert-Pijnen et al., 2011). Also, if their use should lead to attitude or behaviour change, persuasive design plays an important role. Behaviour Change Support Systems (BCSS) are sociotechnical information systems with psychological and behavioural outcomes, and they are designed to form, alter or reinforce attitudes, behaviours or an act of compliance without using coercion or deception (Oinas-Kukkonen, 2013). BCSSs provide content and functionalities that engage users with new behaviours, make them easy to perform and support users in their everyday lives (Oinas-Kukkonen, 2013). In persuasive design, classical principles that are discovered to have an influence on attitudes and behaviours should be used. Basically, strategies are adaptations of the classical strategies that people have known for a long time (King and Tester, 1999). According to Fogg (2009), design teams need a practical understanding of human psychology, especially of the drivers of human behaviour because, without this understanding, they would design by guessing or imitating techniques that have been used in existing systems. There are already several approaches to the design and evaluation of persuasive systems for behaviour change, such as the relatively well-known Functional triad (Fogg, 2003). However, there is a need for a more comprehensive framework which describes how the principles can be implemented; that is, how to transform them into software requirements and functionalities. It is also important to address the question of how to integrate persuasive design approaches into systems development.

A domain where BCSSs can make a difference is e-Health. e-Health means a new approach to delivering services and improving health care locally, regionally and worldwide by using ICT (Eysenbach, 2001). Public health care struggles with financial problems and there are pressures to reduce spending. Several countries, especially in the western world, are going through a demographic change, which has both economic and social implications. Over the last century, average life expectancy has increased while birth rates have declined. In 2011 average life expectancy exceeded 80 years across OECD countries, which is an increase of ten years since 1970 (OECD, 2013). While people live a long time, they suffer more often from many chronic conditions. Diseases such as diabetes and dementia are increasingly prevalent. In 2011, almost 7% of 20–79 year-olds in OECD countries, or over 85 million people, had diabetes. Also, cardiovascular diseases are common, and they are the main cause of mortality in most OECD countries. (OECD, 2013) The situation with the younger population is also challenging. Three out of four children do not undertake moderate-to-vigorous exercise regularly, and more than half (52.6%) of the adult population report that they are overweight or obese. Across the OECD countries, 18% of the adult population is obese and the trend is still growing. Since 2000, obesity rates have increased by a third or more in 16 countries. (OECD, 2013) E-health systems have been seen as a solution to the health care problems, but many e-Health technologies are not successful in realizing sustainable innovations in health care practices (Van Gemert-Pijnen et al., 2011).

Since the global financial and economic crisis began almost six years ago, growth in health spending has slowed significantly (OECD, 2013). These savings

show in people's everyday lives as their not getting help for health problems in their early stage. Although there should be more emphasis on prevention, prevention expenditures in health care have been reduced since 2009 and they count only for around 3–4 % of total health expenditure (OECD, 2013). Lifestyle change is essential in the prevention of diseases, but it also remains a central part of the treatment of chronic diseases, such as Type 2 diabetes, high cholesterol levels, and high blood pressure (Jallinoja et al., 2007).

Few people think about how important lifestyle is in determining our health. It is the single greatest opportunity to improve health and reduce premature deaths, whereas medical care plays a relatively small role (Schroeder, 2007). Determinants of health include: environmental exposure with 5%, health care with 10%, social circumstances with 15%, genetic predisposition with 30%, and behaviour patterns with 40% (Schroeder, 2007). However, studies have shown people are not willing to change their behaviours. According to health care professionals, patients' unwillingness to change their habits is a major barrier to the treatment of lifestyle-related conditions (Jallinoja et al., 2007).

It has been stated that persuasive systems are showing the potential to assist in improving healthy living, reduce the costs on the health care system, and allow elderly people to maintain a more independent life (Chatterjee and Price, 2009). Technology has the potential for dynamic and unbiased information processing, which enables people to monitor their own progress and to be informed about risks specific to evolving contexts and motivations (Kennedy et al., 2012). Systems have many benefits as persuaders, because they are interactive and can adapt their persuasion strategies according to users' actions. This kind of interactivity has not been possible for the traditional media, such as radio, TV or newspapers. They also have many advantages over human persuaders, such as persistence, offering anonymity, managing large amounts of data, using many modalities to influence people, scalability, and ubiquitousness. (Fogg, 2003) Behaviour change support imbedded in e-Health systems can offer support for lifestyle changes and thus lead to cost savings in health care as well as improvements in the quality of life. Thus, there is a need to develop new methods for the design and evaluation of BCSSs in the e-Health domain.

This doctoral thesis focuses on the development of persuasive systems. It presents a framework for designing and evaluating BCSSs and its applicability to e-Health. The research question of this doctoral thesis is as follows:

RQ: How to develop behaviour change support systems?

The structure of the doctoral thesis is as follows. Section 2 describes the research approach and methods. Section 3 presents the background and special attention is given to the key theories of persuasion and persuasive technology that were identified during the development of the Persuasive Systems Design (PSD) model. Section 4 introduces the PSD model constructed during this study. Section 5 describes the validation of the model, and demonstrates how the model can be used to design and evaluate behaviour change support systems. Results of the empirical studies are also summarized. In Section 6, the key implications of this work for

both theory and practice are discussed and the construction process is also evaluated. Finally, Section 7 concludes the work. The original articles are included at the end of this doctoral thesis.

# 2. Research approach and methods

This section provides an overview of the research strategy employed in this doctoral thesis. Both conceptual analysis and empirical observations have been deployed during the course of this study. As a whole, the research question is approached with design science (DS) research methodology.

## 2.1 Design science research methodology

Design science is a paradigm in information system science for understanding, executing, and evaluating research which aims at designing new and novel artefacts intended to solve identified organizational problems (Hevner et al., 2004). The artefacts can be defined as constructs, models, methods, or instantiations. Peffers et al. (2007) have presented a research methodology for both production and presentation of design science research. It includes six practical activities (see Figure 1):

1. Problem identification and motivation
2. Definition of the objectives for a solution
3. Design and development
4. Demonstration
5. Evaluation
6. Communication.

In their methodology, Peffers et al. (2007) also present four research entry points including problem-centred initiation (starts with activity 1), objective-centred initiation (starts with activity 2), design and development-centred initiation (starts with activity 3), and client/context-initiated (starts with activity 4). The research entry point depends on the initiation of the study: Was it, for example, triggered by an observed real life problem or by an industry need. According to Hevner et al. (2004), the design process is a sequence of expert activities that produces an innovative product. The evaluation of the artefact provides feedback and a better understanding of the problem used in order to improve the quality of the product as well as the process. (Hevner et al., 2004)

An analogous research paradigm to design science, constructive research, is known in IS research and management accounting research. Constructive research approach means problem solving through the construction of organizational procedures or models and thus, the term *construction* refers to an entity which produces a solution to an explicit problem (Kasanen et al., 1993). Iivari (1991) has suggested *constructive research* to denote the specific research methods required for constructing artefacts, especially in Computer Science and Software Engineering. Although the approach emphasizes the meaning of a practical problem, an essential part of the constructive approach is to link the problem and its solution with accumulated theoretical knowledge. Also the novelty and the actual working of the solution have to be demonstrated. (Kasanen et al., 1993)

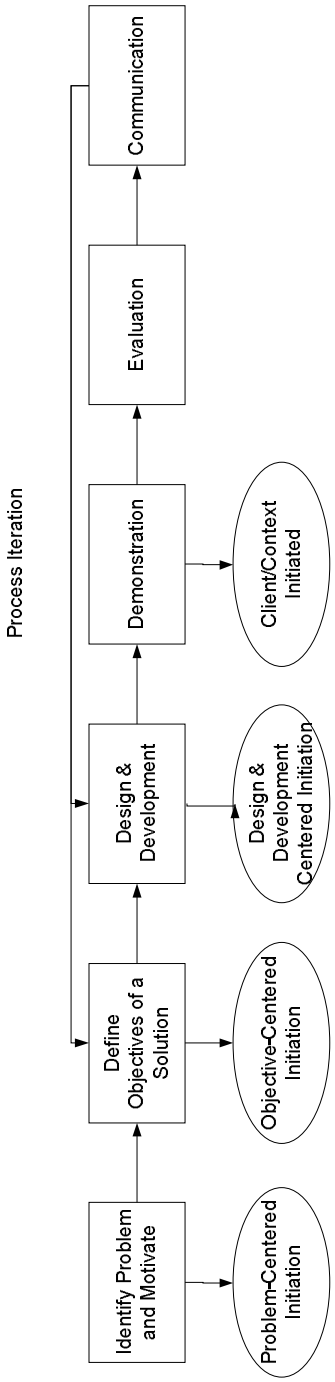



**Figure 1.** Design Science Research Process Model (Peffers et al., 2007).

The constructive research process presented by Kasanen et al. (1993) is almost equivalent to the design science research process presented by Peffers et al. (2007). Its phases are as follows (Kasanen et al., 1993):

- Find a practically relevant problem which also has research potential
- Obtain a general and comprehensive understanding of the topic
- Innovate, i.e., construct a solution idea
- Demonstrate that the solution works
- Show the theoretical connections and the research contribution of the solution concept
- Examine the scope of applicability of the solution.

Compared to design science research, the constructive research process is missing a *definition of objectives for a solution* and *communication* as distinct steps. Also, the iterative nature of the process is not emphasized as much as in design science research.

The design science research approach has been chosen as the research approach of this doctoral thesis, because it provides a methodology for finding solutions for a real-life BCSS development problems and producing research results that are relevant in practice. The design science research approach is well-suited to this task (March and Smith, 1995; Lukka, 2003; Peffers et al., 2007). Based on the Systems Development approach, design science research can be used as a means of better understanding a research domain and also to change the processes and products in the research domain (Nunamaker and Chen, 1990).

Figure 2 shows the study in the context of constructive research based on Lukka (2003). The practical relevance of the problem and the solution was defined based on Case I. The study provides an innovative construction, the PSD model, meant to solve the real world problem. The construct is explicitly linked to prior knowledge of persuasion, persuasive technology and IS development. The study also demonstrates the practical applicability of the construction in three case studies (Cases II, III and IV).

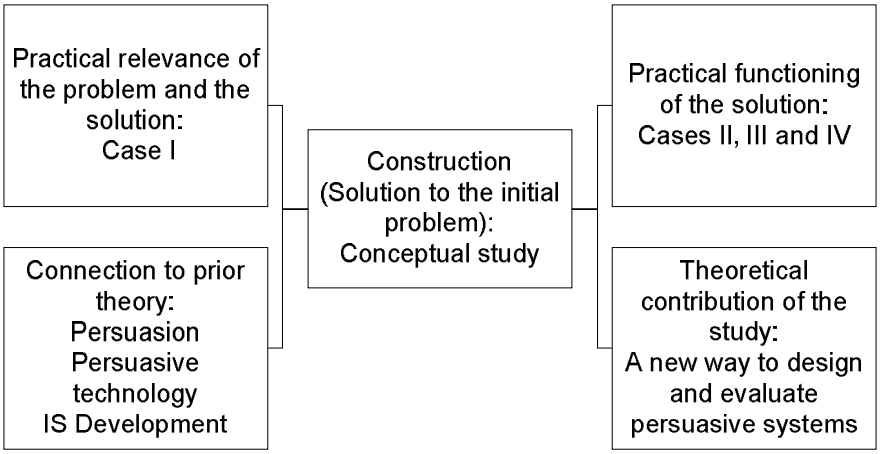



**Figure 2.** The study in the context of constructive research, based on Lukka (2003).

In design science research, it is important to show the research contribution of the solution concept (e.g. Kasanen et al., 1993). Gregor (2006) has classified information systems theories into five types including: 1) Theory for analysing, 2) Theory for explaining, 3) Theory for predicting, 4) Theory for explaining and predicting, and 5) Theory for design and action. Design science research, constructive research and some other similar types of research methodologies are very relevant for the fifth category, design theories (Gregor, 2006). Design theories describe "how to do something". They give explicit prescriptions for constructing an artefact through providing methods, techniques, principles of form and function, as an example. (Gregor, 2006) It has been pointed out that (too) often the focus in design science research is on *design as an activity*, rather than *developing new design theories*, although it has been recognized that the contributions of design science can be foundational for the design science knowledge base (Gregor, 2006). The research presented in this doctoral thesis contributes to the existing knowledge base by describing a theoretical framework for a new area of research where only a few theoretical efforts exist.

## 2.2 Case study

Case study research has been applied in all individual studies presented in this doctoral thesis excluding the one conceptual study based on theoretical analysis. As mentioned earlier the case studies serve two of the central elements of design science research i.e. showing the practical relevance of the problem and the solution (Case I), and a demonstration of the practical functioning of the solution (Cases II, III and IV).

Benbasat et al. (1987) have provided a definition of a case study: *"A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations). The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used"*.

The method was selected because it provides a methodology to study phenomena in their natural context. Because of the applied nature of the IS research, there has been an attempt to promote the use of this kind of idiographic research approach (Franz and Robey, 1984). It has also been stated that case research is a particularly appropriate approach when research and theory are at their early, formative stages and when it is important to capture the experiences of the actors (Benbasat et al., 1987). The case research approach can be applied in design science research as a validation method, as an example. Both approaches are associated with a practical orientation; capturing the knowledge of practitioners (Benbasat et al., 1987) and provision of solutions to a practical problem (Hevner et al., 2004).

Case research strategy usually employs multiple data collection methods and ideally evidence from multiple sources will converge to support the research findings (Benbasat et al., 1987). Yin (2009) lists the sources of evidence that can be used in case studies: documentation, archival records, interviews, direct observations, participant observation, and physical artefacts. The qualitative data analysis should be done thoroughly. Using multiple methods of data collection and working with a research partner increase the accuracy of the data. When the research results are reported it is important to aim to present the richness of the data, establish a clear chain of evidence and show the cause and effect in researcher's reasoning (Benbasat et al., 1987).

When case research strategy is being compared with alternative research methods in the IS field such as laboratory experiments, field experiments and field studies, a fundamental difference is that case study researchers have less a priori knowledge of the variables of interest (Benbasat et al., 1987). However, the authors emphasize that it depends on the study, and case researchers can have more a priori knowledge.

## 2.3 Development process of the PSD model

The objective of this chapter is to describe how the PSD model was developed and how the design science methodology was applied in the process. The chapter is structured according to the six activities of the design science research process model by Peffers et al. (2007). Because the development process followed a problem-centred approach, the process starts with the first activity and proceeds in a nominally sequential order except for the last activity, communication. The research process has involved communication between the different activities.

### 2.3.1 Problem identification and motivation

According to Peffers et al. (2007), the first activity in the design science research process is *problem identification and motivation*. During this activity it is important to define the specific research problem and to justify the value of a solution. It is important to study the state of the art of the problem and the importance of its solution (Peffers et al., 2007). At the First International Conference on Persuasive Technology for Human Well-Being in 2006 the author or this doctoral thesis (Harjumaa née Tyynelä) and Professor Oinas-Kukkonen published their first conceptual article about persuasiveness and information systems. They stated as follows:

> *Our research aims at creating a theoretical framework which can be used as a tool when studying persuasive systems, their persuasion strategies and methods, and their persuasive effect. (Tyynelä and Oinas-Kukkonen, 2006)*

However, the story began already a couple of years earlier, in March 2003, when Professor Oinas-Kukkonen became acquainted with persuasive technology while on his sabbatical at Stanford University. Immediately he started doing research on persuasive technology, and after his return to the University of Oulu in January 2004 he started teaching it. When Professor Oinas-Kukkonen introduced the idea of bringing the concept of persuasiveness into the IS discipline in 2006, it was a relatively new area of research.

### 2.3.2 Definition of the objectives of a solution

The second activity in the design science research process is the *definition of the objectives of a solution* (Peffers et al., 2007). The objectives can be quantitative or qualitative. During this activity it is important to have a knowledge of the state of the problems and possible current solutions and their efficacy. (Peffers et al., 2007)

In 2007 the authors conducted a case study (Case I) in which the persuasiveness of four Finnish language smoking cessation web sites was analysed using as the framework Fogg's Functional Triad (Fogg, 2003). Data was collected with expert-based inspection methods, more specifically with heuristic evaluation. Heuristic evaluation is often used in usability studies: "In a heuristic evaluation, a small set of evaluators inspects a system and evaluates its interface against a list of recognized usability principles – the heuristics. Typically, these heuristics are general principles, which refer to common properties of usable systems." (Jaspers, 2009)

The study showed that some persuasion principles were manifested in these web-portals, but they were not applied to their full extent. Although the main purpose of the study was to understand how persuasiveness is manifested in a web-based e-Health system, the suitability of Fogg's framework for analysing persuasive systems was also studied. It was found out that the principles proposed in the framework are a resource for designers when it comes to fostering new ideas, but how these principles can be implemented should be more clearly described; that is, how to transform them into software requirements and functionalities. The three

categories on persuasive technology functioning as a tool, a media or a social actor were also seen as problematic, because the principles suggested within the categories are not at an equal level of abstraction, the media category is quite limited while it focuses on simulations, and the principles are overlapping.

*The contribution of Case I in the development of the PSD model was to show how persuasiveness can be manifested in an e-Health system, to demonstrate the current practices and to help to identify the research question. Based on Case I, it was concluded that there is a need for a theoretical framework which can be used as a tool when designing and evaluating BCSSs. Case I is described in more detail in Publication I.*

### 2.3.3 Design and development

According to Peffers et al. (2007), the third activity in design science research process is *design and development*. The main objective during this activity is to create the artefact and to contribute to the research at the same time (Peffers et al., 2007). The PSD model was developed during a conceptual study. It started in 2007 when the authors proposed a taxonomy of general persuasive approaches with interpersonal, computer-mediated and human-computer persuasion as the key types (Harjumaa and Oinas-Kukkonen, 2007). In the same article, they also proposed a set of related theories to IS and persuasiveness, namely information processing theory (McGuire, 1973), Cognitive consistency theory (Fraser et al., 2001), the Elaboration Likelihood Model (Petty and Cacioppo, 1986) and Cialdini's (1993) Influence techniques approach. This article is not included in this doctoral dissertation, because it is a work in progress type of article. However, it was an important step, showing that applying theories from social psychology to systems design seems to be a very promising research area, but that more research will be needed.

In design science research the previous scientific research should be acknowledged (Kasanen et al., 1993). Thus, the authors published a concise literature analysis in 2008 (Publication II) which suggested a set of key approaches to human-computer persuasion including Information processing theory (McGuire, 1973), Cognitive consistency theory (Fraser et al., 2001), the Elaboration Likelihood Model (Petty and Cacioppo, 1986), Influence techniques approach (Cialdini, 1993), Coactive approach to persuasion (Simons et al., 2001) and Persuasive technology framework (Fogg, 2003). This diverse set of persuasion theories was used as a mechanism to recognize dimensions and approaches for developing a practical conceptual framework. Theories were selected based on their diversity; some of these theories explain the relationship between attitudes and behaviour, other theories explain the persuasion process more generally, and some theories concentrate on a narrower area of persuasion. All these theories have their own starting points and restrictions, and they often rely on earlier theories of attitude change and human behaviour. As a consequence of this study, subsequent research was more focused, and the analysis of the existing theories helped to inte-

grate and interpret information when the actual conceptual framework was developed. During the study the first definition was also given of a persuasive system:

> *We define a persuasive system as a computerized software or information system designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception. (Oinas-Kukkonen and Harjumaa, 2008a)*

For the definition *reinforcing, changing and shaping* were adopted from Miller (2002), whereas excluding *coercion and deception* was adopted from Fogg (2003), Cassell et al. (1998) and Miller (2002), who stated that persuasion allows people voluntary participation in the persuasion process.

To continue their work, in 2008 the authors published at a conference the first version of the systematic framework for designing and evaluating persuasive systems (Oinas-Kukkonen and Harjumaa, 2008b). Later, in 2009 the article was extended to a journal article describing the PSD model (Publication III). The model provides a holistic process of designing and evaluating persuasive systems.

Although the PSD model is called as "a model", it should be noticed that, based on the categorization of IT artefacts to constructs, models, methods, and instantiations (Hevner et al., 2004), the PSD model is not literally a model but a method for defining a process for the development of behaviour change support systems. The methods provide guidance on how to solve problems, and they can range from formal, mathematical algorithms to informal, textual descriptions of "best practice" approaches, or some combination of these (Hevner et al., 2004).

*The contribution of the Conceptual study is the conceptualization of Persuasive Systems Design (PSD). Based on the Conceptual study, the PSD model was communicated to the research audience, and it was ready for demonstration and evaluation. The Conceptual study is described in more detail in Publications II and III.*

### 2.3.4 Demonstration and evaluation

These two activities of demonstration and evaluation are treated here as one activity, because the difference between them is open to interpretations. The objective of the *demonstration* is to show that the idea works and the artefact solves one or more instances of the problem. Several kinds of activities can be used in the demonstration, such as experimentation, simulation or case study. (Peffers et al., 2007) The objective of *evaluation* is to "observe and measure how well the artefact supports a solution to the problem" (Peffers et al., 2007). Evaluation can take many forms – the artefact's functionality can be compared with objectives that were set earlier, or it can be based on varying kinds of quantitative performance measures. Hevner et al. (2004) categorize design evaluation methods into five categories: 1) Observational (case study, field study), 2) Analytical (static analysis, architecture analysis, optimization, dynamic analysis), 3) Experimental (controlled experiment), 4) Testing (functional testing, structural testing) and 5) Descriptive (informed argument, scenarios). Based on the evaluation, a decision can be made

whether to iterate back to earlier stages, just improve the artefact or continue to communication. (Peffers et al., 2007)

This doctoral dissertation describes three case studies (Case II, III and IV) where the PSD model was evaluated through observational design evaluation methods. The main contributions of the case studies are summarized in Chapter 5. Demonstration of the applicability of the model.

The objective of Case II was to find out how the PSD model can be utilised to support the identification of persuasive functionalities that would increase the persuasiveness of the system. It was a multiple case study in which the PSD model was applied during the user requirements analysis and concept design phases of two selected cases. The data consisted of observation data and adhesive notes describing the new persuasive functionalities and it was collected empirically in co-creation sessions with in total 9 participants.

*The contribution of Case II is the demonstration of the PSD model in information systems design. The model helped to identify new requirements for persuasive systems and it was also useful in increasing the awareness of the possible features. Case II showed that the PSD model is suitable for solving the problem "how to design behaviour change support systems". Case II is described in more detail in Publication IV.*

The objective of Case III was to study how a training programme in a new prototype heart rate monitor promotes proper exercising. It was a multiple case study in which the PSD model was applied for analysing the system features through an expert-based heuristic evaluation and also for guiding the qualitative analysis and structuring the user experience findings. The empirical data was collected during a qualitative, longitudinal (three-month-long) multiple-case study approach where the unit of analysis was an individual user. There were in total 12 participants. The study showed that different people experience the persuasive features in different ways, and it also suggested that more information is needed on the appropriate combinations of persuasive strategies.

*The contribution of Case III is the demonstration of the PSD model in information systems evaluation. Case III showed that the PSD model helps to identify persuasive techniques in system functionality. It also demonstrated how persuasive techniques function in practice, i.e. how users experience them. Case III is described in more detail in Publication V.*

The objective of Case IV was to analyse the adoption of a multimodal medication management system (MMS) targeted on older people and home care professionals. Users' expectations and user experiences were studied in particular. It was a case study in which the PSD model was used to discuss how the persuasive features or a multimodal medicine management system addressed patient-centred factors influencing non-adherence. The empirical data was collected through qualitative co-design sessions and field trials where interviews were used as a data collection method. There were 11 participants in co-design sessions and 8 in field trials, which makes 19 participants in total. The study revealed that a system that merely satisfies users during the prototype building phase does not necessarily succeed as well as expected in the field trials. It was also found that it

would be important to consider reasons for medication non-adherence and non-technology factors influencing willingness to adopt new assistive devices in order to promote diffusion of new MMSs at home.

*The contribution of Case IV is the demonstration of the PSD model in information systems evaluation. Case IV showed that, by helping the identification of persuasive techniques in system functionality and by providing examples of persuasive system functionalities, the PSD model helps to identify new persuasive functionalities that can help to design more effective MMSs. Case IV is described in more detail in Publication VI.*

After its publication, the PSD model has been systematically studied at the University of Oulu and it has been widely adopted by the research community (see Chapter 6. Discussion). Further research has evaluated the feasibility of the categories, as an example, and the results are promising (see e.g. Lehto et al., 2012a; 2012b). The studies have shown that the PSD model has both theoretical and practical relevance, and that there is no need to iterate back to earlier stages of the design science process, but just to improve and refine the artefact.

### 2.3.5 Communication

The sixth activity in the design science research process is the communication. Its purpose is to "communicate the problem and its importance, the artefact, its utility and novelty, the rigour of its design, and its effectiveness to researchers and other relevant audiences such as practicing professionals, when appropriate." (Peffers et al., 2007) Although communication is the "last" activity, it does not necessarily mean that it is performed at the end of the study. Peffers et al. (2007) point out that, although the process is structured in a nominally sequential order, it is not expected that researchers would proceed in sequential order from activity 1 through to activity 6. As the earlier description shows, the design science research process described in this doctoral dissertation has involved communication, such as publication of scientific articles, between the different activities.

### 2.3.6 Summary

Figure 3 illustrates the studies that were conducted during the research process, as well as the resulting publications and their contributions. The primary focus of this doctoral thesis is the construction and demonstration of the PSD model.

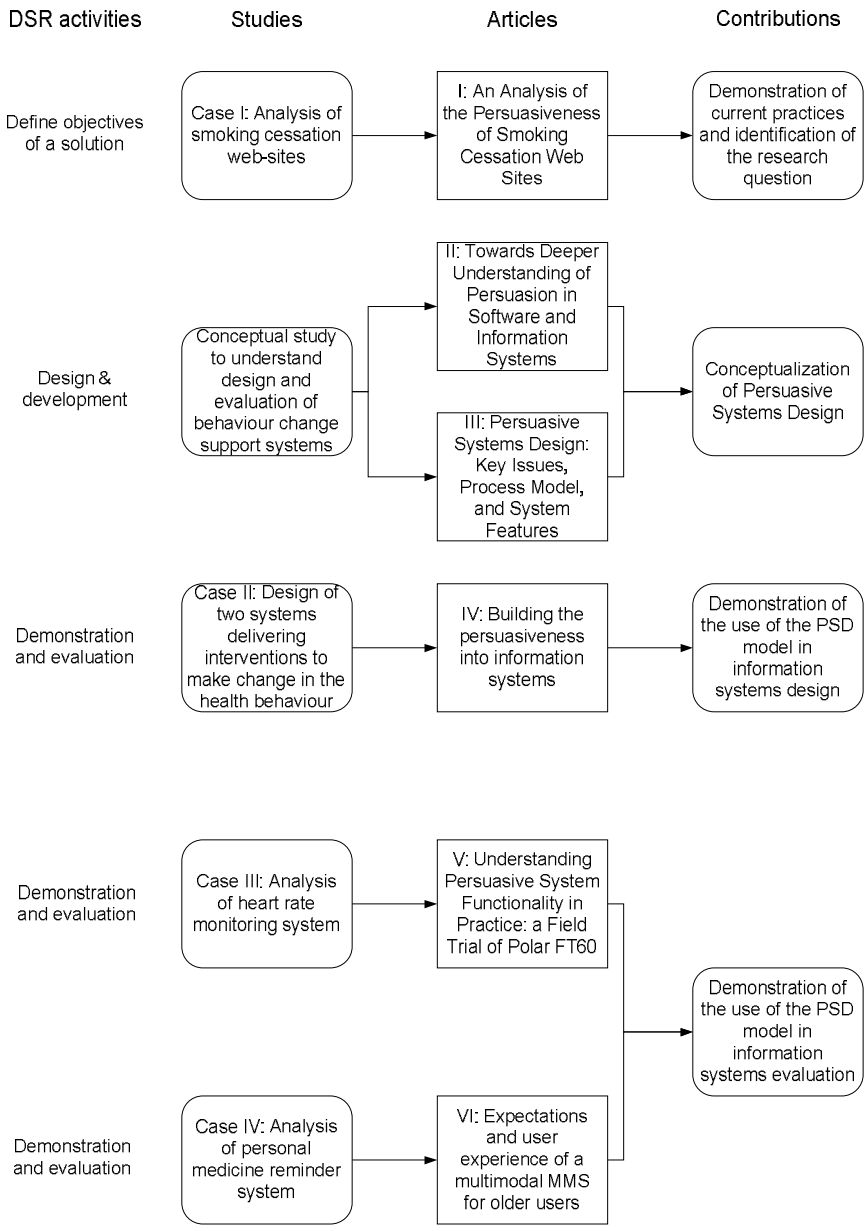



**Figure 3.** Studies, articles and their contributions.

# 3. Related work

This section presents the related work for the doctoral thesis. It presents related research on design and evaluation of behaviour change support systems and also describes the key theories of persuasion and persuasive technology behind the PSD model. As described in Publication II, these key theories include Information processing theory (McGuire, 1973), Cognitive consistency theory (Fraser et al., 2001), Elaboration Likelihood Model (Petty and Cacioppo, 1986), Influence techniques approach (Cialdini, 1993), Coactive approach to persuasion (Simons et al., 2001) and Functional Triad (Fogg, 2003). Furthermore, this chapter presents BCSS frameworks that have been developed for e-Health context especially and discusses some the behaviour change related challenges in the e-Health domain.

## 3.1 Positioning the related work

There are many research fields that can offer frameworks and methods for the development of persuasive systems. In this doctoral dissertation, the theoretical background is discussed through three lenses: 1) traditional persuasion (see 3.2 Attitude and behaviour change), 2) BCSSs (see 3.3 Behaviour change support systems) and 3) e-Health (see 3.4 Behaviour change and e-Health domain). These three lenses are illustrated in Figure 4.

Traditional persuasion theories aim to describe how to change people's attitudes and/or behaviours through traditional communication methods. Often their role is to provide background information and theoretical bases for the actual BCSS frameworks. Sometimes they are also used as such in the IS field.

BCSS frameworks aim to describe how to understand and develop persuasive systems where people's attitudes and/or behaviours are aimed to change through interactive technology. They aim to provide concrete principles and guidelines and, they are, therefore, most useful in the development work, such as concept design, implementation and evaluation.

e-Health discusses the behaviour change-related challenges in e-Health domain and also describes BCSS frameworks that have been developed for an e-Health context, especially. BCSS frameworks for e-Health describe the development process on a more general level and they are, therefore, useful especially in introducing the issue to people who are not that familiar with BCSS development in general.

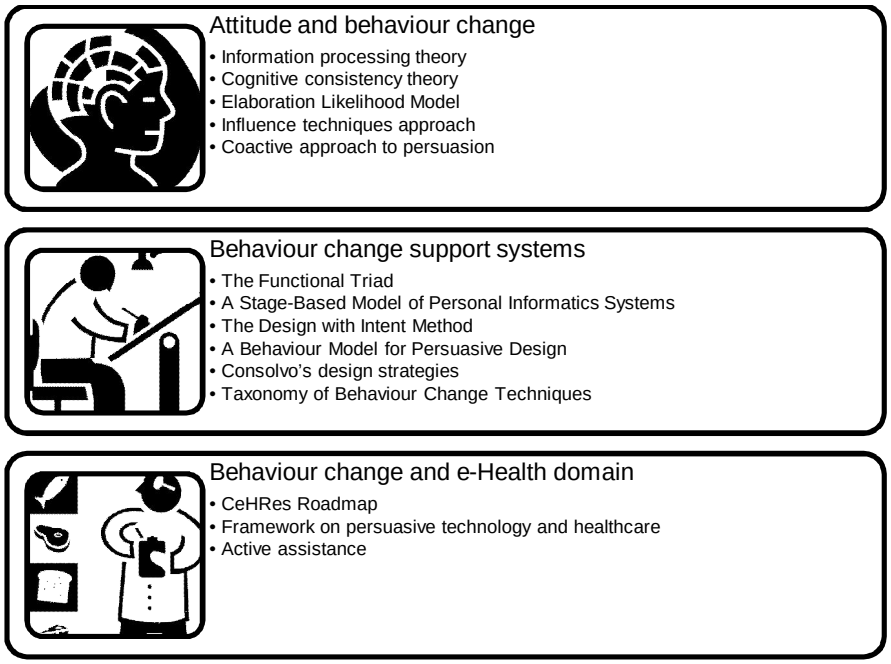



**Figure 4.** Positioning the related work.

## 3.2 Attitude and behaviour change

Attitudes are "general evaluations people hold in regard to themselves, other people, objects, and issues" (Petty and Cacioppo, 1986). Petty and Cacioppo (1986) state that human feelings, beliefs, and behaviours are greatly influenced by attitudes. Persuasion is "human communication designed to influence the autonomous judgments and actions of others" (Simons et al., 2001). In persuasive communication, people intend to persuade someone to change their attitudes or the way they behave (McGuire, 1973). According to Simons et al. (2001), persuasion has three core properties:

- the central character has a clear intent to persuade
- communication is used to accomplish that goal
- message recipients are invited to make a choice of some sort.

Persuasion has traditionally been regarded as a communication process in which a persuader sends a persuasive message to a persuadee or audience, although always leaving the persuadee with the power of decision (Simons et al., 2001). The difference between influence and persuasion is that the term influence refers to any change in attitudes, whereas persuasion refers to "any change in attitudes that results from exposure to a communication" (Petty and Cacioppo, 1986). The persuasion process can lead to three possible behavioural outcomes: a response-

shaping outcome, a response-reinforcing outcome, and a response-changing outcome (Miller, 2002). It is often emphasized in the literature that persuasion differs from other forms of attempted influence, such as material inducements and coercion: “It is not the iron hand of torture, the stick-up, or other such forms of coercion. Nor, in its purest sense, is it the exchange of money or other such material inducements for actions performed by the person being influenced. Nor is it pressure to conform to the group or to the authority of the powerful.” (Simons et al., 2001)

In this doctoral thesis, the relationship between persuasion and IS field is being examined. Earlier persuasion has been studied in many different fields. Systematic study of persuasion was instigated by the ancient Greeks who used rhetoric to create a democratic, civil society. Later rhetoricians have expanded the range of their studies to media critics, cultural analysts, and others. Whereas rhetoricians have had a humanistic and sometimes critical approach to persuasion, social scientists and especially applied social scientists have been interested in mass persuasion, political campaigns and product advertising, having a more permissive approach to persuasion. Social scientists have developed many methodologies for studying persuasion, such as focus group interviews, surveys, polls, and quantitative content analysis. They also conduct experimental research under controlled conditions in order to develop generalizable knowledge. (Simons et al., 2001)

In IS research, studying users’ attitudes and behaviour has a long history. According to Rawstorne et al. (1998) attitudinal theories from social psychology are most widely applied in predicting user intentions and user behaviour, including the Theory of reasoned action (TRA) (Fishbein and Ajzen, 1975), the Technology acceptance model (TAM) (Davis, 1989), the Theory of planned behaviour (TPB) (Ajzen, 1991), and Social cognitive theory (SCT) (Bandura, 1986). Along with many other theories and models, their purpose has been to predict and understand the individual acceptance of information technology. The basic concept underlying all user acceptance models is that the user’s reactions to using information technology influence the user’s intention to use IT and actual use of IT. Also the user’s intentions to use IT influence the actual use of IT (see Figure 5). (Venkatesh et al., 2003) In 2003 Venkatesh et al. reviewed eight acceptance theories and their extensions, and formulated and validated a United Theory of Acceptance and Use of Technology (UTAUT).

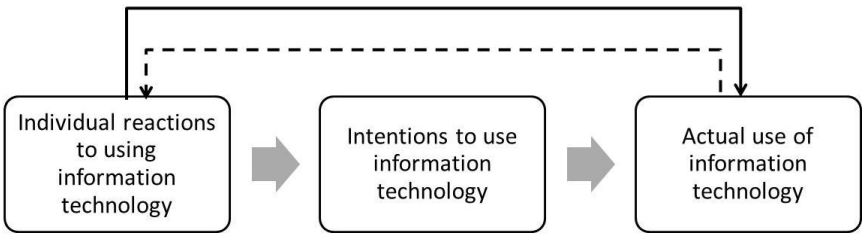



**Figure 5.** Basic concept underlying user acceptance models (Venkatesh et al., 2003).

Although the focus on studying users' attitudes and behaviour has merely been on technology acceptance, there are also studies where the focus is persuasion as such. Parmar et al. (2009) based the design of a personal health information system for rural women to increase their awareness about maternal health on TPB (Ajzen, 1991). They showed that it is beneficial to employ persuasive strategies in an interactive system to increase perceived behavioural control of users against existing social beliefs and practices related to maternal health, because it leads to a higher intention to change behaviour (Parmar et al., 2009). The Elaboration Likelihood Model (ELM) (Petty and Cacioppo, 1986) has been found to be very useful in IS research. It has been used e.g. by Dijkstra et al. (1998) who studied the persuasiveness of expert systems. Because the ELM states that people are likely to make their judgment on peripheral cues if they are less motivated or unable to judge the message on its contents, Dijkstra et al. (1998) studied if the source of the message influences on the objectivity or rationality of the advice given by an expert system. It was found that advice given by a computer is perceived to be more objective and rational compared to that given by human advisors (Dijkstra et al., 1998). Tam and Ho (2005) selected the ELM as the theoretical framework for their study exploring the relationships between different elements of web personalization strategies. They used the model as a source for research questions and hypotheses. They found that matching users' preferences is the key to heightening elaboration and influencing users' choice of personalized offers. Preference matching means that, if a personalization agent is able to generate content that matches the taste and preference of a user, the user is more likely to process the content (e.g. personalized offers) to a greater extent before arriving at a decision (e.g. accepting the offers). (Tam and Ho, 2005) Angst and Agarwal (2009) investigated whether individuals can be persuaded to change their attitudes and opt in to behavioural intentions towards electronic health records (EHR), allowing their medical information to be digitized even in the presence of significant privacy concerns. They applied the ELM to examine attitude change and the likelihood of opting in to an EHR system. They found out that, even when people have major concerns about privacy, their attitudes can be positively altered with appropriate message framing i.e. focusing on the characteristics of the message itself.

As Fogg (2003) has stated, despite the large amount of work that has been done in the field of persuasion, there is not a single definition of persuasion or a theory that would fully explain what motivates people and makes them change their attitudes or behaviour, or both (Fogg, 2003). However, some of the key theories of persuasion are described in this chapter.

### 3.2.1 Information processing theory

McGuire (1973) sees persuasion as a reason for communication: people communicate in order to give information, to ask for help, to give orders, to make promises, to provide amusement, or to express their ideas. They may also communicate because they have an intention to persuade someone to change their

attitudes or behaviours. McGuire states that the study of persuasion is interesting from the scientific side in order to understand people's behaviour, and also from the practical side in order to understand techniques that can be valuable for advertisers, politicians and educators (McGuire, 1973). McGuire represents the experimental research direction and thus points out that it is important to understand the process of persuasion and all the factors that can contribute to the success or failure of the process. Then, by varying each of these factors, it is possible to see what kind of effects they have. The variables can be classified as independent variables, which are manipulated in a study, and dependent variables, which are measured in order to evaluate the expected change. These variables define *the communication–persuasion matrix*, which summarizes the knowledge that exists about the relations between these variables. McGuire's "information processing approach" states that independent variables should relate to the aspects of communication, and dependent variables to the recipient's information processing – what happens when the person receives the message. (McGuire, 1973)

In the information processing approach, the independent variables define "who says what to whom, via what channel, and with what effect" (McGuire, 1973). Thus, there are five classes of independent variables: source, message, channel, receiver, and destination. Regarding the other side of the communication–persuasion matrix, the dependent variables, McGuire defines a six-step process that the person must go through when they are persuaded: 1) Presentation of the communication, 2) Attention of the presented communication, 3) Comprehension of the arguments, 4) Yielding or complying to the new position suggested, 5) Retention or maintenance of the new position, and 6) Action on the new attitude or behaviour suggested. (McGuire, 1973)

McGuire states that the information processing approach helps to organize thinking about persuasion, for instance when designing and evaluating campaigns. He emphasizes the importance of understanding the roles of the attention and comprehension phases in the process, and not only focusing on later phases, such as yielding and overcoming resistance, which have been overemphasized in research. (McGuire, 1973)

McGuire reminds us that the information processing approach is only one of the several approaches that have been applied in the psychological research on persuasive communication. It differs from other approaches by emphasizing the role of the recipient as an active information processor. To compare, McGuire highlights the consistency-theory approach, which states that the recipient is an "honest broker" who is trying to achieve an optimal compromise among many conflicting forces. The second example, the perceptual approach to persuasive communication, states that the recipient is a conceptualization machine who sorts the stimuli into categories and changes his or her categorizing system when necessary. Interpretations of the persuasion situations are different. Whereas the information processing approach sees that the person has changed his or her attitudes, the perceptual approach sees that the person has changed his perception of what his attitude is about. Thirdly, McGuire compares the information processing approach to a functional approach focusing especially on one type of

function, defending one's own ego. This theory states that attitudes serve to help a person live with him or herself and with the inadmissible needs that drive them on. Thus, the attitudes are not derived from experience or knowledge, but the person's own deep-seated needs. Although the approaches have often been seen as competing with each other, McGuire suggests that they are not mutually exclusive, but complementary. (McGuire, 1973)

### 3.2.2 Cognitive consistency theory

Cognitive consistency is a very general idea about people liking that their views about the world are organized and consistent. If there is inconsistency, people feel uneasy and feel obligated to think about the inconsistencies in order to reorganize their thinking and restore consistency. The subject has been studied especially in the 1950s and early 1960s, and several models have been developed to explain this phenomenon. The state when everything is consistent is called equilibrium, congruity, balance or consonance, depending on the model. (Fraser et al., 2001)

One of the theories based on the idea of cognitive consistency is the theory of Cognitive Dissonance (Festinger, 1957). According to Festinger, three types of relationship can exist between two cognitive elements in people's minds. They can be irrelevant to each other, consonant, or dissonant. A dissonant, i.e. conflicting, relationship exists if two cognitive elements seem contradictory to the person who holds them. Festinger states that, if people detect that their thinking shows cognitive inconsistency, they feel uneasy and experience dissonance. It feels unpleasant, and they attempt to remove or reduce the dissonance. According to Festinger, it is likely that dissonance arises every time a person is making a decision between at least two competing alternatives. After the decision making, selective exposure to information occurs and the person avoids exposure to information about the rejected option, but is still open to learn about the chosen option. (Fraser et al., 2001)

The theory of cognitive consistency has been criticized by many researchers. They have pointed out that few people appear to be as consistent as being as the theory proposes, but instead people can live with minor inconsistencies between attitudes and behaviour. Thus, many theorists have proposed narrowing of the scope of the cognitive consistency theory. It has been recognized that, for inconsistency to create dissonance, it is necessary to feel a commitment to the attitudes and behaviour involved. Also, if a person has had no choice but to behave inconsistently, they can live with the inconsistency. Cooper and Fazio (1984) have revised the theory of cognitive consistency by stating that "if someone detects cognitive consistency on her part, and she perceives the inconsistency as having likely aversive consequences for her, and if she accepts personal responsibility for the inconsistency, then dissonance will be aroused" (Fraser et al., 2001). However, "a fleeting sense of unease" is not enough to function as dissonance motivation to encourage person to do something. Only if the dissonance arousal is labelled negatively by the person and she accepts responsibility of the negative arousal,

will she experience dissonance motivation and engage in attitude or behaviour change.

### 3.2.3 Elaboration Likelihood Model

ELM is a general framework for understanding the basic attitude change processes that can result from exposure to persuasive communications. It attempts to integrate many research findings and theoretical considerations under one comprehensive framework. The model outlines two routes to persuasion: central and peripheral routes. The central route is based on a careful and thoughtful assessment of the central merits of the information presented in support of an advocacy. The peripheral route is based on some simple cue (cognitive, affective, or behavioural) in the persuasion context that induces attitude change. The ELM deals with persuasive communications, but the basic principles of ELM may be applied to other attitude change situations.

The ELM is based on seven postulates. The first postulate states that people are motivated to hold correct attitudes. Correctness does not refer to any objective truth, but to the subjective perception of which attitudes are right and wrong. Petty and Cacioppo refer to studies that have shown that often people decide the correctness of an attitude by comparing it to the opinions of the other people. However, they state that besides the number of others who hold this opinion, people use a variety of different standards to determine which attitudes are correct for them. People also use different standards in different situations. Petty and Cacioppo (1986) finally state that people decide the correctness of the attitudes depending on how beneficial they are for the physical or psychological well-being of a person.

The second postulate reminds us that, even if people are motivated to hold correct attitudes, their willingness and ability to engage in order to evaluate a message varies depending on the individual and context. It is possible that, if the motivation and ability to process are really low and some really positive or negative cue occurs, people's attitudes may even change without their awareness. They also assume that the more important the issue is, the more effort people are willing to use to process it. The extent of evaluation or "the extent to which a person carefully thinks about issue-relevant information" is called elaboration (Petty and Cacioppo, 1986). In a persuasion context, it means that people examine the issue-relevant arguments in contained in the persuasive communication. It is said that the elaboration likelihood, the likelihood of people to attend to the persuader's appeal, is high if people have both the motivation and ability to engage in issue-relevant thinking.

The third postulate states that variables can affect the amount and direction of attitude change in three ways: 1) they can serve as arguments, or 2) peripheral cues, or 3) they can affect the extent or direction of issue and argument elaboration. This categorization is suitable for many of the communication variables (source, message, recipient, channel, and context) mentioned in the literature. In the ELM, argument can be defined as "bits of information contained in a communi-

cation that are relevant to a person's subjective determination of the true merits of an advocated position" (Petty and Cacioppo, 1986). People differ with regards to their understanding of the central arguments and, thus, what is "relevant information" may vary from situation to situation and from person to person. Studies have shown that, for example, both high and low self-monitors (measured by the self-monitoring personality scale) follow the central route to persuasion, but they differ regarding the features they find central (Snyder and DeBono, 1985). Petty and Cacioppo emphasize that, in the ELM, arguments can be based on affective, cognitive and behavioural factors, in the same way as for the peripheral cues, if a person perceives that they are the central arguments. In the ELM, "peripheral cues refer to stimuli in the persuasion context that can affect attitudes without necessitating processing of the message arguments" (Petty and Cacioppo, 1986). They trigger primitive affective states that become associated with the attitude object. A variable can also affect persuasion by influencing the extent or direction of message elaboration. The extent can differ from very little to very much. In addition to the quantitative dimension of extent of processing, the ELM makes a qualitative distinction between objective and biased elaboration ($4^{th}$ and $5^{th}$ postulate).

The fourth postulate states that variables affecting motivation and/or ability to process a message in a relatively objective manner can do so by either enhancing or reducing argument scrutiny. When a person has the motivation or ability to process the message in a relatively objective manner, they try to seek or they have the requisite knowledge to consider the arguments. A variable can then either motivate or constrain people to see the strengths of strong arguments and the flaws of the weak ones, or prevents them from doing so.

The fifth postulate states that variables affecting message processing in a relatively biased manner can produce either a positive (favourable) or negative (unfavourable) motivational and/or ability bias to the issue-relevant thoughts attempted. If a variable affects the motivation in a biased manner, it can encourage or constrain the generation of either favourable or unfavourable thoughts in particular. If a variable affects the ability in a biased manner, the person's knowledge base or situational factors make it more likely that one side will be supported over another.

The sixth postulate state that, as motivation and/or ability to process arguments is decreased, peripheral cues become relatively more important determinants of persuasion. Conversely, as argument scrutiny is increased, peripheral cues become relatively less important determinants of persuasion. This means that there is a trade-off between message elaboration and the effectiveness of the peripheral cues. If the person's ability is high but the motivation is low, little argument processing will happen, but the possible influence will be a consequence of simple cues associated with the argument. When the motivation increases, a person's attitude change may occur via the central route. If the motivation is high, but the ability is low, the person wants to process the message arguments, but cannot do so. In this kind of situation, the possible influence may occur whether via the central or peripheral route, but the peripheral route is more likely. When the ability increases, a person's attitude change may occur via the central route. If both motivation and ability are low, the possible influence will happen via the peripheral route.

The seventh postulate states that attitude changes that result mostly from processing issue-relevant arguments (central route) will show greater temporal persistence, greater prediction of behaviour, and greater resistance to counterpersuasion than attitude changes that result mostly from peripheral cues. This postulate is based on the fact that, via the central route, attitude changes are based on thoughtful consideration of issue-relevant information and integrating that information into the existing knowledge. Because this requires more cognitive work than attitude processing via the peripheral route and a person needs to access the schema for the attitude object in order to evaluate each new argument, it strengthens and finally becomes internally consistent, accessible, enduring and resistant. Because of its accessibility, the attitude people are more able to report the same attitude over time, to defend their beliefs, and to act on them. (Petty and Cacioppo, 1986)

### 3.2.4 Influence techniques approach

Cialdini (1993) has presented six persuasion principles that trigger compliance i.e. make people respond favourably to a request made by other person. The principles are mostly based on his work as a participant observer in the field, among those who practice compliance every day. According to Cialdini (1993), there are thousands of different tactics that people use, but the majority of them fall within these six basic categories: reciprocation, commitment and consistency, social proof, liking, authority, and scarcity. These principles are used in human communication to trigger wanted behaviour i.e. to cause automatic response in the receiver. In everyday life, people use learned stereotypes, rules of thumb, to classify things according to a few key features, and then to respond without thinking when one or another of these trigger features is present. Similarly to Elaboration Likelihood Model, Cialdini also brings out that, if people have enough desire and ability, they may respond to triggers also in a controlled way, meaning a tendency to react on the basis of thorough analysis of all of the information. However, Cialdini's work is focused merely on people's automatic responses.

The principle of reciprocation is pervasive in all human societies. Basically, it means that people feel obligated to repay what another person has provided for them. The sense of future obligation enables the development of various kinds of relationships, transactions, and exchanges that are beneficial for society. It has been said that this principle is an important part of humanity – over the years people have survived, because they have felt obligated to share food and other resources in their networks. This category includes many tactics that are variations of the same basic principle. As an example, these include giving something before asking for a certain favour or using rejection-then-retreat technique by starting with an extreme request that is sure to be rejected and then retreating to a smaller request that is likely to be accepted. (Cialdini, 1993)

The principle of commitment and consistency states that people have a desire to be consistent with all the things they have done before and, therefore, people can be persuaded by getting them to make commitments. After making a choice,

people feel pressure to behave consistently with that commitment. Those pressures make people respond in a way that justifies the earlier decision. According to Cialdini, people tend to be convinced that they have made the right choice and feel better about the decision. As mentioned earlier, also social psychologists other than Cialdini see that a desire for consistency is a central motivator of behaviour. One reason to explain this powerful motive is that personal consistency in highly valued in human culture, showing personal strength; generally speaking, consistent conduct is beneficial in everyday life, and consistency to earlier commitments functions as a rule of thumb, a shortcut, and thus makes life easier. (Cialdini, 1993)

The principle of social proof states that correctness of a behaviour is often determined by how other people think or perform in a situation. It is most influential under two conditions. The first one is ambiguous situations where people are unsure about how they should behave in a certain situation, and they use social proof as a rule of thumb to guide them. The second one is similarity – people tend to follow the lead of people like themselves (Cialdini, 1993)

The principle of liking states that people tend to comply with the requests of individuals who they know and like. Thus, emphasizing factors that increase the overall attractiveness and likeability of the persuader promotes persuasion. “Liking” is a vague term, but it consists of three factors: 1) physical attractiveness, 2) similarity and 3) increased familiarity through repeated contact with a person or a thing. (Cialdini, 1993)

The principle of authority states that people tend to comply with the requests of the authorities, even to the extent that they may act against their own preferences. People’s reactions to the authorities can be automatic, and thus, people tend to comply with the request in response even to the mere symbols of authority, such as titles, clothing, and autos (Cialdini, 1993).

The principle of scarcity means that people see things as more appealing and more valuable if they are less available. This “limited number” ploy is widely used in business, and the “deadline” approach in which customers are pressured to make an immediate decision to buy is one variation of it, for instance. The power of scarcity can be explained by two factors. Limited availability can serve as a shortcut cue to its quality. People may also feel that if they will not get something, they will lose freedoms. According to the psychological reactance theory, people respond to the loss of freedoms by wanting to have them more than before. (Cialdini, 1993)

In his book, Cialdini presents many examples from the animal world of triggers and behaviour, but he points out that behaviour patterns are not totally similar between humans and animals. The automatic behaviour patterns of humans tend to be learned rather than innate. They are also more flexible than those animals have, and responsive to a larger number of triggers.

Although people’s cognitive shorthands or rules of thumbs are not always correct, Cialdini (1993) points out that they are beneficial for us. It would be difficult to recognize and analyse all the aspects in each person, event, and situation we encounter every day.

### 3.2.5 Coactive approach to persuasion

Often persuasion has been discussed either from the perspective of the persuadee or the persuader, but in their book Simons et al. (2001) have a dual perspective – it is written for both persuader and persuadee. Their coactive approach to persuasion aims to help persuaders to move psychologically towards persuadees and expects that persuadees will thus change their attitudes or behaviour more easily.

The coactive approach to persuasion is based on six basic characteristics. To begin with, it is receiver-oriented rather than source-oriented. This means that it takes place largely on the message recipients' terms. It assumes that receivers are a heterogeneous group of people and that they are not alike. (Simons et al., 2001)

In addition, the coactive approach is situation-sensitive and recognizes that all receivers respond differently in different situations. Sometimes the message recipient has more time to examine the message more thoroughly, whereas at other times they have to rely on cognitive shorthands. Recipients' expectations are important to recognize, and persuaders have to know what is required from them in certain situations. (Simons et al., 2001)

It is essential that the persuader moves psychologically towards the persuadees by giving an impression of communicating with the recipients rather than communicating at them. This can be done by using similarity, expertise and trustworthiness. Similarities in background, experience, and group affiliation should be emphasized. Sometimes, however, it is beneficial that the persuader appears to be different in ways that makes them appear more expert. Attractiveness and credibility do not always go hand in hand, but the major determinants of credibility are perceived expertise and trustworthiness. (Simons et al., 2001)

Simons et al. (2001) also state that in coactive approach persuaders addresses controversial matters by appeals to premises the audience can accept. They prefer offering arguments and evidence in support of their arguments and they use carrots instead of sticks in conflict situations.

The coactive approach moves audiences from premises to desired actions or conclusions by both appearing reasonable and providing psychological income. This can be done by following many guidelines. These include linking the proposal with beliefs and values already held by the audience, convincing the audience that the proposal has the support of people they most admire, facilitating information processing by simplifying the message, exploiting the benefits of interactive situations for positive reinforcement of desired responses, exploiting the tendency of the persuadees to form not only conscious but also unconscious associations to people and ideas and encouraging role-playing of the desired behaviour with persuadees opposed to the position of the persuader. (Simons et al., 2001)

Finally, Simons et al. (2001) state that the coactive approach aims to make full use of the resources of human communication. This includes not only what is said but also how it is said. It is important to remember that communication is not words alone, but that the surroundings in which the message is delivered makes a difference, and persuaders are sometimes able to arrange and select them. Also,

the medium can make a difference. It can be oral or written, verbal or nonverbal, direct or indirect, and the persuader can select from many options which medium to use – is it newspapers, magazines, word of mouth, television, telephone, memo, e-mail, bulletin board, platform speech, conference, loudspeaker, informal conversation, or a company newspaper. According to Simons et al. (2001) "the medium is nothing but a message carrier". Different media have different kind of technical capabilities and different kinds of ability to invoke feelings.

## 3.3 Behaviour change support systems

According to Oinas-Kukkonen (2013) BCSS can be defined as follows:

> *A behaviour change support system (BCSS) is a sociotechnical information system with psychological and behavioural outcomes designed to form, alter or reinforce attitudes, behaviours or an act of complying without using coercion or deception.*

The PSD model developed in this doctoral thesis is linked to the BCSS research model, as it is applied as the state of the art conceptualization for designing and developing BCSSs. BCSS provides content and functionalities that engage users with new behaviours, make them easy to perform and support users in their everyday lives. (Oinas-Kukkonen, 2013)

When behaviour change and technology development was introduced for the first time together, it was called persuasive technologies. The *study of computers as persuasive technologies* was introduced at CHI 97 as a new area of inquiry (Fogg, 1998). The acronym "captology" was based on the phrase "computers as persuasive technologies" and it referred to a research area focusing on the "design, research, and analysis of interactive computing products created for the purpose of changing people's attitudes or behaviours" (Fogg, 2003). Soon the acronym captology gave place to the term persuasive technology. As not all communications are not persuasive, any new technology is not inevitably persuasive. Persuasive technology does not focus on any attitude or behaviour change that has emerged as a side effect, but it is interested in the planned effects. As was mentioned earlier, true persuasion requires an intent to change attitudes or behaviours and thus, not all behaviour change is the result of persuasion (Fogg, 1998). There is always intentionality involved in the development, distribution or adoption of persuasive technology (Fogg, 1998). Because technology do not have intentions of its own, those who create, distribute, or adopt the technology have the intent to change someone's attitudes or behaviours. Fogg suggests that there are three kinds of intents: by those who design the technology (endogenous), by those who give access or distribute the technology (exogenous), and by the person who adopts the technology (autogenous). (Fogg, 1998)

Although the study of computers as persuasive technologies was introduced in 1997, and in the decade following 1998 several emerging devices, applications, and experimental projects have appeared in the market, persuasive systems are

not a totally new phenomenon (Chatterjee and Price, 2009). Persuasive technologies can be divided into four generations:

1. Prescriptive systems started in the late 1960s and 1970s. They supported the communication between the health care professional and the patient through the use of telephones for communication and computer-generated brochures, as an example, as content.
2. Descriptive systems started in 1985. They provided information and educational content first through text-based systems and later in multimedia format which became popular after the emergence of the Internet, the web, and PC's.
3. Environmental systems started in 1999. They were more advanced compared to their predecessors in the use of body-wearable sensors, context-aware technologies, and real-time exchange of information.
4. Automated systems have started in 2012. These future systems are characterized by advanced automation techniques in which human intervention is minimal. (Chatterjee and Price, 2009)

Regarding the user population, it is expected that the fourth generation systems will have the possibility to reach people more than before, because there are many prevailing trends that support the emergence of BCSSs. First of all, Internet access and use has become more common. In 2013, 79% of European households had access to the Internet, 76% had a broadband connection and more than 60% of Europeans used the internet daily. Certain countries in Europe are ahead of this development with an over 90 % level of access to the Internet and an over 85% level of broadband connection. (Eurostat, 2013) Because internet access and use has become more common, the potential user population of web-based services has increased.

Besides being connected to the internet, people are also mobile. Mobile data traffic is increasing exponentially, and people are using smartphones and tablets instead of traditional mobile phones. In Europe, smartphones are expected to account for more than half of all handset shipments in 2013, and the percentage is expected to continue to grow. This is because of their reduced prices and also the mobile applications they offer. (Digital agenda, 2013) People have an easy access to a wide selection of applications through application stores, which are digital distribution platforms for software. Basically, each major smartphone vendor has an application store (e.g. Apple AppStore, Google Play, Windows Store). This new distribution channel is useful for end-users who can purchase applications at a relatively low price, but also for individual developers, start-ups and research organizations that can quickly attract a very large number of users. (Lane et al., 2010) People perceive they have more and more value from mobile applications that integrate easily into everyday life. "Mobile devices like smartphones and tablets are increasingly moving away from being purely 'utility' devices, with enter-

tainment occupying more and more of a central role in the usage of internet on the go." (Digital agenda, 2013)

Mobility is an important aspect of persuasion, because it enables reaching users at the opportune time and place. In 1998 Fogg predicted that "most persuasive technologies of the future will not be associated with desktop computers; they will be specialized, distributed, or embedded" (Fogg, 1998). He stated that persuasive situations occur most frequently in the context of normal life activities and not in front of a desktop computer. Advancements in mobile and sensory technologies open up new possibilities for persuasion, because they enable behaviour monitoring and feedback 24/7 in an unobtrusive way. Nowadays smartphones have various embedded sensors included, such as an accelerometer, digital compass, gyroscope, GPS, microphone, and camera that provide real-time data gathered from the surroundings of the devices. These sensors are enabling new applications across a wide variety of domains, also including health and wellbeing. (Lane et al., 2010) As an example, based on the data mobile sensing enables context recognition where the current context of the device and its user is deduced. Even if the mobile devices are battery powered and their computational and space resources are limited, studies have shown that even simple classification algorithms can achieve a reasonably good accuracy regarding context recognition if the features calculated from raw data are selected in a suitable way. (Könönen et al., 2010)

People's communication habits have changed. Instead of communicating one-to-one by phone or email, people communicate one-to-many through social media applications, such as Facebook, Twitter, Instagram and WhatsApp. Content has changed from verbal discussions and written messages to images, video, and audio. People can also share context information, such as their location or whose company they are in. The most common online activities in the EU27 in 2012 have still been sending and receiving e-mails (89%) as well as finding information about goods or services (83%), but use of social media is also common: 52% posted messages to social media. (Eurostat, 2012) Besides changed communication habits, the creation of user-generated content has also become more common. According to Oinas-Kukkonen and Oinas-Kukkonen (2013), social activity around content generation characterizes the current era. The authors use the term *social web* to refer to "a pattern of thinking in which end-users jointly create or generate much of, perhaps even most of, the content for the web, whereas companies try to harness the end-users with tools with which they can participate and engage themselves in content production and sharing" (Oinas-Kukkonen and Oinas-Kukkonen, 2013). Regarding BCSSs, people's connectedness through social media is a resource that enables the use of social support principles.

There are many approaches to the development of BCSSs. Some of the key theories are described as follows.

### 3.3.1 The Functional Triad

In 1998 Fogg suggested a “functional view” to computers, the Functional Triad, which is a conceptual framework that illustrates the different roles of computers from the perspectives of the users. The framework was later described in detail in a book (Fogg, 2003). It embeds various perspectives and theories of persuasion.

The Functional Triad states that computers function in three different ways: as tools, as media, and as social actors (see Figure 6). According to Fogg (2003), the Functional Triad helps to leverage and analyse the persuasiveness of technology, because persuasion strategies differ depending on the role that the computer has.

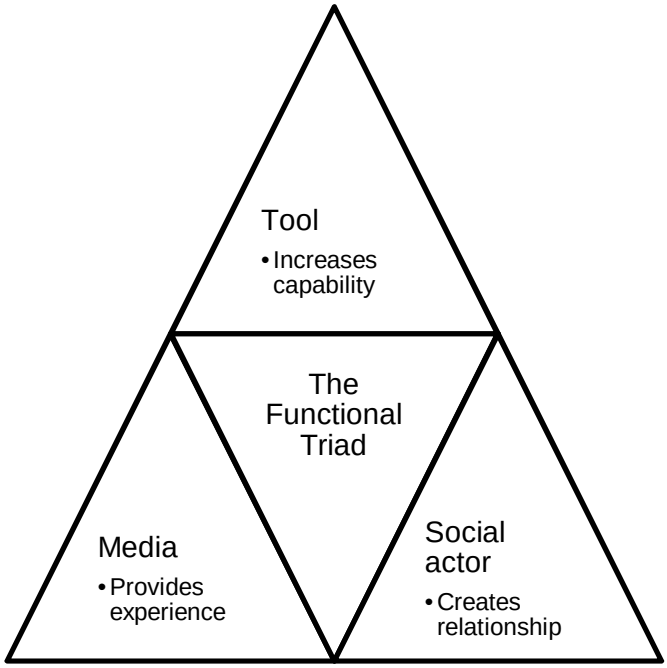



**Figure 6.** The Functional Triad (Fogg, 2003).

Besides the three categories of the Functional triad, Fogg (2003) highlights credibility, mobility and connectivity that are also important for persuasion. Credibility can be defined as *believability* and its key dimensions are trustworthiness and expertise. Referring to Self (1996), Fogg states that people evaluate these two dimensions and then develop an overall assessment of the overall credibility. In his book (Fogg, 2003), Fogg defines seven principles for Credibility and Computers, six principles for Credibility and the World Wide Web and 13 principles for Increasing Persuasion through Mobility and Connectivity, but they are not listed in this thesis.

#### 3.3.1.1 Computers as tools

When computers serve as tools, their goal is to increase capability and make activities easier to do, lead people through a process or perform calculations or measurements that motivate. Fogg has identified seven types of persuasive technology tools: reduction, tunnelling, tailoring, suggestion, self-monitoring, surveillance, and conditioning. (Fogg, 2003)

Different types of persuasive technology tools are briefly described as follows. Reduction technologies make target behaviours easier by reducing a complex activity to a few simple steps. Tunnelling technologies lead users through a predefined sequence of actions or events. Tailoring technologies provide information that is highly relevant to the individuals. Suggestion technologies suggest a behaviour at the most opportune moment. Self-monitoring technologies allow people to monitor themselves so as to modify their attitudes or behaviours and to achieve a predetermined goal of outcome. Surveillance technology allows one party to monitor the behaviour of another to modify behaviour in a specific way. Conditioning technology is based on operant conditioning to change behaviours. (Fogg, 2003)

According to Fogg (2003), these seven types of tool are based on several theories. As an example, reduction technologies are based on psychological and economic theories that suggest that humans seek to minimize costs and maximize gains. Making a behaviour easier to perform increases its benefit/cost ratio and this on one's part increases a person's motivation to engage in this behaviour more frequently. Use of these different tools might also increase a person's self-efficacy or the person's belief in their ability to perform a specific behaviour. This can help a person to develop more positive attitudes about the behaviour and try harder to adopt it and perform it more frequently. The effectiveness of tunnelling technologies is based on commitment and consistency. When people once commit to an idea or a process, most people tend to stick with it. Tailoring technologies are based on several empirical studies that have shown evidence that tailored information is more effective than generic information in attitude and behaviour change. (Fogg, 2003) Suggestion technologies are based on the Kairos principle, which was invented by ancient Greek rhetoricians and means finding the opportune moment to present a message. Fogg (2003) also builds on empirical psychological studies and describes some ways to recognize opportune moments. Self-monitoring technologies make it easier for users to know how well they are performing the target behaviour. They are based on various theories suggesting that people are more likely to do things that are easy to do. In addition, they feed the natural human drive for self-understanding (Fogg, 2003). Surveillance technologies are widely used, and their effectiveness has been shown in social psychological studies: when people know they are being watched, they behave differently (Fogg, 2003). Surveillance technologies differ from the other types of persuasive technologies, because interaction between the user and the technology is not direct, but indirect. Conditioning technologies are based on Skinner's behaviourism.

#### 3.3.1.2 Computers as media

When computers function as media, their goal is to provide experiences by allowing people to explore cause-and-effect relationships, providing people with vicarious experiences that motivate, and helping people rehearse a behaviour. Fogg has identified three types of simulations that are relevant for persuasive technologies: simulated cause and effect scenarios, simulated environments, and simulated objects. (Fogg, 2003)

These three types of simulations are briefly described as follows. Cause and effect scenarios can enable people to observe immediately the link between cause and effect. Simulated environments in which people can rehearse a behaviour can help them to change their attitudes and behaviours in the real world. Simulated objects do not take a person into the virtual world, but bring the virtual objects into the real world to be available in everyday routines.

According to Fogg (2003), the three different types of simulations are based on social science, especially on psychology. The power of cause and effect scenarios comes from the ability to explore cause-and-effect relationships without having to wait a long time to see the results. They also have the ability to convey the effects in vivid and credible ways. Computer simulations are widely used in learning. In simulated environments people can rehearse a behaviour in a safe “place”. Unlike real environments, virtual environments are controllable, which means that users can start and stop their experience whenever they want. Simulated environments have been adopted from education and game design. By bringing the virtual objects into the real world, simulated objects will be available in everyday routines. Thus, they can fit into the context of a person’s everyday life, they are less dependent on imagination, and they make clear the likely impact on certain attitudes and behaviours. (Fogg, 2003)

#### 3.3.1.3 Computers as social actors

Computers as social actors can persuade people by using the same persuasion principles that people use in everyday communication with each other. This is possible because studies have shown that people respond to computers as if they were living creatures (Nass et al., 1995).

When computers serve as social actors, their goal is to create a relationship and be persuasive by rewarding people with positive feedback, modelling a target behaviour or attitude, and providing social support. Fogg has identified five primary types of social cues, namely physical, psychological, language, social dynamics, and social roles. He has also identified five persuasion principles of persuasive technology functioning as social actor: attractiveness, similarity, praise, reciprocity, and authority. (Fogg, 2003)

The five persuasion principles of computers functioning as social actors are briefly described as follows. The principle of attractiveness states that technology that is visually attractive is likely to be more persuasive as well. The principle of similarity states that people are more readily persuaded by computing technology

that is similar to them in some way. The principle of praise states that technology that offers praise can lead users to be more open to persuasion. The principle of reciprocity states that people will feel the need to reciprocate when technology has done a favour for them. The principle of authority states that technology that assumes roles of authority will have enhanced powers of persuasion. (Fogg, 2003)

According to Fogg (2003), the principles are based on earlier studies showing, for example, that attractive people are more persuasive than those who are unattractive. Regarding similarity, Stanford similarity studies have shown that similarity between computers and users influences computers' persuasiveness (Nass et al., 1995). Fogg studied praise in his own laboratory and found out that praise from a computer can generate a similar positive response to praise from another human (Fogg and Nass, 1997). Reciprocity is based on the rule that is followed in every human society according to the anthropologists (Gouldner, 1960). In addition, Fogg has studied reciprocity between humans and computers in his doctoral thesis (Fogg, 1998). Authority has been showed to be powerful in persuasion studies, but Fogg (2003) points out that, apart from authority roles, other social roles that do not leverage authority or status can also be powerful persuaders. (Fogg, 2003)

### 3.3.2 A Stage-Based Model of Personal Informatics Systems

Li et al. (2010) refer to systems which help people to collect and reflect on personally relevant information as *personal informatics*. The information is collected for the purpose of self-reflection and gaining self-knowledge. They have defined a stage-based model of personal informatics which is composed of five stages: 1) preparation, 2) collection, 3) integration, 4) reflection, and 5) action. The model is based on empirical data, surveys and interviews with people who collect and reflect personal information. What is interesting is that Li et al. (2010) have also identified barriers that are related to each stage.

The preparation stage occurs before people start collecting personal information. During this first change, they might face barriers which are typically related to determining what information to collect and what collection tool to use. At the collection stage, people collect information about themselves. Barriers related to this stage are often caused by the tool used for data collection or by the users themselves who might lack time or motivation or who did not remember to collect information. There may be also data-related barriers, such as relying only on subjective information. At the integration stage, the information collected is prepared, combined, and transformed for the user to reflect on later phases. Barriers at this stage include difficulties of collecting data from multiple inputs, exploring multiple outputs, and understanding the format of data collected. These barriers might even prevent users from transitioning from the collection stage to reflection of data. At the reflection stage, the user reflects on their personal information. Barriers at this stage are related to a lack of time or difficulties in retrieving, exploring and understanding information. These barriers can prevent users from exploring and understanding information about themselves. At the last stage, action, people

choose what they are going to do with their understanding of themselves. They might evaluate their progress in relation to their goals or change their behaviours to meet the goals. At this stage, barriers are related to not getting any suggestions on what to do next, which prevents applying new knowledge and information in practice.

They have also proposed a set of guidelines for how to build personal informatics systems:

- They should be designed holistically. Since people experience problems in each of the stages and these barriers cascade to later stages, the design team should consider the system as a whole.
- They should improve support for iteration between stages. Since users' needs change, the flexibility within the system is important: users should be able to change what kind of data they collect and transfer data from one system to another.
- An appropriate balance of automated technology and user control should be applied within each stage to facilitate the user experience. Automatic features make the user experience more enjoyable, but sometimes it is good to leave control in the hands of the users.
- They should explore support for multiple facets of people's lives to enrich the value of systems. Current systems are usually designed only for one aspect of life, but people would like to mix information from different areas of life.

### 3.3.3 The Design with Intent Method

The Design with Intent (DwI) is defined as "design intended to influence or result in certain user behaviour" (Lockton et al., 2008). DwI suggests design techniques for influencing behaviour and provides examples, certain kind of design patterns, of how similar problems have been solved elsewhere. The examples are not based on persuasive technology only, but draw on other fields also, such as environmental and ecological psychology. Examples are grouped under six categories, or lenses, as Lockton et al. (2010) call them: 1) Architectural, 2) Error-proofing, 3) Persuasive, 4) Visual, 5) Cognitive, and 6) Security. Examples in each of these groups share similar considerations, behavioural understanding or assumptions about how to influence users. As an example, the architectural lens draws on techniques used to influence user behaviour in architecture, urban planning and related disciplines such as traffic management and crime prevention through environmental design, and the persuasive lens draws on Fogg's persuasive technology (Fogg, 2003). The approach is design-oriented in a sense that it is interested in changing behaviours which are important to some existing product's, service's, environment's or system's operation or the way it is used. The design process aims to modify users' behaviour to meet the particular target behaviour. Earlier, the DwI method has followed a more structured process (described in detail in Lockton et al., 2010), but recently it has evolved into a more loose idea generation

tool, which provokes design ideas by asking questions and giving examples of particular principles in action (DwI home page).

### 3.3.4 A Behaviour Model for Persuasive Design

Fogg (2009) has presented a model for understanding human behaviour; the Fogg Behaviour Model (FBM). According to this model, people's behaviour is determined by three factors: motivation, ability, and triggers and their subcomponents. The main statement is that, in order to perform a target behaviour, a person must be sufficiently motivated, have the ability to perform a target behaviour and be triggered to perform the behaviour – and all this should occur at the same moment. For design, this implies that, instead of increasing person's motivation endlessly, the system should influence a person's ability. Fogg states that increasing motivation is often not the solution, but increasing the ability by making the behaviour simpler: "People with low motivation may perform a behaviour if the behaviour is simple enough (meaning, high on ability)" (Fogg, 2009). Also, if the motivation is great enough, people might engage in difficult tasks to perform the target behaviour. The third necessary element, a trigger, can take many forms. Fogg has identified that successful triggers have three characteristics: 1) they are noticeable, 2) they can be associated with the target behaviour, and 3) they occur at the opportune moment when the person is motivated and able to perform the target behaviour. The FBM is not drawn from any specific theory, but on its web site (FBM home page) the most relevant background theories are mentioned. They include SCT (Bandura, 1986), Self-efficacy (Bandura, 1977), HSM (Todorov et al., 2002), ELM (Petty and Cacioppo, 1986), TRA (Fishbein & Ajzen, 1975), TPB (Ajzen, 1991), TTM (Prochaska et al., 1993) among many others. FBM is targeted on design teams who can use the model to guide their thinking about human behaviour change and use the model in the analysis and design of persuasive technologies. (Fogg, 2009) The model differs from earlier theories stating that it is targeted only on changing behaviour, not attitudes.

### 3.3.5 Consolvo's design strategies

Consolvo et al. (2009) have proposed design strategies for persuasive technologies that help people who want to change their everyday behaviours. They draw from Goal-Setting Theory (Locke and Latham, 2002), Transtheoretical Model of Behaviour Change (Prochaska et al., 1993), Presentation of Self in Everyday Life (Goffman, 1959) and Cognitive Dissonance Theory (Festinger, 1957).

According to Consolvo et al. (2009), the Goal-Setting Theory suggests that "the goal should be set by the individual or participatively with the help of an expert (rather than being assigned to her with no rationale). It should be easy to gauge her progress and know when she has met her goal, and it should be challenging, yet something that she believes she can realistically achieve. Feedback and in-

centives should be provided as progress is made and not limited solely to goal achievement." (Consolvo et al., 2009)

The Transtheoretical Model of Behaviour Change describes the stages from precontemplation to maintenance through which an individual progresses to modify behaviours. According to Consolvo et al. (2009), the Transtheoretical Model suggests that a persuasive technology that targets precontemplators might focus on education. For contemplators, the design might focus on techniques for overcoming barriers or rewards for performing the desired behaviour. For preparation stagers, it might focus on rewarding behaviours, even when the behaviour is not consistent and increasing awareness of patterns of the behaviour to encourage consistency. For action stagers, the design might focus on keeping track of progress to maintain consistency and possibly incorporate elements of social influence. For maintainers, it might focus on coping strategies for problems encountered previously and on helping the individual realize how she is becoming "the kind of person one wanted to be" (Prochaska et al., 1992).

Based on the theory of Presentation of Self, Consolvo et al. (2009) suggested that technology should support fundamental impression management needs, i.e. the individual should be in control of information about her that is collected and how that information is used.

Based on the Cognitive Dissonance Theory, Self Consolvo et al. (2009) suggested that technology should address whichever factors may prevent the individual from incorporating the change into her everyday life (i.e., by helping her change her behaviour to match her attitudes): "The awareness provided by the technology should be persistently available and easy to access, yet subtle enough so as to support occasional needs for information/situation avoidance" (Consolvo et al., 2009).

The design strategies are as follows (Consolvo et al., 2009):

- Abstract & Reflective: Data abstraction should be used instead of raw or explicit data to display information to the user. Based on the information the user can reflect on his/her behaviours in relation to his/her goals.
- Unobtrusive: Data should be presented in an unobtrusive manner and it should be available at the appropriate time.
- Public: Because of the personal nature of the data, others may not intentionally or otherwise become aware of it. The technology should not make the user uncomfortable in public situations.
- Aesthetic: Especially if the technology is involved in user's everyday life, it is important that it is comfortable and attractive to support the user's personal style.
- Positive: These should be rewarded when they perform the desired behaviour and achieve their goal. However, the user should not be punished for not performing the desired behaviour.
- Controllable: The user should be allowed to add to, edit, delete, and otherwise manipulate data as well as control access to it.

- Trending / Historical: The user should have access to information about their past behaviour as it related to their goals. Information should accommodate changes in lifestyles over time and provide data across devices.
- Comprehensive: Technology should account for the range of behaviours that contribute to the user's desired lifestyle and do not artificially limit data collection and representation to the specific behaviours that the technology can sense or monitor.

These design strategies have been applied in many studies. Consolvo et al. (2009) designed and built the UbiFit Garden system which encourages people to pursue a physically active lifestyle. The basic idea of the system is that it uses the mobile phone's screen background to display a garden that blooms as she performs physical activities throughout the week. Upon meeting her weekly goal, a butterfly appears. Smaller butterflies represent goals attained over the past three weeks. The virtual garden is accompanied with an interactive application, which includes detailed information about the physical activity and a journal. Evaluation showed that the system supported people to maintain a more physically active lifestyle (Consolvo et al., 2009).

### 3.3.6 Taxonomy of Behaviour Change Techniques

Michie et al. (2013) have developed a taxonomy of behaviour change techniques (BCTs) used in evaluation of behaviour change interventions. The authors define BCT as "an observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behaviour; that is, a technique is proposed to be an 'active ingredient'" (Michie et al., 2013). Thus, the taxonomy is not based on persuasion or behaviour change support systems, but it is intervention-oriented and designed from the clinical point of view compared to its predecessor. Motive for Michie et al. (2013) research has been a need for methods of characterizing the active content of interventions in order to replicate studies, implement techniques in practical applications, and to synthesize them in systematic literature reviews. The extended CONSORT statement to randomized trials of non-pharmacological treatment (Boutron et al., 2008) includes a recommendation of a preferred specification of the trial process, but it does not give guidance regarding the descriptive components of the intervention (Michie et al., 2013). According to Davidson et al. (2003) the intervention components are as follows:

- Who delivers the intervention?
- To whom?
- How often?
- For how long?
- In what format?
- In what context?
- With what content?

According to Michie et al. (2013), the latter, the content, is the ingredient that influences people's behaviours, and it is often reported poorly by using the same labels and descriptions of different techniques. This may lead to confusion.

Development of the taxonomy of Michie et al. (2013) has preceded three tasks. At first, the authors have developed a list of distinct BCT labels and definitions and asked for feedback from a multidisciplinary International Advisory Board and members of the study team. Secondly, the inter-rater reliability of coding intervention descriptions using the list of BCTs was then assessed in two rounds of reliability testing. Thirdly, a hierarchical structure was then developed. BCT taxonomy v1 by Michie et al. (2013) consisted of 93 BCTs clustered into 16 groups. The authors suggest that it can be used as a method for specifying the active content of interventions, but is still needs to be developed further and evaluated.

## 3.4 Behaviour change and e-Health domain

Behaviour pattern is the most significant determinant of health. (Schroeder, 2007) Lifestyle change, i.e. changing behavioural patterns, is essential in the prevention of diseases, but it also remains as a central part of the treatment of chronic diseases, such as Type 2 diabetes, dyslipidemia, and high blood pressure (Jallinoja et al., 2007). It has been stated that BCSSs are showing the potential to assist in improving healthy living, reduce the costs to the health care system, and allow the elderly to maintain a more independent life (Chatterjee and Price, 2009). Thus, behaviour change support should be an integral part of e-Health systems. e-Health can be defined as follows (Eysenbach, 2001):

> *"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology."*

In the e-Health domain, the purpose of the BCSSs is often to deliver an intervention whose content is based on an evidence-based theory or model. Barak et al. (2009) define web-based intervention as follows:

> *"A web-based intervention is a primarily self-guided intervention program that is executed by means of a prescriptive online program operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention program itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive web-based components."*

Products are often designed and evaluated from the viewpoints of the primary end-users. However, there are many stakeholders involved in the adoption of

BCSSs in the e-Health domain. According to Payton et al. (2011), health IT stakeholders include healthcare consumers, healthcare providers, health organization administrators and personnel, academic stakeholders, professional associations, private sector vendors, non-profit stakeholders, regulatory stakeholders and government agency stakeholders. Ambient Assisted Living (AAL) Joint Programme has presented a higher level categorization of end-users for the purpose of enhancing the quality of life of older people and strengthening the industrial base in Europe through ICT (AAL, 2012). It is adapted here for the purpose of understanding the stakeholders involved in the adoption of BCSSs in the e-Health domain. See Table 1. According to this categorization, there are three kinds of end-users – primary, secondary and tertiary – who derive different kind of benefits from adopting the system.

**Table 1.** Categorization of end-users based on AAL (2012).

| End-user group | Definition | Benefits |
|---|---|---|
| **Primary end-user** | Person who is actually using a BCSS | Direct benefits, e.g. increased quality of life through health behaviour change |
| **Secondary end-user** | People or organizations directly in contact with a primary end-user, such as formal and informal care persons, family members, friends, neighbours, care organisations and their representatives | Direct benefits when using BCSS (through UI for professional users) and indirect benefits when the care needs and other support of primary end-users are reduced |
| **Tertiary end-user** | Such institutions and private or public organizations that are not directly in contact with BCSSs, but who somehow contribute in organising, paying or enabling them. This group includes the public sector service organisers, social security systems, insurance companies. | Indirect benefits from increased efficiency and effectiveness which result in saving expenses or by not having to increase expenses in the mid and long term |

Regarding health counselling and lifestyle change, the general trend has been to gradually replace the authoritarian and instructive care with patient-centred methods aiming at empowerment (Jallinoja et al., 2007; Kuokkanen and Leino-Kilpi, 2003). More often patients are responsible for the self-management of their chronic diseases (Orsama et al., 2013). Studies have shown that systems supporting self-care are effective in changing behaviours. As an example, use of a mobile telephone-based remote patient reporting and feedback system has been found to significantly reduce HbA1c and weight of diagnosed Type 2 diabetes patients (Orsama et al., 2013). Similarly, it has been found that the addition of a personal digital assistant and telephone coaching can enhance short-term weight loss in combination with an existing system of care (Spring et al., 2013).

There are many drivers for and barriers to the adoption of e-Health. Studies have shown that perception of the health benefit is the most important driver for the adoption of consumer health IT. Other drivers are the perception of convenience and accessibility, rapid responses from clinicians, the benefit of anonymity for sensitive health topics, the benefit of understanding physicians and the health care system, delivering information on devices to patients every day, tailoring patients' interest, providing more benefits for patients in poor health and introducing technology gradually, especially regarding older people. (Jimison et al., 2008) Jimison et al. (2008) also studied the barriers to the use of health information technology, focusing especially on the elderly, people with chronic diseases or disabilities and the underserved. They found out that the primary barrier to use was that people did not perceive that use of the system would bring them enough benefits. A second type of barrier was that technology intervention did not fit into the lifestyle of the people. The third major barrier was that people did not trust the advice given by the system. Other reasons were technological malfunctions, too cumbersome technology, confusion with the technology and content, specific barriers related only to reminding technologies (such as annoying messages), clinical factors (such as a lack of response by physicians), costs, and age and disabilities.

Regarding the secondary end-users, studies have shown that the main barriers to technology adoption among nurses are work demands, lack off access to computers and lack of support. While the nurses themselves did not perceive age to be a barrier, their age was positively correlated with several barriers, including knowledge and confidence in the use of computers. (Eley et al., 2009)

In recent years, public authorities, including public and administrative services, have increased their e-government services for the citizens. More than half of all individuals in Denmark, the Netherlands, Sweden, Finland, France, Luxemburg, Austria and Slovenia reported in 2013 that they have used the internet to contact or interact with public authorities and services. The main purposes for interaction were making income tax declarations, requesting personal documents online and claiming social security benefits. (Eurostat, 2013) The public sector is suffering from huge challenges especially regarding health care services. As a solution, they have started to provide digital health care services targeted on end-user services access instead of focusing only on technological development in back office service management (Häikiö et al., 2010). However, digital health care services for citizens have not become general along with the technological infrastructure that has been established in recent years. Tertiary end-users, such as health care providers and purchasers of health services, could improve patient care and potentially save costs through the wise purchase of interactive health communication applications for patients and employees (Jimison et al., 1999). However, there are several challenges related to technology adoption from the purchaser's side. Products and services should improve the quality of care, be cost-effective and eventually lead to cost savings. Purchasers find it difficult to acquire comparable evaluation information about the products, because the emphasis of the developers in such as competitive environment is often to get products finished as soon as

possible, often with fewer features than originally anticipated and without adequate testing. In order to be able to acquire information about the effectiveness of the products, purchasers should demand evidence and promote the quality and cost of medical care. (Jimison et al., 1999)

There are several e-Health frameworks that are not discussed in this thesis. In their work, Van Gemert-Pijnen et al. (2011) have made a review of existing e-Health frameworks. They identified 60 journal papers, selected 44 of them for a full review and selected 16 e-Health frameworks that matched their inclusion criteria. The frameworks are listed in their article (Van Gemert-Pijnen et al., 2011). A set of recent frameworks useful in the design and evaluation of BCSSs in e-Health domain is presented as follows.

### 3.4.1 CeHRes Roadmap

Van Gemert-Pijnen et al. (2011) have presented a holistic framework for the development of e-Health technologies so as to improve their uptake and impact in the health sector. This has been formulated based on the outcomes of the existing e-Health frameworks they reviewed, empirical research, and discussions with other researchers at conferences. Its theoretical base is on participatory development approach, persuasive design techniques, and business modelling. The framework describes six principles for a participatory e-Health development process:

1. It is a participatory process in which stakeholder participation is essential. Involving stakeholders through the whole development cycle requires project management efforts.
2. It involves continuous evaluation cycles – the development process is iterative, flexible and dynamic.
3. It is intertwined with implementation – implementation is not a post design activity, but implementation issues, such as available resources and end-user characteristics, need to be taken into account right from the start.
4. It changes the organization of health care. The development of e-Health technology can be considered to be the creation of new processes and infrastructures for health care delivery.
5. It should involve persuasive design techniques aimed at changing the behaviours of the people and provide the means for self-management and information sharing.
6. It needs advanced methods to assess its impact; a broader view is needed to evaluate the benefits and drawbacks in terms of risks, ethics, performance, finance, or adherence. It needs to be understood that the impact changes over time and it depends on the user, technology, and context.

CeHRes Roadmap for the development of e-Health technologies has five phases: 1) contextual inquiry, 2) value specification, 3) design, 4) operationalization, and 5) summative evaluation. The five phases and their tasks are described in Figure 7.

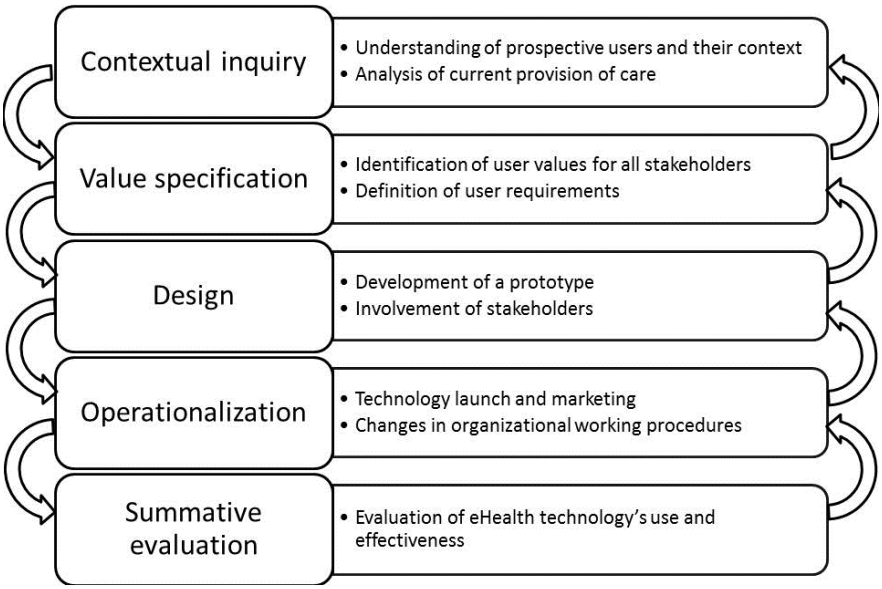



**Figure 7.** Main phases of the CeHRes roadmap (Van Gemert-Pijnen et al., 2011).

### 3.4.2 Framework on persuasive technology and healthcare

Chatterjee and Price (2009) have defined a simple framework for demonstrating how persuasive technologies can impact on healthcare. It has three circles that represent: 1) technology that is the driver of persuasive change, 2) persuasion strategies, and 3) the subdomains in healthcare where persuasive applications could potentially influence. See Figure 8.

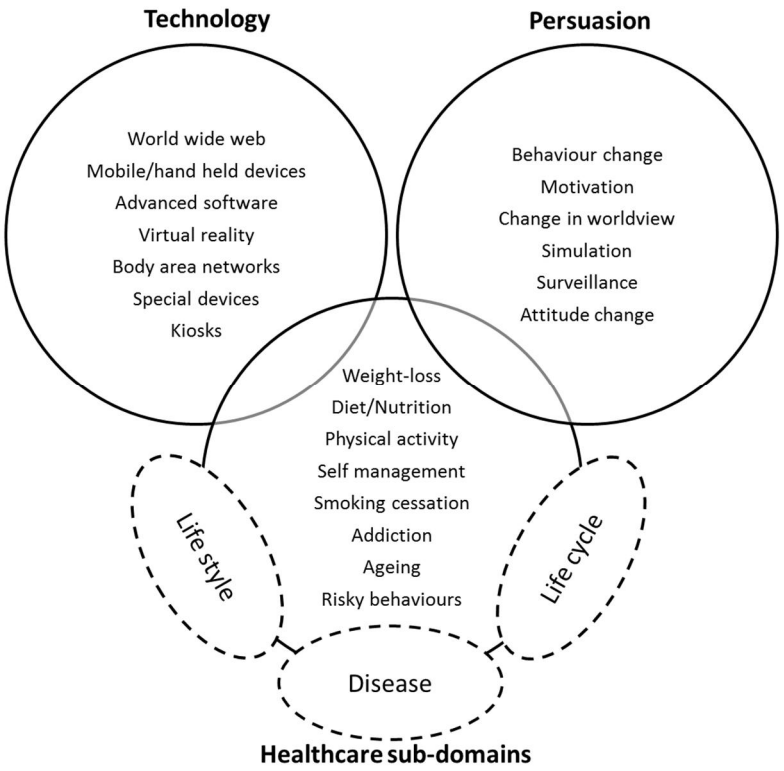



**Figure 8.** Framework on persuasive technology and healthcare (Chatterjee and Price, 2009).

### 3.4.3 Active assistance

Kennedy et al. (2012) have defined a concept of active assistance. It can be defined as "any technology involving automated processing of health or behaviour change information that is ongoing as the user interacts with the technology". In their definition, they want to emphasize that the technology continues to process information during use and may adapt its responses. This differs from passive technology, such as storage devices, videos and web site design, and also from interactive systems that do not process health information or whose responses are not related to the semantic content of the health messages but only their formatting. Active assistance aims to draw attention to semantic information processing during an interactive session. Also, it takes place in an environment in which citizens and experts participate actively in behaviour change intervention – the role of the technology is not to deliver a fully expert-led intervention, but to give users a sense of being in control and to help them to reflect and learn about the obstacles to successful behaviour change. (Kennedy et al., 2012) According to the authors,

many aspects of persuasive technology are relevant for the active assistance, but there are also differences – persuasive technology is not always active in the sense that Kennedy et al. (2012) define it.

Kennedy et al. (2012) have defined three key examples of how active assistance can support behaviour change: 1) Automated reasoning using an explicit knowledge representation, 2) Automated data collection with patterns recognition (smart sensing) and 3) Automated adaption over time (see Figure 9).

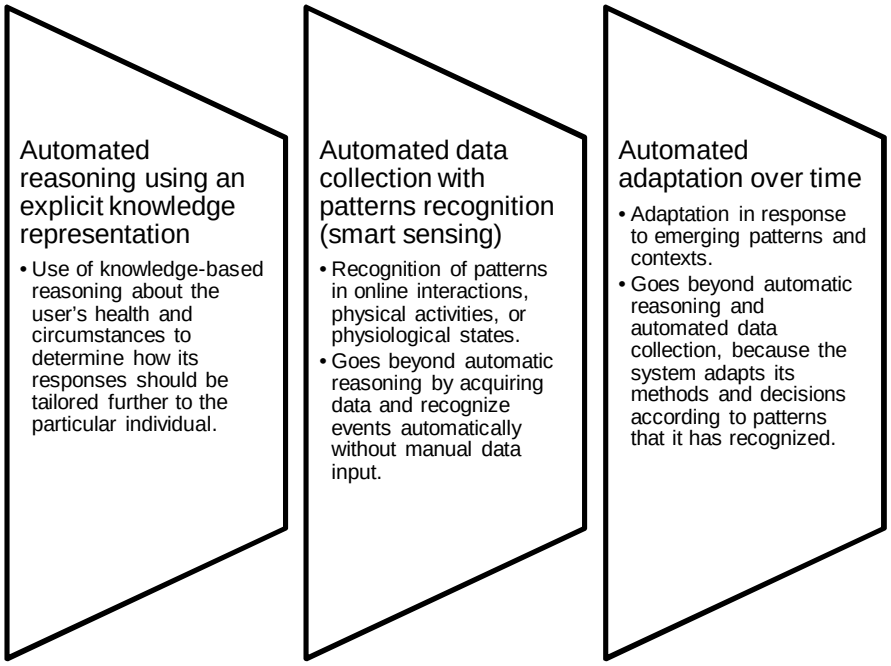



**Figure** 9**.** Active assistance (Kennedy et al., 2012).

## 3.5 Ethics

Although persuasion implies voluntary change in people's attitudes and/or behaviours or both, sometimes people respond with criticism to the idea of being persuaded. They might say that they do not want to be manipulated or they believe that nobody can influence their attitudes and behaviour. According to Miller (1973), "Many people become very upset when they hear that psychologists are trying to control them".

However, psychology is a science that not only attempts to describe and predict attitudes and behaviour, but also to control, and perhaps even to manipulate, them (Miller, 1973), and thus it always raises ethical concerns. Often persuasion literature justifies the research by stating that persuasion is present in our everyday lives whether we want or not, because people are influenced all the time when

they communicate with each other. The principles of persuasive communication, such as reciprocity, are built into our communication system. Miller (1973) has stated:

> *"Language is by all odds the most subtle and powerful technique we have for controlling other people. Nothing that psychologists can invent in their laboratories is likely to be nearly as influential in controlling people as it is familiar tool we call language."*

Advocates state that persuasion is essential for participatory democracy (Barney and Black, 1994) and the existence of civilization as we know it (Miller, 1973). When e-Health technologies are used by individuals the persuader is often the user himself and thus, there are fewer ethical concerns to be considered. Fogg (2003) states that people often put themselves into tunnel situations voluntarily to change their attitudes or behaviours. As an example, they may hire personal trainers who direct them through workouts. However, if a whole organisation adopts an e-Health technology which leverages social support and even peer pressure, there might be ethical concerns that should be considered.

Persuasion researchers and technology designers come from different backgrounds and they make their decisions based on their own ethical viewpoints. There are many perspectives on ethics that may help us to understand these viewpoints. The perspectives include pragmatism, utilitarianism, universalism, dialogic ethics, and situationalism (Solomon, 1984). According to Simons et al. (2001) they seem relevant to the ethics of persuasion.

In short, pragmatism responds to questions of ethics by transforming them into pragmatic questions about the consequences – probable costs and benefits of taking the given action. The basic principle of utilitarianism is to "do more good than harm" (Simons et al., 2001). It means that ends are weighed against means, means against ends, and both against circumstances. From many options the persuader should select the option that will provide the greatest good for the greatest number of people. The persuader is entitled to use ethically questionable means only if their goals as a persuader are worthy beyond question. Universalism "…assumes that some practices are intrinsically virtuous or intrinsically objectionable, no matter what the objective or the circumstances." (Simons et al., 2001) In universalism, the ethics are derived from law or tradition or religion. According to dialogic ethics, communication is ideally dialogic and it is facilitated only if the persons treat each other as a person rather than as an object to manipulate. Communication is based on interpersonal trust. According to situationalism, ethics should be role- or situation-specific, and exceptions to rules are allowed. The persuader should pay attention to the special circumstances of a matter, such as the role or function of the persuader for the audience, expectations of the receivers, the degree of the receiver's persuasion knowledge, the goals and values of the receivers, the degree of urgency and ethical standards for communication held by the receivers. (Simons et al., 2001)

Persuasive technology researchers have also considered ethical questions. Fogg (2003) states that many of the ethical questions related to persuasive tech-

nology are similar to those for persuasion in general. However, he has identified six issues that are unique for persuasive technology only:

- The novelty of the technology can mask its persuasive intent, because users are unaware of the tactics that are being used, and tactics can be subtle.
- Persuasive technology can exploit the positive reputation of computers and therefore users are very eager to accept information and advice from technology.
- Computers can be proactively persistent, and there is a risk that users will finally give in to a suggestion even if they objected it at first.
- Computers control the interactive possibilities and therefore users have a limited set of choices available which differs from human communication.
- Computers can affect the emotions but cannot be affected by them and therefore there is a risk that the communication will lead to non-ethical outcomes.
- Computers cannot shoulder responsibility and therefore they cannot be blamed from errors; the responsible instance varies case by case.

Fogg has presented many approaches to deal with ethical questions in design. In 1988 he suggested that a simple gain/loss analysis for different stakeholders could be used to show whether the technology is ethically questionable. As an example, if a company gains profit or information and an individual loses money, privacy, or freedom, the persuasive technology could be ethically questionable (Fogg, 1998). In 2003 he suggested that "by examining the intentions of the people or the organization that created persuasive technology, the methods used to persuade, and the outcomes of using the technology, it is possible to assess the ethical implications" (Fogg, 2003). One approach to assessing the ethical implications of persuasive technology is stakeholder analysis (Fogg, 2003). Other approaches have been developed by Berdichevsky and Neuenschwander (1999) and Friedman et al. (2006). More recently, Karppinen and Oinas-Kukkonen (2013) have reviewed different approaches to the ethics of BCSSs and have suggested that there are three main approaches: 1) guideline-based approach, 2) stakeholder analysis, and 3) involving users (Karppinen and Oinas-Kukkonen, 2013).

Ethical concerns are related to certain persuasion techniques or principles more often than to others. As an example, Fogg (2003) identified that *tunnelling technologies* can include unethical elements when they ask people to enter their personal information to successfully complete a software installation and give little choice to the user to exit the tunnel without causing any damage. Also *tailoring technologies* might be used unethically because studies have shown that only perception that the information has been tailored is more influential than regular information. This can be explained by the fact that people pay more attention to the information, because they think that it has been tailored for them. Provision of supposed tailored information may lead to situations where users blindly believe that the provided information is beneficial for them, whereas in fact it benefits the

web service provider. (Fogg, 2003) Ethical questions vary not only depending on the persuasion principle, but also depending on the information processing approach. According to Simons et al. (2001), there are more ethical concerns related to peripheral information processing and the use of cognitive shorthands, because then people act mindlessly and are unable or unmotivated to think critically. When people act mindfully and engage in central processing, they have the ability and motivation to think critically. Thus, there are less ethical concerns related to designs that support central processing.

# 4. The model

This section describes the PSD model and the conceptualization process of its authors. This section is related to publication III, which suggests a framework for Persuasive Systems Design (PSD).

### 4.1.1 Overview of the phases of the PSD model

As more and more systems are designed for persuasive purposes, there is a need to improve their possibilities to support users in attitude and/or behaviour change.

> *The key means is to introduce the persuasive design practices into the software development. By combining persuasive design practices and software development, it is possible to describe a new way to develop software.*

The main purpose of the BCSS development process is not only to deliver a product that the customer has required, but to produce a solution that supports users in their attitude and/or behaviour change.

The authors selected the general lifecycle model to describe the development process of persuasive systems and the Functional Triad (Fogg, 2003) as one of the main knowledge bases. These approaches were complemented with the key theories of persuasion. The main objective was to guide the process of developing persuasive system qualities through the lifecycle model. Although the Functional Triad acknowledges the role of the persuasion principles, it does not adequately support the software development activities i.e. the analysis, design and implementation.

According to the PSD model, the Persuasive systems development has three steps: 1) analysis of the persuasion context and selection of persuasive design principles, 2) requirement definition for system qualities, and 3) software implementation (see Figure 10). When following the lifecycle model, these steps should be iterative and incremental (although it is not emphasized in Publication III). The PSD model suggests new design practices for analysing the persuasion context and requirement definition, and also describes example implementations. These design practices should appear in the early stages of the development, during the analysis and design phases, because it makes easier and cheaper to integrate the persuasiveness into the final system.

The authors also suggest that the PSD model can be used for evaluation of persuasiveness. It can be used in two main approaches: as a framework in user-based methods, such as field trials, or inspection-based methods, such as heuristic evaluation.

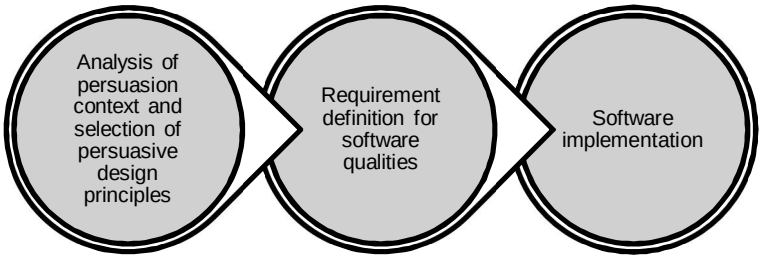



**Figure 10.** Phases in Persuasive Systems Development.

One challenge for the authors was to consider how they could communicate some of the key issues behind persuasive systems – some starting points for research that could not be included in these three development steps. Thus, the authors formulated seven postulates that aim at capturing the understanding gathered during the conceptualization process. Because postulates are not concrete instructions on how to build a persuasive system, but rather a set of statements, it is expected that they will have more relevance for the researchers than for the practitioners.

### 4.1.2 Postulates behind persuasive systems

The first postulate, *information technology is never neutral,* states that technology always influences users' attitudes toward the intended behaviour and behaviour itself in one way or another. The authors sometimes faced criticism of persuasive technology from other researchers saying that "I don't want to be persuaded" or "I can't be persuaded, because I would notice it". The authors wanted to point out that people are constantly exposed to persuasive communication in one way or another. This postulate also states that persuasion should not be considered as a single act, but a process as the background theories by McGuire (1973), Petty and Cacioppo (1986), and Simons et al. (2001) suggest.

The second postulate, *people like their views about the world to be organized and consistent,* states that users' behaviour strives for consistency. Psychological inconsistency disturbs people, and they feel obliged to reorganize their thinking and restore consistency. In addition, making commitments will help users to

change their behaviour. This postulate originates from Cognitive consistency theory (Fraser et al., 2001; Festinger, 1957) and Cialdini's (1993) principle of commitment and cognitive consistency. Commitment could also be regarded as a persuasion principle, but the authors state that concepts of commitment and consistency are closely related and consistency is rather a higher level concept than a principle.

The third postulate, *direct and indirect routes are key persuasion strategies,* states that an individual who carefully evaluates the content of the persuasive message may be approached by the direct route, whereas an individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect route. This postulate implies that a user's personal background and the use situation have an influence on their information processing. When the user has a high motivation and a high ability, they are more likely interested in the content of the persuasive message than when they have a low motivation and a low ability. In challenging situations such as being in a hurry, it is highly likely that one will use heuristics for processing the information. This postulate originates from ELM (Petty and Cacioppo, 1986). By this postulate, the authors want to point out that, by offering information, users will change their behaviour only rarely, and especially when they are using technology in challenging use contexts, such as health-related contexts, it is important to support the indirect route.

The fourth postulate, *persuasion is often incremental,* states that it is easier to initiate people into carrying out a series of actions through incremental suggestions rather than a one-time consolidated suggestion. This postulate does not originate directly from any of the existing key theories, but has been stated by, for example, Mathew (2005). By this postulate the authors want to point out that a persuasive system should enable making incremental steps toward target behaviour.

The fifth postulate, *persuasion through persuasive systems should always be open,* states that it is very important to reveal the designer bias behind the persuasive system, and the overall goal should be users' voluntarily changing attitudes or behaviours. This postulate originates from Fogg (2003), Cassell et al. (1998) and Miller (2002), who stated that persuasion allows people voluntary participation in the persuasion process. By this postulate, the authors want to point out the ethical issues in technology development, and that openness is one aspect related to ethicality.

The sixth postulate, *persuasive systems should aim at unobtrusiveness,* states that systems should avoid disturbing users while they are performing their primary tasks. The principle of unobtrusiveness also means that the opportune (or inopportune) moments for a given situation should be carefully considered. This postulate originates from the ELM, which states that situation-specific factors influence the elaboration of the persuasive message (Petty and Cacioppo, 1986). If users get distracted all the time, they will be more likely to process the information through peripheral processing, which makes the change less enduring. In addition, Distraction conflict theory (DCT) suggests that interruptions result in deteriorating performance, and they may also result in the loss of working memory contents or confusion between cues in memory, which further inhibits decision performance. (Speier

et al., 2003) Fogg (2003) has emphasized the meaning of finding the opportune moment to present the persuasive message, i.e. finding the Kairos moment as the ancient Greek rhetoricians called it. In Greek mythology, Kairos was the youngest son of Zeus and the "god of the favourable moment". Unobtrusiveness is especially related to principle of reminders – how the system should remind users of their target behaviour during the use of the system – and the authors want to point out that persuasive features should not prevent people from using the system for its purpose.

The seventh postulate, *persuasive systems should aim at being both useful and easy to use,* states that the system should serve the needs of the user. This includes a multitude of components, such as responsiveness, ease of access, lack of errors, convenience and high information quality, as well as positive user experience, attractiveness, and user loyalty mentioned in Fogg (2003). As computer scientists, the authors considered that these general software qualities should be regarded as a postulate rather than persuasion design principles. This postulate originates from Oinas-Kukkonen (2000) whose conceptual framework for web-shopping systems introduces both ease of use and usefulness as determinants of web flow. They are also acknowledged in the TAM, where perceived ease of use and perceived usefulness are determinants of attitude toward using a system (Davis, 1989). Also, Fogg (2003) has emphasized the meaning of ease of use as a facilitator of web sites' credibility.

### 4.1.3 Analysis of the persuasion context and selection of persuasive design principles

The PSD model suggests that an analysis of the persuasion context should be included in the Persuasive Systems Development. The analysis requires a thorough understanding of what happens in the information processing event, namely understanding the roles of persuader, persuadee, message, channel, and the larger context (Oinas-Kukkonen and Harjumaa, 2009). Thorough analysis of the persuasion context will help to recognize inconsistencies in a user's thinking, discern opportune and/or inopportune moments for delivering messages, and effectively persuade. The context analysis includes recognizing *the intent* of the persuasion, understanding *the persuasion event*, and defining *the strategy*, which are not considered as traditional system design or human-centred design. These three tasks are described in more detail as follows.

*Intentionality* is a salient part of persuasive communication and thus it is important to determine who the persuader is. The authors adopted Fogg's (1998) definition: as computers do not have intentions of their own, those who create, distribute, or adopt the technology have the intention to affect someone's attitudes or behaviour. Fogg has recognized three different sources of intentions: those who create or produce the interactive technology (endogenous); those who give access to or distribute the interactive technology to others (exogenous); and the very user adopting or using the interactive technology (autogenous).

The understanding of intentionality is important, because it is needed in the later steps of the development. It influences the selection of the principles, and it might also lead to further considerations about the target groups of the system. As an example, if a municipality distributes persuasive home care technology for elderly users, they can have several intentions to change the behaviours of the users. However, the users might not be motivated to change their behaviour nor to adopt the system. In this case, the system functionality should not only support the users' primary tasks, but also motivate them to change their behaviour – especially because the initiative for system use did not come from them. This can be done, for example, by applying the principles from social support category.

*The understanding of event* consists of three dimensions: recognizing the use context, user context and technology context. The use context includes problem domain-dependent features. The user context includes user-dependent features, such as user's goals, motivation, lifestyle and others, whereas the technology context includes technology-dependent features. Basically, the understanding of an event can be seen as a backbone for the overall concept design.

The authors did not adopt this approach directly from any existing theory, but it was shaped during the conceptualization process. Also, Hassenzahl and Tractinsky (2006) have used categorization into user, technology and use context, but in a different sense. They state that the user experience is a consequence of a user's internal state (predispositions, expectations, need, motivation, mood, etc.), the characteristics of the designed system (complexity, purpose, usability, functionality, etc.), and the context (or the environment) in which the interaction occurs.

In both of these approaches, persuasive systems design and user experience, these dimensions have similar meanings, but the PSD model lays more stress on behaviour change aspects. As an example, when the use context is analysed, it means that the designer has to understand the domain-specific features. In the domain of health and well-being it usually means that health care professionals, such as physicians, physiotherapists, and psychologists, have to be involved in the design so as to provide the actual content for the system. The content might, for example, be a self-care plan of a chronic disease, home exercise program, or an intervention to reduce stress. Conversely, the designers can have expertise of the problem area which they have gained through earlier experiences.

Analysis of the user context for its part should have its emphasis on characteristics that are relevant to the behaviour change, such as user's readiness to change and personal characteristics than can be used to personalize the system.

Analysis of the technology context should cover the overview of available technologies including devices with larger displays for longer sessions of use, mobile devices for shorter sessions of use, devices for home measurements, and wearable devices for continuous monitoring.

*The understanding of strategy* states basically the same as the third postulate, *direct and indirect routes are key persuasion strategies*. An individual who carefully evaluates the content of the persuasive message may be approached by the direct route, whereas an individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect

route. Especially if the use context is challenging in a way that the user cannot carefully evaluate the content of the message, it is important to support the indirect route.

Strategy selection influences the third phase of persuasive systems design which is *requirement definition.* As an example, if it is expected that the users will change their behaviour through the direct route, it would be feasible to persuade smokers to quit smoking by providing information about the dangers or financial costs of smoking. If is expected that the target group will change its behaviour through the indirect route, it would be feasible to design a subtle suggestion to stub out a cigarette if nobody else in the room is smoking either.

### 4.1.4 Requirement definition for system qualities

The PSD model suggests that requirement definition for persuasive system qualities is an important step in the Persuasive Systems Development. The PSD model lists 28 design principles for persuasive system content and functionality and describes example software requirements and implementations. These categories and principles of the PSD model are expected to be especially useful in requirements definition. The authors state that a systematically designed persuasive system has software requirements that apply persuasion principles.

Following the modern methods of requirement elicitation, the categories and design principles could be useful in co-creation sessions where people work in collaboration to find inspiration for the core design team (Stickdorn and Schneider 2011).

Most of the principles of the PSD model have been adopted from Fogg (2003), but some of the design principles are novel. Also, a new categorization of these principles is proposed, consisting of the primary task, dialogue, system credibility, and social support categories (see Figure 11). The authors have aimed to describe the principles and to explain how the suggested design principles can and should be transformed into software requirements and be further implemented as actual system features. Basically, the categories were formed by having all the principles on the table and then grouping them into classes within a conceptual scheme.

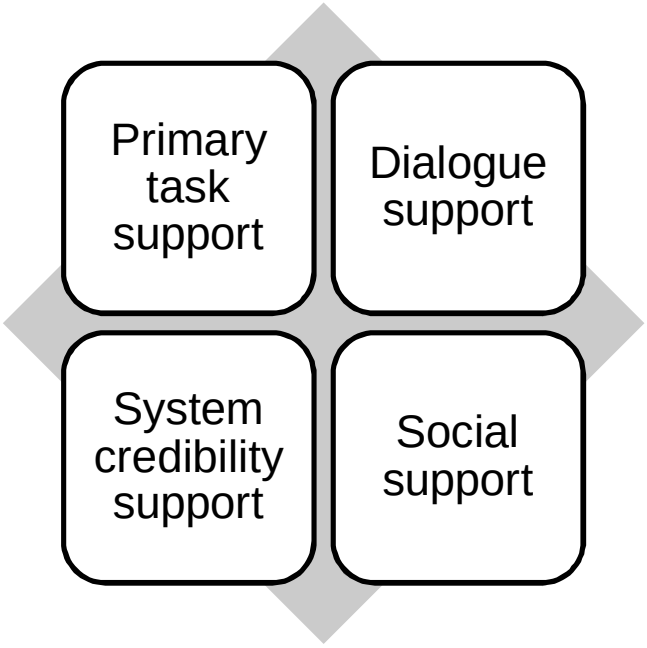



**Figure 11.** The PSD model (Oinas-Kukkonen and Harjumaa, 2009).

The design principles in *the primary task support category* support the carrying out of the user's primary task. Task can be defined as the action carried out by the user in turning input into output (Goodhue and Thompson, 1995). All design principles in this category are based on the work of Fogg (2003), more precisely on the tool category. However, there are also many differences to these. Based on the understanding of the authors, *the principle of suggestion* emphasizes the importance of provision of meaningful content for the user rather than providing support for carrying out a process or making a task simpler to do. For this reason, it has been moved into another category. Also, *principles of surveillance and conditioning* have been omitted, because of their discrepancy with the fifth postulate. The authors also tend to think that users act more or less rationally in the way in which they form and modify attitudes on the basis of beliefs and values rather than performing behaviour as a result of conditioning. The design principles in this category are reduction, tunnelling, tailoring, personalization, self-monitoring, simulation, and rehearsal.

The design principles in *the dialogue support category* are related to human-computer interaction, or dialogue, as the authors call it, and more specifically to the user feedback. The design principles in this category are partly based on Fogg (2003) and more specifically to the social actor category (attractiveness, similarity, and praise) and media category (virtual rewards). *Reminders and social role* are novel design principles, whereas *the principle of reciprocity* was excluded from this

framework because it was seen as a characteristic of a user rather than a system feature. The design principles in this category include praise, rewards, reminders, suggestion, similarity, liking, and social role.

The design principles in *the system credibility support category* describe how to design a system so that it is more credible and thus more persuasive. The design principles in this category have been adopted and modified from Fogg (2003), but there are, however, some differences. The *principles of fulfilment, ease-of-use, responsiveness, and near perfection* have been excluded from this category, because they are considered to belong to the postulates. Since personalization is very closely related to tailoring, it can be found from primary task support category. On the other hand, the key benefit of referring to an authority is to increase system credibility in a similar manner to other principles in this category, and thus, it is listed here. Undoubtedly *principles of presumed credibility, reputed credibility, and earned credibility* would influence users, but since these cannot really be represented as system features, they are excluded here. The design principles in this category include *trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability*.

The design principles in *the social support category* describe how to design the system so that it motivates users by leveraging social influence. These principles have been adopted from Fogg's (2003) principles on mobility and connectivity. *Kairos factors* and the principles of *convenience, mobile simplicity, mobile loyalty, mobile marriage, and information quality* have been covered in the postulates. The design principles in this category include *social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition*.

# 5. Demonstration of the applicability of the model

This section demonstrates how to use the PSD model. The PSD model has been used in publications IV, V and VI where it has been used in an e-Health context. The fourth publication concentrates on investigating how the PSD model can be utilized in the design work, whereas the fifth and sixth publications focus on how the PSD model can be utilized in the evaluation work. This section summarizes the main contribution of the publications.

## 5.1 Applicability of the PSD model in the design of e-Health systems

The fourth publication concentrates on investigating how the PSD model can be utilized in the design work – to support an identification of persuasive aspects in the early stages of iterative, user-centred, information systems development. Although the PSD model has been described in the publication through a more traditional software development process, the study showed that especially the design principles can be a fruitful source for new functionalities in an iterative, user-centred development process.

In order to integrate the PSD model into the systems development it was necessary to select real life practice-based problems where this kind of design approach was needed and to use the PSD model in them. This study describes experiences from two health-related system design cases. The objective of both of these systems is to deliver an intervention which seeks to make a positive change in the health behaviour of the users. Case 1 involves a fall risk assessment and fall prevention system to deliver an intervention designed to reduce fall risk (see Figure 12). More detailed information about the system is available in Similä et al. (2013). Case 2 involves an existing smartphone application designed to increase mental well-being by teaching skills that boost psychological flexibility and mental wellness (see Figure 13). More detailed information about the application is available in Ahtinen et al. (2013).

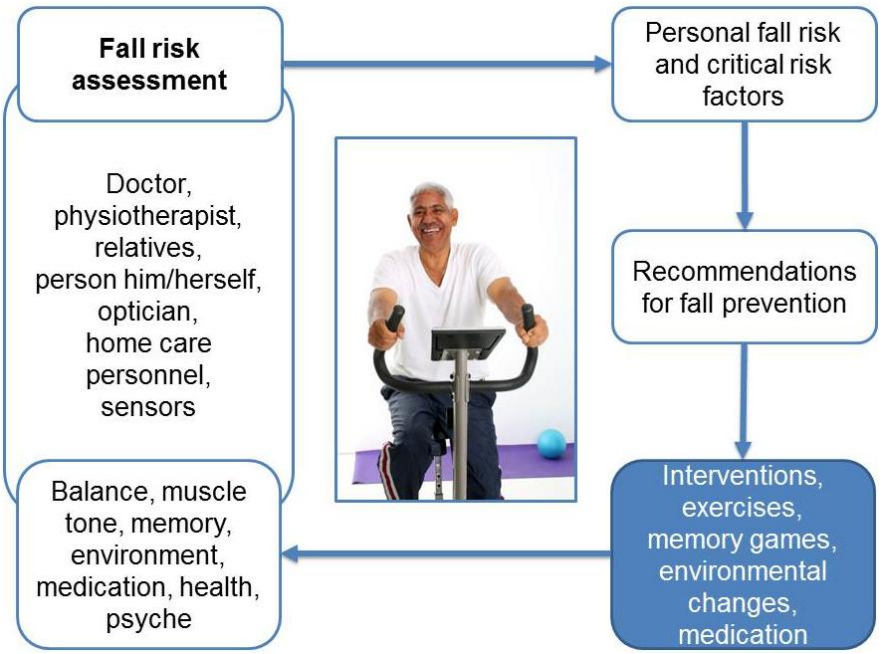



**Figure 12.** Concept of a fall risk assessment system studied in Case 1 (the figure is reproduced with kind permission from Ageing in Balance project, VTT, Finland).

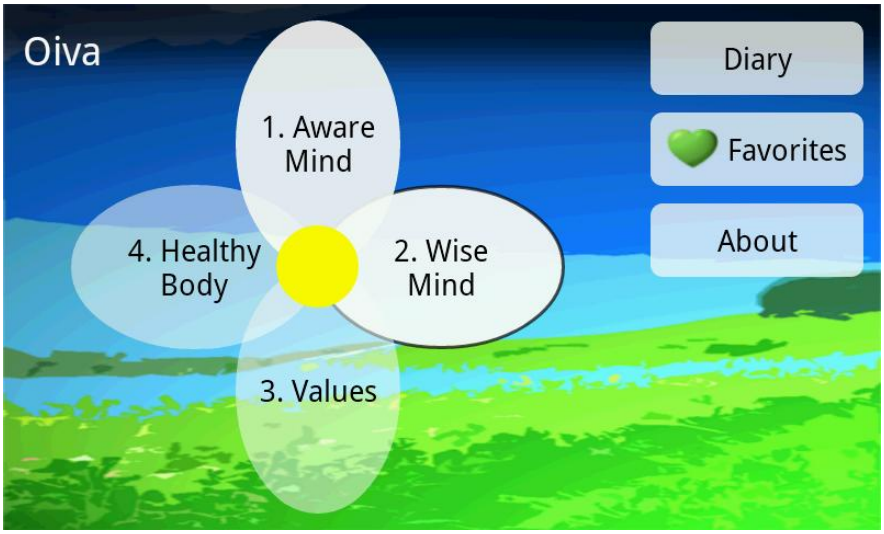



**Figure 13.** Prototype of a mobile mental wellness training for stress management studied in Case 2 (the figure is reproduced with kind permission from SalWe SHOK, VTT, Finland).

Because one of the objectives of the PSD model is to show examples of how the suggested persuasive design principles can be transformed into software requirements and further implemented as actual system features (Oinas-Kukkonen and Harjumaa, 2009), the PSD model was applied during the user requirements analysis and concept design phases. In practice, this meant that a co-creation session was organized for the people working in the two selected cases. In order to bring the PSD model closer to practice, the author outlined a design canvas which was aimed at facilitating the ideation work. The basic building blocks of the resulting Persuasive Technology Design Canvas are: 1) Analysis of the intention, 2) Design of the content and 3) Design of the functionalities (see Figure 14). By making a clear distinction between the content and the functionalities, the author wanted to emphasize that the Persuasive Technology Design Canvas is not limited to any particular theoretical model of behaviour change; it can be used across many kinds of design work. As an example, the content in Case 2 was based on Acceptance and Commitment Therapy (ACT) (Hayes et al., 2006).

<table>
<tr><td>ANALYSIS</td><td colspan="3">INTENTION –<br>Who, What, When, Where, Why?</td></tr>
<tr><td rowspan="3">DESIGN</td><td>CONTENT – What?<br>What theories, methods or assumptions the technology relies on?<br>What kind of content is provided?<br>What kind of content could be provided?</td><td colspan="2">FUNCTIONALITIES – How?<br>How technology has been implemented?<br>How technology could be implemented?</td></tr>
<tr><td rowspan="2"></td><td>Primary task<br>E.g. principles of reduction, tunnelling, tailoring, personalization, self-monitoring, simulation, and rehearsal.</td><td>Dialogue<br>E.g. principles of praise, rewards, reminders, suggestion, similarity, liking, and social role.</td></tr>
<tr><td>Credibility<br>E.g. principles of trustworthiness, expertise, surface credibility, real world feel, authority, third-party endorsements, and verifiability.</td><td>Social support<br>E.g. principles of social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition.</td></tr>
</table>

**Figure 14.** The Persuasive Technology Design Canvas.

The study shows that, where the PSD model was utilized, participants of the co-creation sessions were able to identify more persuasive functionalities compared to their existing preliminary user requirements or designs. Initially there were 15 different persuasive functionalities applying principles from three categories in Case 1 and after the co-creation workshop there were 39 different functionalities from applying principles from the four PSD model categories (see Table 2). In Case 2 it was identified that in the current application there were 17 different persuasive functionalities applying principles from three categories, and after the co-creation workshop there were 27 different functionalities applying principles from the four PSD model categories.

**Table 2.** Quantity of the persuasive functionalities before and after the co-creation session.

| | Before | After | Increase |
|---|---|---|---|
| **Case one** | 15 | 39 | 160% |
| **Case two** | 17 | 27 | 60% |

To summarize, the study demonstrated how persuasiveness can be built into systems. It also specified the purpose of the PSD model; it clearly helps to identify new requirements for persuasive systems. It seemed, however, that is was the most useful in increasing the awareness of the features needed to accomplish an e-Health system that aims to support changes users' behaviour.

## 5.2 Applicability of the PSD model in the evaluation of e-Health systems

The fifth publication demonstrates how the PSD model can be utilized in the evaluation – to identify the persuasive functionalities embedded into the functionality of a heart rate monitoring system. The sixth publication is similar to the fifth publication; it also demonstrates how the PSD model can be utilized in the evaluation – to identify the persuasive functionalities embedded into functionality of a medicine reminder system.

### 5.2.1 Evaluation of a heart rate monitoring system

The fifth publication describes the findings of a qualitative, longitudinal field trial with 12 users who adopted a prototype of a heart rate monitor (HRM), the Polar FT60. The HRM includes a persuasive training program, which aims to promote proper exercise. The study demonstrates how persuasive techniques can be identified in system functionality, and how persuasive techniques function i.e. how the users experience them.

The PSD model was used in two phases during the study: to analyse the system features through an expert analysis and to guide the qualitative analysis and structure the user experience findings.

#### 5.2.1.1 Expert analysis of the system features

The study shows that the HRM applied three principles related to supporting the primary task, four principles related to supporting system-user dialogue, and three principles related to supporting the system credibility. It was not possible to explore techniques related to the category of social support, because the system did not support communication between users through designated functionality at the time of the study. The persuasion principles that were found to have been applied in the design of the HRM were: reduction, tailoring, self-monitoring, praise, rewards, reminders, social role, trustworthiness, expertise, and surface credibility (see Table 3).

**Table 3.** Identified persuasion principles in Polar FT60 HRM.

| **Primary task support** | | | **Dialogue support** | | |
|---|---|---|---|---|---|
| **+** | | Reduction | + | | Praise |
| | - | Tunnelling | + | | Rewards |
| **+** | | Tailoring | + | | Reminders |
| | - | Personalisation | | - | Suggestion |
| **+** | | Self-monitoring | | - | Similarity |
| | - | Simulation | | - | Liking |
| | - | Rehearsal | + | | Social role |
| **System credibility support** | | | **Social support** | | |
| **+** | | Trustworthiness | | - | Social learning |
| **+** | | Expertise | | - | Social comparison |
| **+** | | Surface credibility | | - | Normative influence |
| | - | Real-world feel | | - | Social facilitation |
| | - | Authority | | - | Cooperation |
| | - | Third-party endorsements | | - | Competition |
| | - | Verifiability | | - | Recognition |

Over the course of the study it was found that all users responded positively to eight out of the ten techniques. These techniques are, in the order of their relative strength, the following: *self-monitoring, reduction, reminders, trustworthiness, tailoring, social role, expertise, and surface credibility*. The impact of applying these principles was fairly consistent, whereas responses towards *praise and rewards* varied by user. The persuasive system features and how they functioned are described as follows.

The principle of *reduction* is applied to lessen the effort that users need to invest in planning and carrying out the right kinds of exercises. The program provides easily executed weekly goals based on expert knowledge in physiology and sports medicine. This makes it easier for the user to carry out their exercise regimen and improves the cost-benefit ratio of the target behaviour.

The principle of *tailoring* is applied to tailor the personal training program with respect to the user's personal information such as age, gender, weight and heart rate information as well as the long-term goal that the user has set for the training program.

The principle of *self-monitoring* is applied to provide information during exercise and to change current behaviour according to it. After the exercise, the program gives feedback which helps the user to change their plans for the following exercises that week. The weekly follow-up helps the user to evaluate their progress compared to past weeks and to plan future weeks.

The principle of *praise* is applied in positive verbal feedback that the system gives after each exercise, such as "Maximal performance improving," or through weekly feedback, e.g. "Excellent!" or "Well done!"

The principle of *rewards* is applied in virtual rewards that the personal training program gives users if they have reached their goals in an excellent manner. Rewards are in the form of one to three stars or a trophy that appear on the user's wrist unit display.

The principle of *reminders* is not used as a reminder to perform exercises as you would expect, but as a reminder to re-check the results of a past week's exercises and thus follow progress on a regular basis. The reminder is implemented as an envelope on the wrist unit's display.

The principle of *social role* is not implemented explicitly as an image of a virtual coach, but a more subtle concept of a personal trainer who gives verbal feedback and guidance based on users' actions.

An estimation of the credibility was made based on the expert analysis. The principle of *trustworthiness* was communicated through the "Polar" brand in this case, and because the company has a history of high-quality products, it is positioned as a market leader, and it bases its products on scientific research. The research was conducted in Finland, where the Polar brand is generally well-known. The principle of *expertise* was communicated through the training program, which is based on expert knowledge in physiology and sports medicine. The principle of *surface credibility* was communicated through the credible appearance of the system.

#### 5.2.1.2 User experience findings

The target group of this study can be characterized as "sports enthusiasts". All participants were already active in sports and their primary goals for exercising were to maintain and improve their fitness. Most of the participants (n = 8) had prior experience of HRM systems. According to the users' own opinions, they

knew how they should exercise. However, they admitted that they did not always exercise according to their best knowledge. The most interesting user experience finding was that the users felt that it was difficult to exercise less intensively as they had been used to training more intensively. The biggest challenge in adoption of the personal training program was that users did not want to include lighter exercises in their weekly plan.

However, after participants had been using the training program for two weeks, eight out of 12 carried out the suggested amounts of exercises and followed the three intensity zones. They changed their actual behaviour during the exercises and also started to plan their exercises in a new way.

The study suggests that leveraging goal setting, tracking performance, adopting social roles, along with high overall perceived credibility influences user behaviour. Short-term verbal system feedback via praise and rewards may provide additional support in persuading some people. It was also emphasized in the results that, even if the product is designed for a homogeneous target group, small individual differences between users may weigh in the persuasion. It was suggested that it is safer to select a set of persuasion principles and use them together than rely on one principle only. On the other hand, it was found that the persuasion principles are inter-linked. The effect of persuasion principles may be "more than the sum of its parts". As an example, offering tailored information to a user may have a positive effect on system credibility, whereas repeating rather trivial praises may have a negative effect on system credibility.

### 5.2.2 Evaluation of a medicine management system

The sixth publication presents a study in which the PSD model was used in order to discuss how the persuasive features or a multimodal medicine management system addressed patient-centred factors influencing non-adherence. Also, the expectations of the system and user experience findings from an empirical qualitative field trial are presented.

#### 5.2.2.1 Expert analysis of the system features

The Personal Medicine Assistant (PMA) is a multimodal reminder system which reminds its primary end-users to take their medicines, supports them in the medication taking process, and provides medicine information and personalized feedback. For home care professionals, the PMA provides an opportunity to monitor medication taking. The system is based on basic off-the-shelf equipment – a tablet PC with a touch screen, text to speech synthesizer application, an external Near Field Communication (NFC) reader/writer device, and regular medicine packages tagged with NFC labels. The main purpose of the PC is to display the calendar, alert the user with reminders, and provide a view for care professionals for medication planning and adherence, whereas the NFC reader/writer device and tagged medicine packages are used for storing and reading medicine information from

NFC tags. The role of the speech synthesizer is to transform the text displayed on the screen into speech. PMA's main view of the graphical user interface for elderly users is presented in Figure 15.


**Figure 15.** PMA's main view for elderly users (the figure is reproduced with kind permission from HearMeFeelMe project, Tecnalia, Spain).

The main view of the interface shows a medication plan for a day, and thus the system aims to reduce the effort required to remember to take the correct medicines at the correct time (*principle of reduction*). The plan shows the medicine and dosage information of the medicines that the user has to take during the day. Information provided can be tailored according to the user's needs (*tailoring*). The default medication plan is divided into four sections. By default these are breakfast (desayuno), lunch (comida), dinner (cena), and bedtime (dormir), but they can be personalized based on the needs of the particular user (e.g. snack/merienda can be added) (*personalization*).

The system aims to guide users through the medication process (*tunnelling*). When it is time to take medicines, the PMA reminds users visually by showing a reminder and providing an audio description (*reminders*), and informs the user which medicine to take one by one and the respective dosage. Then it asks the user to find the medicine package and to place it on the NFC reader to verify its content. Once the medicine is identified and the reminder system confirms that it is the right one (*reduction*), the user receives a positive response and a prompt to take the medicine. Then the user confirms their medicine consumption by touching the "OK" button on the PC screen, and the system registers that the user has taken their medicines. When the user gives confirmation, the system notifies the user by displaying the reminder window in a green colour. The previous verification

and confirmation steps will be repeated, one by one, until all the medicines are taken. When the confirmation process is finished, the calendar will be shown again with information about the next medicine and dosage of the day. The PMA uses praise via words to give motivating feedback about successful medicine taking.

The designers have also aimed at using terminology which would be familiar to elderly users (*similarity*) and selecting attractive colours and figures (*liking*). Using an avatar "virtual nurse", the system adopts a social role. The system provides information that is perceived as trusted by the users, because it is managed by home care professionals (*trustworthiness*). The system is also viewed as incorporating expertise, because it is provided by home care professionals (*expertise*). The system has been designed to have a competent look and feel (*surface credibility*). In addition to the scheduled medication process, PMA can be used to provide information about the medicines at any time. The user can read the information stored in the NFC tag attached to the medicine package by placing the NFC-labelled medicine package on top of the NFC reader.

To summarize, the persuasion principles that were found to have been applied in the persuasive design of the personal medicine assistant were: reduction, tunnelling, tailoring, personalisation, praise, reminders, similarity, liking, social role, trustworthiness, expertise, and surface credibility (Table 4).

**Table 4.** Identified persuasion principles in PMA.

| **Primary task support** | | | **Dialogue support** | | |
|---|---|---|---|---|---|
| + | | Reduction | + | | Praise |
| + | | Tunnelling | | - | Rewards |
| + | | Tailoring | + | | Reminders |
| + | | Personalisation | | - | Suggestion |
| | - | Self-monitoring | + | | Similarity |
| | - | Simulation | + | | Liking |
| | - | Rehearsal | + | | Social role |
| **System credibility support** | | | Social support | | |
| + | | Trustworthiness | | - | Social learning |
| + | | Expertise | | - | Social comparison |
| + | | Surface credibility | | - | Normative influence |
| | - | Real-world feel | | - | Social facilitation |
| | - | Authority | | - | Cooperation |
| | - | Third-party endorsements | | - | Competition |
| | - | Verifiability | | - | Recognition |

The user experience findings, which are described in the next chapter in more detail, showed that elderly users' perceived need for this kind of system was low, even if a need for the system was identified earlier in the development process.

Publication VI discusses whether the reason was that users' reasons for non-adherence and other possible factors influencing technology adoption were not understood thoroughly enough. Thus, it is possible that the system partly failed to provide value for the users. Publication VI points out that it would be important to understand patient-centred factors that influence non-adherence and how the use of persuasive functionalities in a Medication Management System (MMS) could address these reasons. Also, concrete examples are presented. As an example, if the reason for non-adherence is *misunderstanding of prescribing instructions*, following persuasion principles could be helpful:

- Reduction: MMS can reduce users' efforts to manage medicines by providing a daily medication plan.
- Tunnelling: MMS can provide the means to guide the user through the medication process and therefore users are able to avoid mistakes and learn to take the right medicines at the right time.
- Personalization: MMS can help users to understand prescription instructions by using personalized medicine names which are familiar for the user.
- Rehearsal: MMS can provide the means to rehearse the medication process.
- Reminders: MMS can remind users to take their medicines.
- Similarity: MMS can help to understand prescription instructions by using language that is familiar to users.
- Tailoring: MMS can provide tailored information showing only information that is relevant to the current user

Other patient-centred factors that influence non-adherence (based on Vlasnik et al., 2005) and examples of how persuasive functionalities could be used in a (MMS) are described in Publication VI.

#### 5.2.2.2 User experience findings

The study showed that the PMA system was expected to provide concrete assistance with medication management by reminding people to take their medicines and guiding users through the medication process, providing a monitoring functionality for home care professionals and even helping home care professionals to identify patients' cognitive problems at an early stage. In addition, multimodality was expected to bring benefits through providing information in audio format, reinforcing reminders using visual feedback and requiring users to pick up the medication package during the medication process.

The user experience analysis showed that the older participants considered many of the system qualities to be useful for themselves or somebody else in a certain situation, such as a person living alone or a person whose medication plan has been changed. Users experienced that the system offers concrete assistance

with medication management through reminding them to take their medicines and guiding them through the medication process. Users' attitudes towards the multimodality with audio feedback and touch-based user interfaces were positive. However, elderly users' perceived need for this kind of system was low, even if a need for the system was identified both in the early stages of the development as well as later by the home care professionals. The reasons are discussed in more detail in Publication VI.

## 5.3 Summary and future directions

According to the design science research approach, it is important to reflect the empirical findings back to theory. Thus, this section summarizes the results of the demonstration and pinpoints challenges that should be acknowledged in the future.

In the design science research approach the success of the construction correlates more with the practical relevance of the solution than with the theoretical analysis which is more common in empirical-analytical research. It is important to show that the developed construct is better than its predecessors. The demonstration shows that the categories and principles of the PSD model can be successfully applied during the user requirements analysis and concept design phases to identify new potential persuasive functionalities (Publication IV) and analysing the persuasive functionalities of an existing product (Publication V and VI).

When the PSD model is compared to the Functional Triad (Fogg, 2003), it can be seen that both models can be used as a resource to foster new ideas, but only the PSD model introduces persuasive design practices into the IS development. By combining persuasive design practices and IS development it is possible to describe a new way to develop software – how to transform the persuasion principles into software requirements and functionalities.

The motivation for this study was explored in Publication I and some criticism was also presented of the Functional Triad. After the construction of a new framework, it is useful to show the differences between the PSD model and the Functional Triad regarding the criticism that was presented in Publication I (see Table 5). The analysis shows that the PSD model succeeded in meeting some of the objectives, but not all.

**Table 5.** Differences between the Functional Triad and the PSD model.

| The Functional Triad | The PSD model |
|---|---|
| The views on persuasive technology functioning as a tool, a media or a social actor are problematic. However, they are justified by stating that persuasion strategies will differ depending on whether a computing technology is functioning as a tool, a media or a social actor. | The new categorization was formed by having all the principles on the table and then grouping them into classes within a conceptual scheme. It was considered necessary to classify the principles based on their purpose. Further research supports the feasibility of the categories of the PSD model (Lehto et al., 2012a; 2012b). |
| The suggested principles within the tool, the media and the social actor categories are not at an equal level of abstraction. | The new categorization of the principles aims to be more comprehensive by relocating the principles and not including overlapping principles. However, researchers reported on not understanding the difference between all of the principles and finding them ambiguous (Publication IV). |
| The media category is quite limited while it focuses on simulations. | After the new categories were formed, media category was not seen necessary any more. |
| The principles are overlapping. There appears to be a need for reorganizing and renaming the principles with respect to understanding their application in practice. | The PSD model aimed to reorganize and rename some of the principles. However, the PSD model still cannot be considered as a normative framework. |

The analyses of the persuasive functionalities of existing products showed that the system qualities fall quite easily into the four categories of primary task support, dialogue support, system credibility support and social support. However, it was observed that some principles were ambiguous, and thus, it would be important for there to be universal understanding of the meaning of the design principles. It has been stated that some of the principles are ambiguous (e.g. in Langrial et al., 2012a) and therefore, there should be more thorough explanations of the principles. There are also some principles that are difficult to identify based on expert analysis because of their subjective nature, such as liking and surface credibility, and thus it would be preferable to identify them based on user experience findings.

The field trial findings indicate that, from the user experience perspective, the persuasion principles are inter-linked. The effect of persuasion principles may be "more than the sum of its parts". As an example, offering tailored information to a user may have a positive effect on system credibility, whereas repeating rather trivial praises may have a negative effect on system credibility. Thus, there is a need for a deeper understanding of distinct design principles. Interestingly, although the PSD model suggests following the three steps of a more traditional software development process i.e. analysis, design and implementation, the study reported in Publication IV showed that the model can be a fruitful source for new functionalities in an iterative, user-centred development process following a prototyping software development strategy. Thus, even if the PSD model has been

described in the publication (Publication III) by using a traditional system development process stage model, it encompasses the viewpoint of more modern software development processes and practices.

The PSD model suggests that it is important to understand the meaning of intentionality in the persuasion process. However, in the information systems field the intention or motivation behind the technology is often difficult to identify (see e.g. Langrial et al., 2012a), and there is a need to understand intentionality in a more thorough way. Fortunately, this issue has been studied further and Oinas-Kukkonen (2013) has suggested an O/C Matrix for analysis of the intent. Also, Wiafe et al. (2011, 2012) have suggested a new model that can be used for analysing the intent, the event, and the strategy. The most fundamental difference of the 3-Dimensional Relationship between Attitude and Behaviour (3D-RAB) model (Wiafe et al., 2012) compared to the PSD model is that the technology context of the PSD model is studied as part of design strategy, because it is not feasible to select the technology before the strategy is selected.

The PSD model comprises many components that are all relevant for the development of behaviour change support systems, and so, it might seem to be a complicated model when compared to some other approaches. For comparison, Fogg's model of a design process has eight distinct steps (Fogg, 2009). This is problematic for the PSD model, since the practical usefulness of the results is a primary criterion for assessing the results in applied studies. Their relevance, simplicity and easiness of operation are important. (Kasanen et al., 1993) If the model is perceived to be too complicated or if it does not respond to a real life need, people will rather live with the problem than accept a solution which they do not understand (Meredith, 1993). The PSD model has also received some criticism for being too high a level model, because it does not provide a sufficient guide to the designer in how to perform the activities mentioned in the model (Wiafe et al., 2012). To summarize, there is a need to simplify the process, but more guidance should be provided for the designer. Fortunately, recent studies have succeeded also in providing a deeper view of the technological aspects involved in the BCSS development. As an example, Alahäivälä et al. (2013) have presented a software architecture design of a BCSS that can be used as a basis for further designs.

Although the PSD model proposes how persuasive systems should be developed in a very holistic manner, its disadvantage is that it does not explicitly advise including customers or users in the development process. One of the new design practices, analysing the persuasion context, describes that it is important to understand the user, but the actual user participation is not mentioned. However, the importance of user participation has been acknowledged in many studies and also in the context of e-Health technologies (e.g. Van Gemert-Pijnen et al., 2011). According to ISO 9241-210:2010 standard human-centred design is based upon an explicit understanding of users, their tasks and environments and the design is expected to lead to good usability and user experience (ISO 9241-210:2010). In future work, the role of the users in the development of BCSSs should be described at a more detailed level. User participation could take place during any of

the three phases of an iterative user-centred development (see Publication IV). It would be necessary for the analysis of the persuasion context (Langrial et al., 2012a) and for understanding the overall value of the system. Customer involvement in software requirements analysis process has already been acknowledged in software engineering (Pressman, 2000), but it has mainly focused on identification of the functional values of the system. Ervasti (2013) has presented an extensive framework of value dimensions, which can also be used in the design and evaluation of BCSSs. It presents a rich description of values prioritized by different customer groups in mobile service contexts, and extends the traditional understanding of value and usefulness. Also, Tuunanen et al. (2010) have pointed out the importance of value creation in the information systems development.

> *It has been stated that information systems are social systems, because they are developed by people for people, and their success is determined by social factors. The role of the technology is secondary – a system should benefit the customer or it will not be used. (Maciaszek, 2001)*

# 6. Discussion

This section has three objectives: 1) to discuss the relevance, validity and applicability of the work, 2) to identify implications for the research and development of health behaviour change support systems, and 3) to suggest topics for further research.

## 6.1 Theoretical implications

This doctoral thesis contributes to the body of scientific knowledge by presenting a conceptual framework for designing and evaluating behaviour change support systems and demonstrating its use in an e-Health context. Because behaviour change support systems were a relatively new area of research at the time of the conceptual study, and still are, all theoretical efforts made for promoting scientific research in the area are valuable. Publishing the PSD model in a scientific journal has not only made the model open for discussion and further improvement, but it has opened a new theoretical discussion of the BCSS-related methodology in general.

The PSD model can help researchers to understand the key concepts of persuasive systems and the phases of persuasive systems development. Thus, the framework can help researchers to develop new and improved conceptual models, and to study the meaning of different categories and principles more deeply.

Since its publication in 2009, the PSD model has been used as inspiration for further theoretical research, and it has several implications (see Table 6). As an example, the PSD model has been used to study perceived persuasiveness (Drozd et al., 2012; Lehto et al., 2012a; Lehto et al., 2013) and adherence of web-based health interventions (Kelders et al., 2011; Kelders et al., 2012). Li and Chatterjee (2010) use the PSD model to focus their study: their focus is computer-human interaction implemented through dialogue support and they use four persuasion principles: praise, reward, reminder and suggestion.

The model has also been applied in other research frameworks, such as in a persuasive Communication Privacy Management (CPM) framework (Coopamootoo and Ashenden, 2011). In their framework, the authors have combined the original CPM framework (Petronio, 2002) with the PSD model. The purpose of the framework is to help in designing online privacy and thus make it more usable for the end-users.

The PSD model is also applied in the BCSS concept. In his theory-creating article, Oinas-Kukkonen (2013) provides a foundation for studying BCSSs. The two main

constructs of the concept are the PSD model and the O/C matrix. In this concept, the role of the PSD model is to function as the state of the art conceptualization for designing and developing BCSSs (Oinas-Kukkonen, 2010; 2013).

Wiafe et al. (2012) have developed a model for analysis of the persuasion context (which has been proposed in the PSD model itself; the persuasion context), and they apply their new approach to the PSD model. Based on their findings, the authors suggest improvements to the PSD model through a more detailed model for analysis of the persuasion context. Table 6 describes how the PSD model has been used in different studies.

Asterisk symbol (*) in Tables 6–8 denotes that at least one of the authors of the article studies BCSSs at the University of Oulu, and thus, the use of the PSD model is purposefully selected.

**Table 6.** Examples of theoretical implications.

| Reference | Use of the PSD model |
|---|---|
| **Coopamootoo and Ashenden (2011)** | The authors use the PSD model to design a persuasive Communication Privacy Management (CPM) framework. |
| **Drozd et al. (2012)*** | The authors apply the PSD model in a quantitative analysis to test perceived persuasiveness of a web-based intervention designed to influence eating behaviours. They also study how perceived persuasiveness of the intervention relates to usage. The study shows that the categories of the model have a significant impact on perceived persuasiveness and actual system usage. |
| **Kelders et al. (2012)**<br>**Kelders et al. (2011)** | The authors apply the model to web-based health interventions in order to systematically study how the three categories are used in interventions and investigate their possible influence on adherence. The credibility support category was omitted, because these principles were not reported in the studies. The review of 83 interventions shows that a mean of 5.6 out of a possible 21 elements were employed in them, and the primary task support elements were the most commonly employed. The study also revealed that persuasive technology can improve adherence to web-based interventions.<br>The preliminary analysis published in 2011 is focused on weight loss interventions. |
| **Lehto et al. (2012)*** | The authors propose and test factors affecting perceived persuasiveness of the system and whether perceived persuasiveness predicts intention to adopt virtual health coaching. The PSD model is used for category-level analysis. |
| **Lehto et al. (2013)*** | The authors construct and test a model predicting perceived persuasiveness of the system and actual usage of a BCSS. The PSD model is used for category-level analysis. |
| **Li and Chatterjee (2010)** | The authors use the PSD model to focus their study: their focus is computer-human interaction implemented through dialogue support and they use four persuasion principles: praise, reward, reminder and suggestion. The study shows that different communication channels in combination with persuasive system qualities will have different persuasive effectiveness. It also shows that adding a positive emotion to a message that leads to a better user experience could increase persuasive effectiveness. |
| **Oinas-Kukkonen (2013)*** | The author suggests the concept of a behaviour change support system (BCSS) in which the PSD model is one of the key constructs. |
| **Wiafe et al. (2012)** | The authors have developed a model for analysis of the persuasion context, and they apply it to the PSD model. Based on their findings, the authors suggest modifications to the analysis of the persuasion context. |

## 6.2 Practical implications

The conceptual framework presented in this doctoral thesis can help designers to understand the key issues behind persuasive systems, to analyse the persuasion context and to design persuasive system qualities. Until now, it seems that the PSD model has a more established position in academia than in the business field, but the model has, however, been used to *design* rather practical applications (see Table 7) and to *evaluate* them (see Table 8).

The PSD model has been used in the development of BCSSs to describe the overall process (Alahäivälä et al., 2013), analyse the persuasion context (Young, 2010) and to design system qualities (Derrick et al., 2011; Langrial and Oinas-Kukkonen, 2012; Langrial et al., 2012b; Pribik and Felfernig, 2012; Stibe and Oinas-Kukkonen, 2012a; Stibe and Oinas-Kukkonen, 2012b; Young, 2010). Table 7 describes in more detail how the PSD model has been used in different studies.

**Table 7.** Examples of practical implications to design.

| Reference | Use of the PSD model |
|---|---|
| **Alahäivälä et al. (2013)*** | The authors present a software architecture design of a BCSS supporting weight loss and maintenance. They have used the PSD model in the systems development to describe the process and to design persuasive system qualities. |
| **Derrick et al. (2011)** | The authors aim to develop intelligent agents which combine sensor technology, artificial intelligence, customized interfaces and avatars. They apply the four categories and design principles to provide examples of how the intelligent agent could persuade users. |
| **Langrial and Oinas-Kukkonen (2012)*** | The authors used the PSD model to design a system for supporting users in reducing their soft drink consumption. The study shows that the participants reduced their soft drink intake and they perceived reminders as a successful persuasion principle. |
| **Langrial et al. (2012b)*** | The authors use the PSD model to design a system for supporting users to improve their sleep quality. Principles of reduction, tunnelling, self-monitoring, reminders, rehearsal and social learning are applied in the system. |
| **Pribik and Felfernig (2012)** | The authors use the PSD model to design a system for software developers to encourage them to improve the software quality. The applied principles are reduction, tunnelling, self-monitoring and suggestion. The study shows that the behaviours of the developers were changed. |
| **Stibe and Oinas-Kukkonen (2012a, 2012 b)*** **Stibe and Oinas-Kukkonen (2014a, 2014b, 2014c)*** | The authors use the PSD model and its social support principles as one of component of their research framework. Principles were also built into a social feedback sharing system and the evaluation indicated several positive effects on user perceptions and user behaviour. |
| **Young (2010)** | The author analyses the persuasion context and designs the system qualities of a system promoting physical activity among teenagers. |

The PSD model has also applied in the evaluation of existing systems by providing heuristics for expert evaluations (Chang et al., 2013; Langrial et al., 2012a; Myneni et al., 2013; Lehto and Oinas-Kukkonen, 2010; Lehto and Oinas-Kukkonen, 2011) and systematic ways to analyse user experience data (Basic et al., 2013; Segerståhl et al., 2010). Interestingly, it has also been applied to identify persuasion strategies used by the carers of elderly people from empirical interview data (Vargheese et al., 2013). Table 8 describes how the PSD model has been used in different studies.

**Table 8.** Examples of practical implications to evaluation.

| Reference | Use of the PSD model |
|---|---|
| **Basic et al. (2013)** | The authors use the categories and design principles of the PSD model for supporting systematic analysis of the persuasive system qualities (from user experience data) of a web service targeting weight loss. |
| **Chang et al. (2013)** | The authors present a multidisciplinary expert review of 12 mobile applications for mental well-being. The reviews were carried out from the point of view of user acceptance, mobile intervention design and persuasive design. The goal-setting principle was added in the primary task category of the PSD model, and the complemented model was used for supporting systematic analysis of the persuasive system qualities. |
| **Langrial et al. (2012a)*** | The authors analyse the persuasion contexts and identify the persuasive system qualities of 12 mobile applications promoting personal well-being using the persuasion principles as heuristics in expert evaluation. |
| **Lehto and Oinas-Kukkonen (2010)*** | The authors explore the utilization of various persuasive features on six weight loss websites by applying the PSD model. |
| **Lehto and Oinas-Kukkonen (2011)*** | The authors extract and analyse persuasive system features in web-based interventions for substance use by applying the PSD model. |
| **Myneni et al. (2013)** | The authors used the three categories of the PSD model to identify the persuasive system qualities of an online social network for smoking cessation. The credibility support category was omitted (no explanation was given). |
| **Segerståhl et al. (2010)*** | The authors studied situations in which the persuasive techniques do not function as expected. The authors used the PSD model for supporting systematic analysis of the persuasive system qualities (from user experience data) of a web service targeting weight loss. |
| **Vargheese et al. (2013)** | Based on interviews, the authors have identified persuasion strategies used by carers of elderly people and grouped them into direct and indirect strategies as suggested by the PSD model. They also present a profile assessment model for choosing a persuasive strategy. The authors aim to develop digital interventions that promote and encourage social interaction for elderly people. |

## 6.3 Evaluation of the construction process

Nunamaker and Chen (1990) have stated as follows:

> *"A research process involves understanding of research domains, finding out meaningful research questions, and applying valid research methodologies to address these questions. Results from a good research project can contribute to the body of knowledge both by expanding knowledge in a given domain and by enlarging applicable methodologies in the domain."*

The author has applied a design science research approach for showing that there is a practical need to understand the design and evaluation of behaviour change support systems and has participated in the development and evaluation of a construction that aims to solve this challenge.

One of the strengths of this study is that the PSD model has brought to light many scientific background theories that are relevant for both researchers and practitioners in this field. In the IS field, it is important to understand the research domains (Nunamaker and Chen, 1990) and also to acknowledge the previous scientific research, especially in constructive research (Lukka, 2003). This might sometimes be challenging for "construction researchers" who represent rather a practical approach.

However, this study also has some limitations. The research question was approached with a design science research approach, which satisfies the requirements of valid applied research (Kasanen et al., 1993). However, the approach has also been criticized. There has been a debate on whether the design science research is a method or methodology or even a research paradigm. Gregory (2011) suggests that design science research is a research approach, something in between a research method and a more general philosophy of science, or a research paradigm. Also, many scholars in IS have come to believe that design science research conducted by researchers is not science but consulting, because it is characterized by the notion of building, constructing, or creating something new that solves a real-world problem. (Gregory, 2011) However, even if an integral part of the research process is the search for a solution to a relevant problem (Hevner et al., 2004), design science research emphasizes the study of design artefacts and the involving processes in order to generate new insights and make a contribution to knowledge (Winter, 2008). (Gregory, 2011)

This research methodology based on systems development is not that common, for example, in clinical research of health behaviour change, but it is, however, "an age-old method and process that human beings use to study nature and to create new things" (Nunamaker and Chen, 1990). Although the artefacts studied are artificial and man-made, the approach is actually very natural for humans. Also, it should be pointed out that much of the research published in the area of BCSSs is theory-testing by nature; based on quantitative modelling and laboratory experiments. Thus, studies based on theory-building approaches are well suited to complement the body of knowledge.

At the beginning of the study, when all available research relevant to this research question was evaluated and interpreted, the work could have been more systematic. Now a set of key background theories was selected and it is possible that a different kind of selection of theories would have led to a different kind of solution. Also, the connection of the theories to the PSD model could have been clearer; now that the connection is not that clear, researchers tend to improve the model itself by providing theoretical explanations for the persuasion principles (see Derrick et al., 2011). The process would have benefited from a systematic literature review procedure (Kitchenham, 2004) or another similar systematic analysis method.

One of the weaknesses of the demonstration is that the PSD model was applied in these case studies as a normative framework, although it has not been iteratively improved between the studies. According to the design science research paradigm, the build-and-evaluate development loop of an artefact is typically iterated a number of times before the final design artefact is generated (Markus et al., 2002). In retrospect, new iterations of the model would probably improve practical relevance of the solution as a whole. However, it is important to understand that, following the design science research approach, development of the PSD model differs from the traditional theory building where the three phases of description, explanation and testing are repeated iteratively until the models are expanded into frameworks and finally into theories (Meredith, 1993). Whereas a theory is a coherent group of interrelated concepts and propositions used as principles of explanation and understanding (Meredith, 1993), a construct refers to an entity which produces a solution to an explicit problem (Kasanen et al., 1993). Thus, constructs are being evaluated with respect to their utility provided in problem solving (Hevner et al., 2004) rather than their ability to describe “the truth”.

Another weakness of the demonstration is that the actual behaviour change of the users was not measured. The PSD model was used in the case studies as an inspection-based analysis method or as a framework to describe user experience findings. The benefit of the inspection method is that the feasibility and usefulness of the persuasive system can be estimated through prototypes before it has been implemented and exposed to empirical testing with real users. However, actual user studies would have showed more clearly how the different principles function in practice.

Although Fogg’s Functional Triad (Fogg, 2003) and the PSD model have both been published some time ago, they are both still answering questions that are relevant today. The analyses described in Publications IV–VI demonstrate the further need for persuasive design, especially for leveraging social support principles, since they were not used in any of the existing designs. This has also been acknowledged in other studies. Designers are keen to design systems to support the primary task of the users, and especially the degree of social support is low (Langrial et al., 2012a; Kelders et al., 2011). There is still a lack of knowledge related to the development of BCSSs and especially to the variety of persuasion principles that are available. It is expected that in the future, when the designers acknowledge the social support category and its principles, the systems will be

more persuasive. Also, the new UI technologies that can be used for dialogue support will enable more lifelike and natural interactions.

In many behaviour change interventions technology is still used as a passive medium where its main purpose is to make the process more efficient, enable communication or contribute to a positive user experience. The health information provided can be static, or else the tailoring is determined a priori and the processing of health information is not automated. (Kennedy et al., 2012) Improvements are also required regarding the reporting of interventional studies of persuasive systems. Many studies do not identify which aspects of technology contributed to the observed outcomes (Kennedy et al., 2012), which makes it difficult to replicate studies, implement techniques in practical applications, or to synthesize them in systematic literature reviews. New methods, such as Michie et al. (2013) taxonomy of behaviour change techniques (BCTs), should be adopted in order to understand the technological aspects in more detail in the future.

Promotion of physical health has been the most covered health topic of behaviour change applications (Kennedy et al., 2012), whereas mental wellness applications are still in their infancy (Harrison et al., 2011). The development of mental wellness applications would be important, because mental ill health is becoming a key issue for the well-functioning of OECD's labour markets and social policies. It also causes an enormous economic burden. (OECD, 2012) Studies have shown that mental wellness training applications can be acceptable and useful among working-age participants, and people can engage with their use (Ahtinen et al., 2013).

According to Chatterjee and Price (2009), future persuasive systems will be characterized by advanced automation techniques in which human intervention is minimal. They rely on extensive pervasive sensing of the users and their environment, and they can effectively process and mine data and send suggestions in a completely automated way. These technologies will leverage the advances in pervasive computing, sensor technology, and agent technology.

In order to nourish the adoption of BCSSs in healthcare, it is necessary to understand that products and services cannot be added on top of the existing processes without any modifications, but their development should be done in cooperation with the purchasing organization. According to Vargo and Lusch (2004), physical goods should be seen as platforms or appliances that assist in providing benefits. Therefore, they are best viewed as distribution mechanisms for services, or the provision of satisfaction for higher-order needs. Already some time ago Jimison et al. (1999) have suggested an evaluation cycle, which includes a needs assessment before system development, usability testing during development, and studies of use and outcomes in natural settings. Van Gemert-Pijnen et al. (2011) has stated that introducing e-Health technologies into the health care system requires careful coordination and communication among health care professionals, patients, informal caregivers, end users, and others.

There is no reason to limit future plans only to research or to the health domain. The practical implications showed that some of the systems studied are existing commercial products (e.g. in Segerståhl et al., 2010) or are designed for an existing customer (e.g. in Alahäivälä et al., 2013). As a new research innovation, the PSD

model and the BCSS concept (Oinas-Kukkonen, 2013) in general has the potential to open up new business possibilities for companies. As an example, by combining the BCSS concept with software tools it is possible to persuade software developers to improve the quality of their work (e.g. in Pribik and Felfernig, 2012). In these kinds of tools, the persuasiveness could be used as a source to obtain competitive advantage over other companies.

As e-Health becomes a part of people's everyday life, it is challenging to compete with the attractiveness of other applications. BCSSs have to compete with the other applications for users' time. It will be especially difficult to compete with entertainment applications which have a more and more central role in the usage of the internet (Digital agenda, 2013). Recent research has shown that less than 10% of the almost 200,000 users of an online and a mobile application for healthy eating remained active (Helander et al., 2014; Kaipainen et al., 2012). Thus, behaviour support systems should have a compelling user experience, and they should offer clear value to their users in order to be used. Oinas-Kukkonen and Oinas-Kukkonen (2013) have pointed out that, in the web environment especially, providing a rich user experience refers not only to the surface, but also to the provision of positive user experience on a profound psychological level.

In the future, new diagnostics solutions combined with BCSSs will dramatically change the way that care services are organized. According to Turner (2013), "Escalating healthcare costs together with consumer demand is likely to generate a new generation of inexpensive wearable, integrated and less-invasive sensors amenable to mass production to support the maintenance of wellbeing, care of the elderly, pharmaceutical development and testing, and distributed diagnostics." There will be new easy-to-use, portable devices for use by non-specialists for decentralized, in situ or home analysis, which can be mass produced at low cost. The trend towards personalized medicine is emerging. (Turner, 2013)

Besides the development of new technology and preventing life style-related risk factors, also more far-reaching changes are needed in society in order to increase people's wellbeing. Health equity differs depending on where people are born and raised: "A person who has been born and lives in Japan or Sweden can expect to live more than 80 years; in Brazil, 72 years; India, 63 years; and in several African countries, less than 50 years" (Marmot et al., 2008). Differences are also excessive within countries. The poorest people have high levels of illness and premature mortality, but at all levels of income, the ones who are in a lower socioeconomic position have a worse health situation (Marmot et al., 2008). It has been suggested that, in order to increase health equity, it is important to improve the daily living conditions of people, tackle the inequitable distribution of power, money, and resources, as well as measure and understand the problem and assess the results of actions (Marmot et al., 2008).

# 7. Conclusions

As more and more systems are designed for supporting attitude and/or behaviour change in the users, there is a need to introduce persuasive design practices into the software development. This study describes a construction and demonstration of a model for design and evaluation of behaviour change support systems.

The study shows that there is practical need to understand the design and evaluation of behaviour change support systems. The study describes the history of the constructed model and how it is connected to earlier theory. The main research question is the practical functioning of the solution.

The findings show that the model can be successfully applied during the user requirements analysis and concept design phases in order to identify new potential persuasive functionalities and analyse the persuasive functionalities of an existing product. The constructed model has already been used in academia as inspiration for further theoretical research, and it has several implications in practice. The model has been used for design and also for evaluation. The study shows that, by combining persuasive design practices and software development, it is possible to describe a new way to develop software.

# References


AAL (2012) Definition of end-users in the AAL Joint Programme [online]. Available at: http://www.aal-europe.eu/get-involved/i-am-a-user-2/ (referenced 28.4.2014)

Ahtinen, A., Mattila, E., Välkkynen, P., Kaipainen, K., Vanhala, T., Ermes, M., Sairanen, E., Myllymäki, T. and Lappalainen, R. (2013) Mobile Mental Wellness Training for Stress Management: Feasibility and Design Implications Based on a One-Month Field Study. Journal of Medical Internet Research, 15(7).

Ajzen, I. (1991) The Theory of Planned Behavior. Organizational Behavior and Human Decision Processes, 50(2), pp. 179–211.

Alahäivälä, T., Oinas-Kukkonen, H. and Jokelainen, T. (2013) Software Architecture Design for Health BCSS: Case Onnikka. Lecture Notes in Computer Science, 2013, Volume 7822, Persuasive Technology, pp. 3–14.

Angst, C. M. and Agarwal, R. (2009) Adoption of Electronic Health Records in the Presence of Privacy Concerns: The Elaboration Likelihood Model and Individual Persuasion. MIS Quarterly, 33(2), pp. 339–370.

Bandura, A. (1977) Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), pp. 191–215.

Bandura, A. (1986) Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice Hall.

Barak, A., Klein, B. and Proudfoot J. G. (2009) Defining internet-supported therapeutic interventions. Annals of Behavioral Medicine, 38(1), pp. 4–17.

Barney, R. D. and Black, J. (1994) Ethics and professional persuasive communications. Public Relations Review, 20(3), pp. 233–248. Referenced in Fogg (2003).

Basic, J., Yadamsuren, B., Saparova, D. and Ma, Y. (2013) Persuasive Features in a Web-Based System for Weight-Loss Team Competition. In: C. Stephanidis (Ed.), HCI International 2013 - Posters' Extended Abstracts, Vol. 374, pp. 125–129. Berlin, Heidelberg: Springer.

Benbasat, I., Goldstein, D. K. and Mead, M. (1987) The Case Research Strategy in Studies of Information Systems. MIS Quarterly, 11(3), pp. 369–386.

Berdichevsky, D. and Neuenschwander, E. (1999) Toward an ethics of persuasive technology. Communications of the ACM, 42(5), pp. 51–58.

Boutron, I., Moher. D., Altman, D. G., et al. (2008) Extending the CONSORT statement to randomized trials of non-pharmacologic treatment: Explanation and elaboration. Annals of Internal Medicine, 148, pp. 295–309.

Cassell, M. M., Jackson, C. and Cheuvront, B. (1998) Health Communication on the Internet: An Effective Channel for Health Behavior Change. Journal of Health Communication, 3, pp. 71–79.

Chang, T., Kaasinen, E. and Kaipainen, K. (2013) Persuasive Design in Mobile Applications for Mental Well-Being: Multidisciplinary Expert Review. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, Wireless Mobile Communication and Healthcare, Volume 61, pp. 154–162.

Chatterjee, S. and Price, A. (2009) Healthy living with persuasive technologies: framework, issues, and challenges. Journal of the American Medical Informatics Association, 16(2), pp. 171–178.

Cialdini, R. (1993) Influence: Science and Practice (3rd edition). New York: HarperCollins College Publishers.

Consolvo, S., McDonald, D. W. and Landay, J. A. (2009) Theory-driven design strategies for technologies that support behavior change in everyday life. In: Proceedings of the 27th international conference on Human factors in computing systems (CHI '09). New York: ACM Press. Pp. 457–466.

Coopamootoo, P. and Ashenden, D. (2011) Designing Usable Online Privacy Mechanisms: What Can We Learn from Real World Behaviour? In: S. Fischer-Hübner, P. Duquenoy, M. Hansen, R. Leenes, and G. Zhang (Eds.). Privacy and Identity Management for Life, Volume 352, Berlin Heidelberg: Springer. Pp. 311–324.

Cooper, J. and Fazio, R. H. (1984) A new look at the dissonance theory. In L. Berkowitz (ed.) Advances in Experimental Social psychology, 17. New Work: Academic press. Referenced in: Fraser et al. (2001).

Davidson, K. W., Goldstein, M., Kaplan, R. M. Kaufmann, P. G., Knatterud, G. L., Orleans, C. T., Spring, B., Trudeau, K. J. and Whitlock, E. P. (2003) Evidence-based behavioral medicine: What is it and how do we achieve it? Annals of Behavioral Medicine, 26, pp. 161–171.

Davis, F. D. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. Mis Quarterly, pp. 319–340.

Derrick, D. C., Jenkins, J. L. and Nunamaker Jr., J. F. (2011) Design principles for special purpose, embodied, conversational intelligence with environmental sensors (SPECIES) agents. AIS Transactions on HumanComputer Interaction, 3(2), pp. 62–81.

Digital agenda (2013) Commission staff working document. Digital Agenda Scoreboard 2013. Brussels, 12.6.2013 SWD (2013) 217 final. Available online: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/4-18122013-BP/EN/4-18122013-BP-EN.PDF (referenced 29.3.2014)

Dijkstra, J. J., Liebrand, W. B. G. and Timminga, E. (1998) Persuasiveness of expert systems. Behaviour & Information Technology, 17(3), pp. 155 –163.

Drozd, F., Lehto, T. and Oinas-Kukkonen, H. (2012) Exploring Perceived Persuasiveness of a Behavior Change Support System: A Structural Model. Lecture Notes in Computer Science, 2012, Volume 7284, Persuasive Technology. Design for Health and Safety, pp. 157–168.

DWI home page: http://www.danlockton.com/ (referenced 17.5.2014)

Eley, R., Fallon, T., Soar, J., Buikstra, E. and Hegney, D. (2009) Barriers to use of information and computer technology by Australia's nurses: a national survey. Journal of Clinical Nursing, 18(8), pp. 1151–8.

Ervasti, M. (2013) Understanding and predicting customer behaviour: Framework of value dimensions in mobile services. Journal of Customer Behaviour, 12(2), pp. 135–158.

Eurostat (2012) Internet access and use in 2013. More than half of the internet users post messages to social media [online]. Eurostat newsrelease 185/2012. 18th of December. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/4-18122012-AP/EN/4-18122012-AP-EN.PDF (referenced 29.4.2014)

Eurostat (2013) Internet access and use in 2013. More than 60 % of individuals in the EU28 use the internet daily [online]. Eurostat newsrelease 199/2013. 18th of December. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/4-18122013-BP/EN/4-18122013-BP-EN.PDF (referenced 25.3.2014)

Eysenbach, G. (2001) What is e-health? Journal of Medical Internet Research 3(2), e20.

FBM home page: http://www.behaviormodel.org/ (referenced 17.5.2014)

Festinger, L. A. (1957) Theory of Cognitive Dissonance. Stanford, CA: Stanford University Press.

Fishbein, M. and Ajzen, I. (1975) Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research. Reading: Addison-Wesley publishing company.

Fogg, B. J. (1998) Charismatic Computers: Creating More Likable and Persuasive Interactive Technologies by Leveraging Principles from Social Psychology. Stanford, CA: Stanford University.

Fogg, B. J. (1998) Persuasive computers: perspectives and research directions. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '98). New York: ACM Press. Pp. 225–232.

Fogg, B. J. (2003) Persuasive Technology: Using Computers to Change What We Think and Do. San Francisco: Morgan Kaufmann Publishers.

Fogg, B. J. (2009) A behavior model for persuasive design. In: Persuasive '09 Proceedings of the 4th International Conference on Persuasive Technology. New York: ACM Press: Article No. 40.

Fogg, B. J. and Nass, C. (1997) Silicon sycophants: the effects of computers that flatter. International Journal of Human-Computer Studies, 46(5), pp. 551–561.

Franz, C. R. and Robey, D. (1984) An investigation of user-led system design: rational and political perspectives. Communications of the ACM, 27(12), pp. 1202–1209.

Fraser, C., Burchell, B., Hay, D. and Duveen, G. (2001) Introducing social psychology. Cambridge: Polity.

Friedman, B. F., Kahn, P. H. and Borning, A. (2006) Value sensitive design and information systems. Advances in Management Information Systems, 6, pp. 348–372.

Goffman, E. (1959) The Presentation of Self in Everyday Life. New York: Doubleday Anchor. Referenced in Consolvo et al. (2009).

Goodhue, D. L. and Thompson, R. L. (1995) Task-Technology Fit and Individual Performance. MIS Quarterly, 19(2), pp. 213–236.

Gouldner, A. (1960) The norm of reciprocity: A preliminary statement. American Sociological Review, 25(2), pp. 161–178.

Gregor, S. (2006) The nature of theory in information systems. Mis Quarterly, 30(3), pp. 611–642.

Gregory, R. W. (2011) Design Science Research and the Grounded Theory Method: Characteristics, Differences, and Complementary Uses. Theory-Guided Modeling and Empiricism in Information Systems Research, pp. 111–127.

Harjumaa, M. and Oinas-Kukkonen, H. (2007) Persuasion Theories and IT Design. Lecture Notes in Computer Science, Vol. 4744, Springer-Verlag, Berlin Heidelberg, pp. 311–314.

Harrison, V., Proudfoot, J., Wee, P. P., Parker, G., Pavlovic, D. H. and Manicavasagar, V. (2011) Mobile mental health: review of the emerging field and proof of concept study. Journal of Mental Health, 20(6), pp. 509–24.

Hassenzahl, M. and Tractinsky, N. (2006) User experience – a research agenda. Behaviour Information Technology, 25(2), pp. 91–97.

Hayes, S. C., Luoma, J. B., Bond, F. W., Masuda, A. and Lillis, J. (2006) Acceptance and commitment therapy: Model, processes and outcomes. Behaviour Research and Therapy, 44(1), pp. 1–25.

Helander, E., Kaipainen, K., Korhonen, I. and Wansink, B. (2014) Factors related to sustained use of a free mobile app for dietary self-monitoring with photography and peer feedback: Retrospective cohort study. Journal of Medical Internet Research, 16(4), e109.

Hevner, A. R., March, S. T., Park, J. and Ram, S. (2004) Design Science in Information Systems Research. MIS Quarterly, 28(1), pp. 75–105.

Häikiö, J., Wallin, A. and Isomursu, M. (2010) Digitally-enhanced services for the elderly. International Journal of Services Sciences, 3(2/3), pp. 232–249.

Iivari, J. (1991) A paradigmatic analysis of contemporary schools of IS development. European Journal of Information Systems, 1(4), pp. 249–272.

ISO 9241-210:2010 Ergonomics of Human-System Interaction. Part 210: Human-Centred Design for Interactive Systems.

Isomursu, M. Ervasti, M. Kinnula, M. Isomursu, P. (2011) Understanding human values in adopting new technology – A case study and methodological discussion. International Journal of Human-Computer Studies, 69(4), pp. 183–200.

Jallinoja, D. P., Absetz, P., Kuronen, R., Nissinen, A., Talja, M., Uutela, A. and Patja, K. (2007) The dilemma of patient responsibility for lifestyle change: Perceptions among primary care physicians and nurses. Scandinavian Journal of Primary Health Care, 25(4), pp. 244–249.

Jaspers, M. W. (2009) A comparison of usability methods for testing interactive health technologies: methodological aspects and empirical evidence. International journal of medical informatics, 78(5), pp. 340–353.

Jimison, H., Adler, L., Coye, M., Mulley, A. and Eng, T. R. (1999) Health Care Providers and Purchasers and Evaluation of Interactive Health Communication Applications. American Journal of Preventive Medicine, 16(1), pp.16–22.

Jimison, H., Gorman, P., Woods, S., Nygren, P., Walker, M., Norris, S. and Hersh, W. (2008) Barriers and Drivers of Health Information Technology Use for the Elderly, Chronically III, and Underserved. Evidence Reports/Technology Assessments, No. 175. Rockville (MD): Agency for Healthcare Research and Quality.

Kaipainen, K., Payne, C. R. and Wansink, B. (2012) Mindless Eating Challenge: Retention, weight outcomes, and barriers for changes in a public web-based healthy eating and weight loss program. Journal of Medical Internet Research, 14(6), e168.

Karppinen, P. and Oinas-Kukkonen, H. (2013) Three Approaches to Ethical Considerations in the Design of Behavior Change Support Systems. Lecture Notes in Computer Science, 2013, Volume 7822, Persuasive Technology, pp. 87–98.

Kasanen, E., Lukka, K. and Siitonen, A. (1993) The Constructive Approach in Management Accounting Research. Journal of Management Accounting Research, Vol. 5, pp. 241–264.

Kelders, S. M., Van Gemert-Pijnen, J. E. W. C., Werkman, A., Nijland, N. and Seydel, E. R. (2011) Effectiveness of a Web-based Intervention Aimed at Healthy Dietary and Physical Activity Behavior: A Randomized Controlled Trial About Users and Usage. Journal of Medical Internet Research, 13(2):e32.

Kelders, S. M., Kok, R. N., Ossebaard, H. C. and Van Gemert-Pijnen, J. (2012) Persuasive system design does matter: A systematic reivew of adherence to web-based interventions. Journal of Medical Internet Research, 14(6), e152.

Kennedy, C. M., Powell, J., Payne, T. H., Ainsworth, J., Boyd, A. and Buchan, I. (2012) Active assistance technology for health-related behavior change: an interdisciplinary review. Journal of Medical Internet Research, 14(3), e80.

King, P. and Tester, J. (1999) The landscape of persuasive technologies. Communications of the ACM, 42(5), pp. 31–38.

Kitchenham, B. (2004) Procedures for performing systematic reviews. Keele: Keele University.

Könönen, V., Mäntyjärvi, J., Similä, H., Pärkkä, J. and Ermes, M. (2010) Automatic feature selection for context recognition in mobile devices. Pervasive and Mobile Computing, 6(2), pp. 181–197.

Lane, N., Miluzzo, E., Lu, H., Peebles, D., Choudhury, T. and Campbell, A. (2010) A survey of mobile phone sensing. IEEE Communications Magazine, 48(9), pp. 140–150.

Langrial, S., Lehto, T., Oinas-Kukkonen, H., Harjumaa, M. and Karppinen, P. (2012a) Native Mobile Applications for Personal Well-Being: A Persuasive Systems Design Evaluation. In: Proceedings of the 16th Pacific-Asia Conference on Information Systems (PACIS 2012), paper 93.

Langrial, S. and Oinas-Kukkonen, H. (2012) Less Fizzy Drinks: A Multi-Method Study of Persuasive Reminders. Lecture Notes in Computer Science, 2012, Volume 7284, Persuasive Technology. Design for Health and Safety, pp. 256–261.

Langrial, S., Oinas-Kukkonen, H. and Wang, S. (2012b) Design of a Web-based Information System for Sleep Deprivation – A Trial Study. Communications in Computer and Information Science, Volume 313, pp. 41–51.

Lehto, T. and Oinas-Kukkonen, H. (2010) Persuasive Features in Six Weight Loss Websites: A Qualitative Evaluation. Lecture Notes in Computer Science, Persuasive, Vol. 6137, pp. 162–173.

Lehto, T. and Oinas-Kukkonen, H. (2011) Persuasive Features in Web-Based Alcohol and Smoking Interventions: A Systematic Review of the Literature. Journal of Medical Internet Research, 13(3), e46.

Lehto, T., Oinas-Kukkonen, H. and Drozd, F. (2012a) Factors Affecting Perceived Persuasiveness of a Behavior Change Support System. International Conference on Information Systems (ICIS 2012). Pp.16–19.

Lehto, T., Oinas-Kukkonen, H., Pätiälä, T. and Saarelma, O. (2012b) Consumers' Perceptions of a Virtual Health Check: An Empirical Investigation. In: Proceedings of the 20th European Conference on Information Systems (ECIS 2012), paper 154.

Lehto, T., Oinas-Kukkonen, H., Pätiälä, T. and Saarelma, O. (2013) Virtual Health Coaching for Consumers: A Persuasive Systems Design Perspective. International Journal of Networking and Virtual Organisations, 13(1), pp. 24–41.

Li, H. and Chatterjee, S. (2010) Designing Effective Persuasive Systems Utilizing the Power of Entanglement: Communication Channel, Strategy and Affect. Lecture Notes in Computer Science, Persuasive Technology, Volume 6137, pp. 274–285.

Li, I., Dey, A. and Forlizzi, J. (2010) A stage-based model of personal informatics systems. In: Proceedings of the 28th international conference on Human factors in computing systems (CHI '10), New York: ACM Press. Pp. 557–566.

Locke, E. and Latham, G. (2002) Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. American Psychologist, 57(9), pp. 705–717.

Lockton, D., Harrison, D. and Stanton, N. (2008) Design with intent: Persuasive technology in a wider context. Lecture Notes in Computer Science Volume 5033, Persuasive Technology, pp. 274–278.

Lockton, D., Harrison, D. and Stanton, N. A. (2010) The Design with Intent Method: a design tool for influencing user behaviour. Applied Ergonomics, 41(3), pp. 382–92.

Lukka, K. (2003) The constructive research approach. In: L. Ojala and O.-P. Hilmola (eds.) Case study research in logistics. Publications of the Turku school of economics and business administration series B1, pp. 83–101.

Maciaszek, L. A. (2001) Requirement Analysis and System Design. Harlow: Addison-Wesley.

March, S. and Smith, G. (1995) Design and natural science research on information technology. Decision Support Systems, 15(4), pp. 251–266.

Markus, M. L., Majchrzak, A. and Gasser, L. A. (2002) Design Theory for Systems that Support Emergent Knowledge Processes, MIS Quarterly, 26(3), pp. 179–212.

Marmot, M., Friel, S., Bell, R., Houweling, T. A. and Taylor, S. (2008) Closing the gap in a generation: health equity through action on the social determinants of health. The Lancet, 372(9650), pp. 1661–1669.

Mathew, A. P. (2005) Using the environment as an interactive interface to motivate positive behavior change in a subway station. In: CHI 2005 Extended Abstracts on Human Factors in Computing Systems. Pp. 1637–1640. New York: ACM Press.

McGuire, W. J. (1973) Persuasion. In: G. A. Miller (ed.) Communication, language, and meaning: Psychological perspectives. New York: Basic Books. Pp. 242–255.

Meredith, J. (1993) Theory Building through Conceptual Methods. International journal of operations & production management, 13(5), pp. 3–11.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J. and Wood, C. E. (2013) The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine, 46(1), pp. 81–95.

Miller, G. (1973) Pyschology and communication. In: G. A. Miller (ed.) Communication, language, and meaning: Psychological perspectives. New York: Basic Books. Pp. 3–12.

Miller, G. (2002) On being persuaded: Some basic distinctions. In: J. P. Dillard and M. Pfau (Eds.). The Persuasion Handbook: Developments in Theory and Practice. Thousand Oaks: Sage Publications.

Myneni, S., Iyengar, S., Cobb, N. and Cohen, T. (2013) Identifying persuasive qualities of decentralized peer-to-peer online social networks in public health. Lecture Notes in Computer Science, Persuasive Technology, Volume 7822, pp. 155–160.

Nass, C., Moon, Y. and Fogg, B. (1995) Can computer personalities be human personalities? International Journal of Human-Computer Studies, 43(2), pp. 223–239.

Nunamaker, J. F. and Chen, M. (1990) Systems development in information systems research. In: Proceedings of the Twenty-Third Annual Hawaii International Conference on System Sciences, IEEE. Pp. 631–640.

OECD (2012) Sick on the Job? Myths and Realities about Mental Health and Work, Mental Health and Work [online], OECD Publishing. Available at: http://dx.doi.org/10.1787/9789264124523-en (referenced 2.5.2014)

OECD (2013) Health at a Glance 2013: OECD Indicators, OECD Publishing. http://dx.doi.org/10.1787/health_glance-2013-en (referenced 2.5.2014)

Oinas-Kukkonen, H. (2000) Balancing the vendor and consumer requirements for electronic shopping systems. Information Technology and Management 1, pp. 73–84.

Oinas-Kukkonen, H. (2010) Behavior Change Support Systems: A Research Model and Agenda. Lecture Notes in Computer Science, Persuasive, Vol. 6137, pp. 4-14, 2010, Springer-Verlag, Keynote Paper.

Oinas-Kukkonen, H. (2013) A foundation for the study of behavior change support systems. Personal and Ubiquitous Computing, 17(6), pp. 1223–1235.

Oinas-Kukkonen, H. and Harjumaa, M. (2008a) Towards Deeper Understanding of Persuasion in Software and Information Systems. First International Conference on Advances in Human-Computer Interaction (ACHI 2008). Pp. 200–205.

Oinas-Kukkonen, H. and Harjumaa, M. (2008b) A Systematic Framework for Designing and Evaluating Persuasive Systems. Lecture Notes in Computer Science, Vol. 5033, pp. 164-176, Springer-Verlag.

Oinas-Kukkonen, H. and Harjumaa, M. (2009) Persuasive Systems Design: Key Issues, Process Model, and System Features. Communications of the Association for Information Systems, Vol. 24, Article 28, pp. 485–500.

Oinas-Kukkonen, H. and Oinas-Kukkonen, H. (2013) Humanizing the Web Change and Social Innovation. New York: Palgrave Macmillan.

Orsama, A.-L., Lähteenmäki, J., Harno, K., Kulju, M., Wintergerst, E., Schachner, H., Stenger, P., Leppänen, J., Kaijanranta, H. Salaspuro, V. and Fisher, W. A. (2013) Active assistance technology reduces glycosylated hemoglobin and weight in individuals with type 2 diabetes: results of a theory-based randomized trial. Diabetes Technology & Therapeutics, 15(8), pp. 662–9.

Parmar, V., Keyson, D. and De Bont, C. (2009) Persuasive Technology to Shape Social Beliefs: A Case of Persuasive Health Information Systems for Rural Women in India. Communications of AIS, 1, 427–454.

Payton, F. C., Pare, G., Le Rouge, C. M. and Reddy, M. (2011) Health Care IT: Process, People, Patients and Interdisciplinary Considerations. Journal of the Association for Information Systems, 12(2), article 4.

Peffers, K., Tuunanen, T., Rothenberger, M. A. and Chatterjee, S. (2007) A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems, 24(3), pp. 45–77.

Petronio, S. (2002) Boundaries of privacy: dialectics of disclosure. Albany, NY: SUNY Press.

Petty, R. E. and Cacioppo, J. T. (1986) Communication and Persuasion: Central and Peripheral Routes to Attitude Change. New York: Springer-Verlag.

Pressman, R. S. (2000) Software Engineering: a practitioner's perspective, New York: McGraw-Hill Publishing Company.

Pribik, I. and Felfernig, A. (2012) Towards Persuasive Technology for Software Development Environments: An Empirical Study. Lecture Notes in Computer Science, Persuasive Technology. Design for Health and Safety, Volume 7284, pp. 227–238.

Prochaska, J. O., DiClemente, C. C. and Norcross, J. C. (1993) In search of how people change: Applications to addictive behaviors. Journal of Addictions Nursing, 47(9), pp. 2–16.

Rawstorne, P., Jayasuriya, R. and Caputi, P. (1998) An integrative model of information systems use in mandatory environments. In: Proceedings of the International Conference on Information Systems, Association for Information Systems. Pp. 325–330.

Schroeder, S. A. (2007) We Can Do Better – Improving the Health of the American People. The New England Journal of Medicine, 357, pp. 1221–1228.

Segerståhl, K., Kotro, T. and Väänänen-Vainio-Mattila, K. (2010) Pitfalls in Persuasion: How do Users Perceive Persuasive Techniques in a Web Service? Lecture Notes in Computer Science, Persuasive 2010, Volume 6137/2010, pp. 211–222. Berlin Heidelberg: Springer-Verlag.

Self, C. S. (1996) Credibility. In: M. Salwen and D. Stacks (ed.) An Integrated Approach to Communication Theory and Research. Mahwah, NJ: Lawrence Erlbaum Associates.

Similä, H., Immonen, M. García Gordillo, C., Petäkoski-Hult, T. and Eklund, P. (2013) Focus Group Evaluation of Scenarios for Fall Risk Assessment and Fall Prevention in Two Countries. Lecture Notes in Computer Science, Ambient Assisted Living and Active Aging, Volume 8277, pp. 39–46.

Simons, H. W., Morreale, J. and Gronbeck, B. (2001) Persuasion in Society. Thousand Oaks, CA: Sage Publications Inc.

Snyder, M. and DeBono, K. G. (1985) Appeals to image and claims about quality: Understanding the psychology of advertising. Journal of Personality and Social Psychology, 49, pp. 586–597. Referenced in: Petty and Cacioppo (1986).

Solomon, R. C. (1984) Ethics: A brief introduction. New York: McGraw-Hill. Referenced in Simons et al. (2001).

Speier, C., Vessey, I. and Valacich, J. (2003) The Effects of Interruptions, Task Complexity, and Information Presentation on Computer-Supported Decision-Making Performance. Decision Sciences, 34(4), pp. 771–797.

Spring, B., Duncan, J. M., Janke, E. A., Kozak, A. T., McFadden, H. G., DeMott, A., Pictor, A., Epstein, L. H., Siddique, J., Pellegrini, C. A., Buscemi, J. and Hedeker, D. (2013) Integrating technology into standard weight loss treatment: a randomized controlled trial. JAMA Internal Medicine, 173(2), pp. 105–111.

Stibe, A. and Oinas-Kukkonen, H. (2012a) Comparative Analysis of Recognition and Competition as Features of Social Influence Using Twitter. Lecture Notes in Computer Science, Volume 7284, Persuasive Technology. Design for Health and Safety, pp. 274–279.

Stibe, A. and Oinas-Kukkonen, H. (2012b) Exploring the Effects of Social Influence on User Behavior Targeted to Feedback Sharing. In: Proceedings of the IADIS WWW/Internet 2012 Conference (ICWI 2012).

Stibe, A. and Oinas-Kukkonen, H. (2014a) Using social influence for motivating customers to generate and share feedback. Lecture Notes in Computer Science, Volume 8462, Persuasive Technology, pp. 224–235.

Stibe, A. and Oinas-Kukkonen, H. (2014b) Designing persuasive systems for user engagement in collaborative interaction. In: Proceedings of the 22nd European Conference on Information Systems (ECIS 2014).

Stibe, A. and Oinas-Kukkonen, H. (2014c) User engagement in feedback sharing through social influence. In: P. Isaias, P. Kommers and T. Issa (ed.) The evolution of the Internet in the business sector: Web 1.0 to Web 3.0. IGI Global. (In press)

Stickdorn, M. and Schneider, J. (2011) This is Service Design Thinking. Amsterdam: BIS Publishers.

Tam, K. Y. and Ho, S. Y. (2005) Web Personalization as a Persuasion Strategy: An Elaboration Likelihood Model Perspective. Information Systems Research, 16(3), pp. 271–291.

Todorov, A. Chaiken, S. and Henderson, M. D. (2002) The heuristic-systematic model of social information processing. In: The Persuasion Handbook: Developments in Theory and Practice J. P. Dillard and M. Pfau (Eds.) Thousand Oaks: Sage Publications.

Turner, A. P. F. (2013) Biosensors: sense and sensibility. Chemical Society Reviews, 42(8), pp. 3175–3184.

Tuunanen, T., Myers, M. D. and Cassab, H. (2010) A Conceptual Framework for Consumer Information Systems Development. Pacific Asia Journal of the Association for Information Systems, 2(1), article 5.

Tyynelä, M. and Oinas-Kukkonen, H. (2006) Information Systems as a Discipline to Study Persuasiveness. In: Y. de Kort, W. Ijsselstein, C. Midden, B. Eggen and E. van den Hoven (Eds.) Adjunct proceedings of the First International Conference on Persuasive Technology for Human Well-Being (Persuasive ’06). Pp. 9–12.

Van Gemert-Pijnen, J. E. W. C., Nijland, N., Van Limburg, M., Ossebaard, H. C., Kelders, S. M., Eysenbach, G. and Seydel, E. R. (2011) A holistic framework to improve the uptake and impact of eHealth technologies. Journal of Medical Internet Research, 13(4), e111.

Vargheese, J. P., Sripada, S., Masthoff, J., Oren, N., Schofield, P. and Hanson, V. L. (2013) Persuasive Dialogue for Older Adults: Promoting and Encouraging Social Interaction. In CHI '13 Extended Abstracts on Human Factors in Computing Systems, pp. 877–882. New York: ACM.

Vargo, S. and Lusch, R. (2004) Evolving to a new dominant logic for marketing. Journal of marketing, 68(1), pp. 1–17.

Venkatesh, V., Morris, M., Davis, G. and Davis, F. (2003) User Acceptance of Information Technology: Toward A Unified View. MIS Quarterly, 27(3), pp. 425–478.

Vlasnik, J. J., Aliotta, S. L. and DeLor, B. (2005) Medication adherence: Factors influencing compliance with prescribed medication plans. The Case Manager, 16(2), pp. 47–51.

Wiafe, I., Nakata, K., Moran, S. and Gulliver, S. (2011) Considering user attitude and behaviour in persuasive systems design: the 3D-RAB model. In: Proceedings of the 19th European Conference on Information Systems (ECIS 2011), paper 186.

Wiafe, I., Alhammad, M. M., Nakata, K. and Gulliver, S. R. (2012) Analyzing the persuasion context of the persuasive systems design model with the 3D-RAB model. Lecture Notes in Computer Science, Vol. 7284, Springer-Verlag, Berlin Heidelber, pp. 193–202.

Winter, R. (2008) Design Science Research in Europe. European Journal of Information Systems, 17, pp. 470–475.

Yin, R. K. (2009) Case study research: Design and methods (4th Ed.). Thousand Oaks: Sage Publications.

Young, M. M. (2010) Twitter Me: Using Micro-blogging to Motivate Teenagers to Exercise. Lecture Notes in Computer Science, Global Perspectives on Design Science Research, Volume 6105, pp. 439–448.

PUBLICATION I

# An Analysis of the Persuasiveness of Smoking Cessation Web Sites

In: Proceedings of the Second International Symposium on Medical Information and Communication Technology (ISMICT 2007). December 11–13, Oulu, Finland. 5 p.

# AN ANALYSIS OF THE PERSUASIVENESS OF SMOKING CESSATION WEB SITES

Marja Harjumaa
University of Oulu
Oulu, Finland

Harri Oinas-Kukkonen
University of Oulu
Oulu, Finland

ABSTRACT

The internet provides smoking cessation Web portals that may reach people who would not otherwise visit a smoking cessation clinic. The Web portals offer both non-interactive information and interactive features which aim at helping users to change their attitudes towards smoking or change their behaviour i.e. quit smoking. In this study four Finnish language smoking cessation Web portals were evaluated and their persuasiveness was studied through Fogg's functional triad as the framework. Some Fogg's persuasion principles were recognised in them, but they were not applied to a full extent. The results also suggest that Fogg's framework need's to be extended to be for studying and analyzing persuasive systems.

## I. INTRODUCTION

Smoking is a serious problem for individuals as well as for the society. Many people want to quit smoking but they find it difficult because smoking causes physical, emotional and social addiction that is hard to overcome. The internet provides smoking cessation Web portals that may reach people who would not otherwise visit a smoking cessation clinic [1]. Commonly, The Web portals for smoking cessation offer both *non-interactive information*, such as scanned booklets, fact sheets, pictures, audio and video files, addresses of smoking cessation clinics, telephone numbers of quitlines, links, news and untailored email-messages, and *interactive features*, such as discussion forums, chats, exchange of personal stories, interactive tests, FAQs, interactive quizzes, computer tailored counselling systems, tailored email-messages and one-to-one counselling by email [1]. The purpose of these features is to get users to change their attitudes towards smoking or change their behaviour i.e. to quit smoking.

Changing attitudes and/or behavior is called persuasion. Persuasion is one form of influence. It can be defined as an attempt to change people's attitudes or behaviors or both without using coercion or deception [2]. Besides changing attitudes, persuasion occurs when attitudes are being shaped or reinforced [5]. A persuasive system is a computerized information system designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception [9].

Persuasive technology studies interactive computer systems designed to change people's attitudes and behaviour [2]. There are two strategies for persuasion, a direct and an indirect route [9] [3] [4]. An individual who carefully evaluates the content of the persuasive message may be persuaded by the direct route, whereas an individual who is less thoughtful and uses a simple cue (e.g. the source of the message) or a rule of thumb ("experts can be trusted") for evaluating the information may be persuaded through the indirect route [9]. The smoking cessation Web portals try to appeal both, user's reason and intelligence by offering information, and emotions by offering attractive interactive features. In an optimal situation the Web portal is persuasive enough so that the user registers and then it supports the attitude and behaviour change process by guiding the user to the right direction. Also people who have already quit smoking may find the Web portals useful because of the reinforcement they offer.

The study of persuasive technology is interested in human-computer interaction, in particular how people are being persuaded when interacting with computer technology. This may be called *human-computer persuasion*, while other types of persuasion are *interpersonal* and *computer-mediated persuasion* [6]. A relatively well-known framework of persuasive technology is Fogg's functional triad [2] [7], which provides one way to explore the persuasiveness of an information system. It defines three persuasive roles for computer technology and several persuasion principles.

The object of this study is twofold: 1) to explore how the smoking cessation Web portals persuade users by using Fogg's functional triad as the framework, and 2) to evaluate how suitable Fogg's framework is for studying and analyzing persuasive systems (in this case Web portals).

## II. RESEARCH SETTING

### A. The smoking cessation Web portals

We chose four Finnish language smoking cessation Web portals for a closer look. General health portals were excluded, because their smoking cessation pages contained only text-based content without interactive functionalities. The smoking cessation specific Web portals were chosen based on their interactivity and offering of a versatile set of functionalities. The portals were heuristically evaluated.

Stumppi (www.stumppi.fi, later C1) is a relatively extensive information service for smokers, health professionals, teachers and coaches. It is produced by a Social Insurance Institution and several health promotion associations.

Fressis (www.fressis.fi, C2) is quite simple information service for young people. The portal has a compelling "pink coffinshop" –theme. The portal is produced by the association of Finnish cancer leagues.

Lopeta ja voita (http://www.lopetajavoita.fi, C3) is part of the international Quit&Win -campaign which encourages smokers to stop smoking for a month or for six months. The money prizes are quite encouraging; the first prize is 6000€. In Finland, the competition is organized by Social Insurance Institution.

Lopeta (http://www.lopeta.fi/, C4) offers some information about positive health consequences of smoking

cessation, treatments, nicotine addiction and smokers' diseases. It is produced by GlaxoSmithKline, a pharmaceutical company.

### *B. The persuasion principles*

Fogg defines three roles for persuasive computer technology. Computers serve as *tools*; they make things easier or more efficient to do or they do things that would be impossible without technology. Computers can serve as tools by reducing complex behaviour to simple (*reduction*), guiding users through a process or experience (*tunneling*), providing tailored information (*tailoring*), offering suggestions at the opportune moments (*suggestion*), offering quick ways to track performance or status (*self-monitoring*), observing other's behaviour (*surveillance*), or using positive reinforcement to shape complex behaviour (*conditioning*).

Secondly, computers serve as *media*. Computers can serve as media by using simulations to demonstrate the link between cause and effects (*cause and effect*), providing a simulated environment in which the user can rehearse a behaviour (*virtual rehearsal)*, rewarding people in a virtual world (*virtual rewards*), or using portable simulation technologies (*simulations in real-world contexts*).

Thirdly, computers serve as *social actors*. People sometimes respond to information technology as if it were a living being. Systems persuade people by applying the same persuasion principles that people have been using in interpersonal persuasion. Computers can serve as social actor by making technology visually attractive (*attractiveness*), making technology similar to users in some way (*similarity*), offering praise (*praise*), making technology to do "a favour" to a user (*reciprocity*), or making technology assuming roles of authority (*authority*).

Besides the functional triad, Fogg [2] has also defined a set of principles that leverage social influence. These principles base on the fact that people can achieve a greater degree of attitude and behaviour change when they are working together than working alone. Systems can leverage social influence by providing methods to observe others, or giving an impression that others are performing along with you (*social facilitation*), providing information on how user's performance compares with the performance of others (*social comparison*), providing methods to work as a group and feel peer pressure (*normative influence*), or providing ways to observe others performing a behaviour and being rewarded for it (*social learning*).

### *C. Evaluation method*

The framework utilized is rather a body of information about persuasion than an explicit tool for analyzing the persuasiveness of the solutions. Because of that, it was necessary to create a checklist which creates a link between a persuasion principle and a Web portal's persuasive characteristic. The checklist is presented in Table 1.

Table 1: Checklist for recognizing the principles

| Principle | Characteristic |
|---|---|
| Reduction | Interactive tests |
| | User's actions have been made easier by presenting a link to related information |
| | A possibility to challenge a friend |
| | A competition which encourages smokers to stop smoking at once |
| Tunneling | A link or information is presented immediately after another related operation |
| Tailoring | Tailored information |
| Suggestion | A link or information is presented at the opportune moment |
| Self-Monitoring | Technologies that give data about user's physical state |
| | Diary |
| | Interactive tests |
| Surveillance | It is possible to monitor the behaviour of others |
| Conditioning | Rewards, such as sounds, visuals, virtual or physical rewards |
| Cause and effect | Cause and effect simulations |
| | Interactive tests |
| Virtual Rehearsal | A simulated environment for rehearsal |
| Virtual Rewards | Virtual rewards, such as a trophy |
| Simulations | Portable simulations |
| Attractiveness | Physically attractive characters |
| | The system greets the user |
| Similarity | The system uses the same kind of language with the users |
| Praise | The portal offers praises |
| Reciprocity | Receiving favours, such as audio and video files |
| Authority | The portal adopts a social role of some authority |
| Social Facilitation | Discussion forum |
| | Awarded people are listed on the Web page |
| | Visitor counter |
| Social Comparison | Discussion forum |
| | Exchange of personal stories |
| | Diary |
| Normative Influence | Discussion forum |
| | The Web portal offers a possibility to challenge a friend |
| | Reward (if other people are being rewarded) |
| Social Learning | People are being awarded and awarded people are listed on the Web page |
| Competition, cooperation and recognition | Reward |

## III. RESULTS

### A. Persuasive characteristics of smoking cessation portals

*Reduction* was one of the most used principles in the tool-category. C1, C2 and C4 offered an interactive test, which made easier for the user to evaluate how addicted he or she is on tobacco. In two portals (C2, C4) the user's actions were made easier by presenting a link to related information after an interactive test. In one portal (C3) the quitting process was made to look easier through a quitting competition in which a user was encourages to quit smoking at one.

*Tunneling* was used in two portals in which a link or information was presented immediately after another operation (C2, C4).

*Tailoring* was applied only in one portal (C2) in which the Web portal's content was different for different user groups (who are not going to quit smoking, who are going to quit, who are already quitting and so forth).

*Suggestion* was used in two Web portals (C2, C4) by offering a possibility to read about medication (C4) or ways to quit (C2) immediately after the "how addicted you are" test.

The Web portals did not take advantage of technologies that would give data about user's physical state, but interactive tests offered ways for *self-monitoring*, such as the test "how addicted you are" (C1, C2, C4).

*Conditioning* was used in one Web portal (C3) which offered rewards to reinforce the successful behaviour.

It was not possible to monitor the behavior of others in any portal so the principle of *surveillance* was missing.

Media principles were not used in the Web portals. There were not cause and effect simulations, simulated environment for rehearsal, virtual rewards or portable simulations.

Only one portal applied social actor principles by offering an attractive Web portal for young people. In C2 the visual look was attractive (*attractiveness*), the portal included music files and digital photos which the user could download. After these gifts it is assumed that the users will feel the need to reciprocate (*reciprocation*). The language was designed to appeal young people (*similarity*) and there was a humoristic authority, a male called "Fressispentti" who answered questions about smoking. *Praise* was not used in the computer-human persuasion, but users praised each other in discussion forums (computer-mediated persuasion).

*Social facilitation* was used in two portals (C1, C2) which had discussion forums. Through these forums users were able to discern that others were performing the new behavior along with them. One portal (C3) published a list of awarded people on their Web page and one portal had a visitor counter (C1), which also gave users this feeling of "making things together".

The users were able to compare their behavior with others (*social comparison*) through discussion forums (C1, C2), reading personal stories of other quitters (C3), and reading diary (C1).

The users were able to feel peer pressure (*normative influence*) when they used discussion forums (C1, C2) or when they were able to send a challenge to a friend (C4) or when other people were rewarded (C3).

The Web portals used *social learning* when people were rewarded of the behavior and awarded people were listed on the Web page (C3).

One Web portal used *competition* (C3) for motivating users by leveraging human beings' natural drive to compete.

### B. Summary of the results

The summary of the results is gathered into Tables 2-4. It seems that the social actor principles were applied to some extent and the media principles were lacking, while the tool principles and the principles of social influence were much more widely utilized.

Table 2: Tool principles in the Web portals

| Principle | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| Reduction | + | ++ | + | ++ |
| Tunneling | | + | | + |
| Tailoring | | + | | |
| Suggestion | | + | | + |
| Self-Monitoring | + | + | | + |
| Surveillance | | | | |
| Conditioning | | | + | |

Table 3: Social actor principles in the Web portals

| Principle | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| Attractiveness | | + | | |
| Similarity | | + | | |
| Praise | | | | |
| Reciprocity | | + | | |
| Authority | | + | | |

Table 4: Social influence principles in the Web portals

| Principle | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| Social Facilitation | ++ | + | + | |
| Social Comparison | ++ | + | + | |
| Normative Influence | + | + | + | + |
| Social Learning | | | + | |
| Competition, cooperation and recognition | | | + | |

The surveillance principle from tool category was not used in the smoking cessation Web portals. If people would know that for example their employer is able to follow their diary notes, they would act differently. They would either reduce smoking or they would write faulty notes. Many principles from tool category would be useful. For example, the system could make suggestions at opportune moments, e.g. when one wants a cigarette. This requirement leads to another requirement: the persuasive system for smoking cessation should operate in a mobile device that people always carry with them in order for the system to persuade at an opportune moment.

The media principles were lacking from the Web portals. This may originate from the fact that Web site designers do not have knowledge of their usefulness and simulations may sometimes be too heavy to be provided at a regular Web page. Moreover Fogg has designed his framework for all kinds of interactive computer systems, not just Web sites. The principle of *cause and effect* could have been used during the quitting process to illustrate the positive health consequences. The Web portals did not offer *virtual rehearsal*. The system could, for example, to apply virtual rehearsal by presenting pictures of situations which user will encounter in real world and the user could respond to them by choosing a proper alternative. Users could be rewarded with *virtual rewards* for their good performance. For example pictures, animations, sounds or songs could be provided for the user as a reward.

Only one portal tried to persuade users through social cues. This is surprising considering the fact that attractiveness, similarity, reciprocity, and authority are well known principles in advertising. Products are wrapped up in attractive packages, children advertise toys and other children products, people get free gifts from the manufactures and people in white coats advertise natural products. The same principles could be used also in virtual world.

The principles of social influence were applied quite extensively in the smoking cessation Web portals. They offered ways for the user to communicate with other users through public diaries and discussion forums. People were encouraged to quit smoking through rewards and social learning, i.e. users were able to observe others performing the behaviour and being rewarded for it. Interviews of awarded people and pictures from the award ceremony were published at the Web page.

We believe that principles of social influence will be the most effective ways in changing users' attitudes and behavior. According to Maslow's hierarchy of needs [11], the belonging needs are the most important for a human being after the physiological and safety needs. It is motivating if people can see with the help of the technology that others are performing a behavior with them, they can compare their performance with others and feel peer pressure. The Web portal could offer possibilities to work as a virtual or physical group. The diaries and discussion forums in the studied Web portals do not tie the group together as much as they could have and they do not offer ways to observe the performance by others. It would be easy for a user to compare his/her performance with others if the portal provided, for example, graphs about smoked cigarettes per day or other measurable or illustrative data. Besides material rewards, users should be encouraged to tell others about the positive health consequences.

### C. *Critique of the functional triad*

As it was mentioned earlier, Fogg's framework is rather a body of information about persuasion than an explicitly applicable tool for analyzing the persuasiveness of the Web portals. To quote Fogg "Beyond the Web, persuasive technology can take on many forms from mobile phones to 'smart' toothbrushes to the computerized trailers that sit by the roadside and post the speed of passing cars in an attempt to persuade drivers to abide by the speed limit" [2]. The strength as well as the weakness of Fogg's framework lies in its generality. The principles proposed in the framework are a resource for designers when it comes to fostering new ideas. However, it does not describe how the principles can be implemented; that is, how to transform them into software requirements and functionalities. Conceptualization of how to implement persuasive principles in SW applications is a challenging task, as different environments have distinct possibilities and limitations when it comes to persuasion. For example, simulations may function better in desktop applications than in mobile applications.

The views on persuasive technology functioning as a tool, a media or a social actor are problematic in many ways. First, this categorization did not appear to be very useful in the analysis aiming at evaluating the persuasiveness of the Web portals. According to Fogg [2] the categorization is important, because persuasion strategies will differ depending on whether a computing technology is functioning as a tool, a media or a social actor. However, this study showed that when a principle is transformed into a persuasive characteristic of an application, this one characteristic may apply persuasion principles from all of the categories: the tool, the media and the social actor.

Second, the suggested principles within the tool, the media and the social actor categories are not at an equal level of abstraction. In practice, principles falling under the tool category refer to the structure and features of the system (for example tunneling; what is the sequence in which the information is presented), the principles in the media category refer to the content (for example in the form of a simulation demonstrating the cause and the effect), and the social actor principles refer to the social cues that the system imposes (for example praise: the system praises the user). It is arguable that some kind of categorization is needed, but in our opinion it should be based on something other than the different roles that computers play.

Third, the media category is quite limited while it focuses on simulations. Either the name of the category should be changed so that it would better describe its content or the organization of the principles should be reconsidered and simulation principles should be moved to another category. The principles themselves are interesting. For example, virtual rehearsal has been found useful in driving schools and suchlike. Also Atkinson [10] criticizes the functional triad on the naming of the media category because generally 'media or medium' is defined as 'the means by which something is communicated'.

Fourth and last, there is some overlap between the principles. For example rewards are mentioned as a positive reinforcement mechanism when referring to the *conditioning* principle from the tool category and rewarding people in a virtual world is in line with the principle of *virtual rewards* from the media category. Some may also see *praise* from the social actor category as a mechanism for rewarding the targeted behavior. There appears to be a need for reorganizing and renaming the principles with respect to understanding their application in practice.

The functional triad is based on persuasion theories that focus on communication between people. For example Cialdini [8] has mentioned principles such as reciprocation, social proof, liking, and authority which are comparable with Fogg's reciprocity, normative influence, attractiveness, and authority. There are a number persuasion theories in social psychology and it is very difficult to take all of them into account. However, there are some highly potential theories that could be applied to persuasive technology. Such include theories of commitment and cognitive consistency (see, e.g. [8]). Commitment theory implies that when people take a certain stand or a position they tend to agree on requests that are in line with their prior commitment. Theory on cognitive consistency proposes that people like their views about the world to be organized and consistent. People are disturbed by psychological inconsistency and they feel obligated to reorganize their thinking and restore consistency. Persuasive systems could apply these principles by offering users ways to commit, such as joining a smoking cessation group, or by offering ways to recognize the inconsistencies in their thinking and decision paths or mental models that may lead to a favorable change in attitude.

The generality of the functional triad, inconsistencies and overlapping of the tool, the media and the social actor categories and the existence of unattended persuasion theories imply that there is a need for further research and improvements of the functional triad.

## IV. CONCLUSION

The evaluation of the persuasiveness of Finnish smoking cessation Web sites was a qualitative study, based upon the first presented conceptual framework for persuasive technology. Deficiencies in the framework may have influenced on the results. Some of the principles were more precise than others and they were easier to recognize than those which blend with the underlying characteristics of the information system.

The evaluation showed that the Finnish language smoking cessation Web portals are not very persuasive. At least they take little advantage of the persuasion principles mentioned in the functional triad.

The functional triad presents key persuasion principles well and the principles proposed in the framework are a resource for designers when it comes to fostering new ideas. However, deeper understanding is still needed, because the functional triad is quite general, it has inconsistencies and overlaps between different categories and there may be need to expand its theoretical background. Also the evaluation of the persuasiveness of software and information systems is problematic without a proper method.

It has to be recognized that ethical questions are always present when designing persuasive systems. These systems may have a very high impact on people because of their interactivity and other engaging characteristics.

One key factor in persuasion is to present the right information at the right moment. The ongoing research shows that the future persuasive systems will concentrate on health issues and they will consist of a mobile application and wearable technologies for measuring and monitoring. For example Toscos et al. [12] presented a mobile application and a pedometer for motivating teenage girls to exercise and Silva et al. [13] presented a mobile application with a heart rate monitor to help people with their nutrition and exercise issues.

## V. ACKNOWLEDGEMENTS

We would like to acknowledge the help of Jukka Peltoperä for the general overview of the smoking cessation portals which he made in his master's thesis.

## REFERENCES

[1] J. Etter, "The internet and the industrial revolution in smoking cessation counselling," *Drug & Alcohol Review,* vol. 25, pp. 79-84, 01. 2006.

[2] B. J. Fogg, *Persuasive Technology: Using Computers to Change what we Think and do*. Morgan Kaufmann Publishers, San Francisco, 2003.

[3] R. E. Petty and J. T. Cacioppo, *Communication and Persuasion: Central and Peripheral Routes to Attitude Change.* Springer-Verlag, New York, 1986.

[4] A. Todorov, S. Chaiken and M. D. Henderson, "The heuristic-systematic model of social information processing," in *The Persuasion Handbook: Developments in Theory and Practice* J. P. Dillard and M. Pfau, Eds. Sage Publications, Thousand Oaks (Calif.), 2002.

[5] G. R. Miller, "On being persuaded: Some basic distinctions," in *The Persuasion Handbook: Developments in Theory and Practice* J. P. Dillard and M. Pfau, Eds. Sage Publications, Thousand Oaks (Calif.), 2002.

[6] M. Harjumaa and H. Oinas-Kukkonen, "Persuasion theories and IT design," in *The Second International Conference on Persuasive Technology (PERSUASIVE 2007),* 2007, pp. 311.

[7] B. J. Fogg, "Persuasive computers: Perspectives and research directions," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* Los Angeles, California, United States: ACM Press/Addison-Wesley Publishing Co, 1998, pp. 225-232.

[8] R. B. Cialdini, *Influence - Science and Practice.* 2nd ed. Harper Collins, New York, 1988.

[9] H. Oinas-Kukkonen and M. Harjumaa, "Towards deeper understanding of persuasion in software and information systems," in *The First International Conference on Advances in Computer-Human Interaction (ACHI 2008),* 2008. Accepted for publication.

[10] B. Atkinson, "Captology: A Critical Review" in Proceedings of the First International Conference on Persuasive Technology for Human Well-Being (PERSUASIVE 2006), pp. 171-182, 2006.

[11] C. Handy, *Understanding organizations*. Penguin Group, London, 1999.

[12] T. Toscos, A. Faber, S. An and M. P. Gandhi, "Chick clique: Persuasive technology to motivate teenage girls to exercise," in *CHI '06: CHI '06 Extended Abstracts on Human Factors in Computing Systems,* 2006, pp. 1873-1878.

[13] J. M. Silva, S. Zamarripa, E. B. Moran, M. Tentori and L. Galicia, "Promoting a healthy lifestyle through a virtual specialist solution," in *CHI '06: CHI '06 Extended Abstracts on Human Factors in Computing Systems,* 2006, pp. 1867-1872.

PUBLICATION II

# Towards Deeper Understanding of Persuasion in Software and Information Systems

In: Proceedings of the First International Conference on Advances in Human-Computer Interaction (ACHI 2008). February 10–15, Sainte Luce, Martinique, pp. 200–205.

# Towards Deeper Understanding of Persuasion in Software and Information Systems

Harri Oinas-Kukkonen and Marja Harjumaa

***Abstract*—A growing number of information technology systems and services are being developed for persuasive purposes, i.e. to change users' attitudes or behaviour or both. Despite the fact that attitudinal theories from social psychology have been quite extensively applied to the study of user intentions and behaviour, computer scientists and user interface designers are not very familiar with the theories related to attitude change. Moreover, these theories are not directly applicable for developing software and information systems. This paper builds upon the attitude change theories from social psychology recognising dimensions and approaches that help move towards a practical conceptual framework for understanding and designing persuasion in information systems.**

***Index Terms*—Computer-human interaction, human factors, persuasive technology, social factors, systems design.**

## I. Introduction

THERE has been great interest recently in studying how information technology influences people's attitudes and motivates behaviour change. Tam and Ho [1], for instance, studied the effects of Web personalization strategies on the users' attitude changes, Marcus and Chen [2] presented a mobile application which delivers periodic reminders to mobile phone users to encourage them to keep in touch with their friends, Tester et al. [3] presented an in-car entertainment system which motivated the driver to listen to the news by asking questions and giving rewards for correct answers, and Cheng and Vassileva [4] discussed the motivation of active system use by means of higher service quality.

The study of users' attitudes and behaviour has a long history in information system (IS) research. Theories from social psychology have been widely used for predicting user intentions and behaviour [5], including the Theory of Reasoned Action (TRA) proposed by Ajzen and Fishbein [29], the Theory of Planned Behaviour (TPB) put forward by Ajzen [30], and Social Cognitive Theory and Self-efficacy Theory as introduced by Bandura [31] [32]. A well-known derivative of the TRA is the Technology Acceptance Model (TAM) proposed by Davis [17]. Beside these attitude and behaviour change theories there are also other useful theories in social psychology, like the Elaboration Likelihood Model (ELM) of Petty and Cacioppo [6]. It is a processing model for attitude change and it has been used in IS research, e.g., to explain why users sometimes agree with incorrect advice given by an expert system [7] and to study the effects of Web personalization [1]. These attitude change theories are not very well known in IS research, however.

A key element in attitude change is *persuasion* which is an attempt to change attitudes or behaviours or both (without using coercion or deception) [8]. Persuasion has traditionally been regarded as a communication process in which a persuader sends a persuasive message to a persuadee or audience with the intention of changing the recipient's attitudes or behaviour, although always leaving the persuadee with the power of decision [9]. The most intensively studied aspects of traditional persuasion have been the source, message and receiver features that are likely to bring about such a change in the receiver's attitudes.

Interactive information technology designed for changing users' attitudes or behaviour is called *persuasive technology* [8]. Traditionally persuasion has meant "… human communication designed to influence the autonomous judgements and actions of others" [9]. In his seminal book, Fogg [8] argues that besides human communication, human-computer interaction can also be persuasive. The Web, Internet and mobile technologies create opportunities for persuasive interaction, because users can be reached easily. In addition, the Web and other Internet-based systems are optimal for persuasive communication, because they combine the positive attributes of interpersonal and mass communication [10]. There are certain areas where persuasive systems could be especially useful. For example in health care ubiquitous computing and context-aware algorithms may be used to develop electronic devices that motivate people towards healthy behaviour, and thereby delay or even prevent medical problems and ease the economic situation in public health care [11]. Moreover, persuasive systems can motivate users and help them to achieve their goals better. According to Fogg [8], persuasive systems may also be used in welfare, commerce, education, safety, environmental preservation, occupational effectiveness, among other fields.

To put it simply, information technology always influences people's attitudes and behaviour in one way or another. Whereas attitudinal persuasion theories from social psychology have been applied to information systems research

H. Oinas-Kukkonen is with the Department of Information Processing Science, University of Oulu, Rakentajantie 3, 90570 Oulu, Finland (phone: 358-8-5531900; fax: 358-8-5531890; e-mail: Harri.Oinas-Kukkonen@oulu.fi).

M. Harjumaa is with the Department of Information Processing Science, University of Oulu, Rakentajantie 3, 90570 Oulu, Finland (e-mail: Marja.Harjumaa@oulu.fi).

0-7695-30876-9/08 $25.00 © 2008 IEEE
DOI 10.1109/ACHI.2008.31

quite extensively, the theories of attitude change are not that well known. Section 2 will discuss the attitude change theories. Section 3 will build upon these theories recognising dimensions and approaches for developing a practical conceptual framework for understanding and designing persuasion in information systems.

## II. Background

Attitude has been described as the single most important concept in social psychology [12], and as one of the fundamental concepts of persuasion. Attitude is a general opinion that people hold with regard to themselves, other people, objects and issues [6]. Simons et al. [9] define: "An attitude is a judgment that a given thing is good or bad, desirable or undesirable, or something to be embraced or avoided. The 'thing' may be literally anything: a person, an event, an idea, a proposal for action, or an action itself. Attitudes predispose us to act in one way rather than another."

Interest in research into attitudes gained momentum in the U.S. in the 1930's [13], partly because commercial public opinion poll organizations were interested in describing attitudes through large-scale surveys, while at the same time academic researchers felt that it was their responsibility to analyse and explain attitudes. Prior to the 1970's studies on the relationship between attitudes and behaviour produced controversial results – some suggesting that attitudes predict behaviour and others that they do not. Finally, by the late 1970's, Ajzen and Fishbein, among some others, had specified conditions under which attitudes would or would not predict behaviour [6]. They introduced the Theory of Reasoned Action, which aims at explaining volitional behaviour, and suggests that the strongest predictor of behaviour is one's *intention* towards it [15]. According to Fishbein [16], intentions are a function of *attitudes towards modes of behaviour* and *subjective norms*. Thus, the theory suggests that a person's attitudes towards behaviour and subjective norms indicate how that person will act in a situation [9]. TRA is widely used in information systems research for predicting user intentions and user behaviour, and Davis [17] has employed it to create a model of individual human acceptance of technology, known as TAM.

As persuasion tries to alter the way others think, feel, or act, it is a form of attempted influence. There are also other forms of attempted influence, however, like material inducements and coercion, which differ from persuasion. Material inducements are exchanges of money or other such things for actions by the person being influenced [9], whereas coercion implies force and economic sanctions, whereas persuasion relies on the power of verbal and non-verbal symbols and allows people voluntary participation in the persuasion process [8, 10, 12]. For instance, Pop-up windows that always lead to the same outcome (e.g. downloading a file) whether you choose "ok" or "cancel" can be considered coercive rather than persuasive.

Three different types of persuasion exists: interpersonal persuasion, computer-mediated persuasion and human-computer persuasion [28]. *Interpersonal persuasion* occurs when two or more people interact with each other, involving e.g. verbal and non-verbal behaviour, feedback, and coherence of behaviour. *Computer-mediated persuasion* means people persuading others through computer-mediated communication, e.g. e-mail, instant messages, or blogs. *Human-computer persuasion* is the study of how people are persuaded when interacting with computer technology [8][22]. It differs from other persuasion types in that it is not always clear who is the persuader. As computers do not have intentions of their own, those who create, distribute, or adopt the technology have the intention to affect someone's attitudes or behaviour [8][22]. Although computers cannot communicate in the same way as humans, recent studies suggest that some patterns of interaction similar to social communication are possible in human-computer interaction [20], [21]. For example, the interaction between a personalized Web agent and a user can be considered persuasive communication [1]. However, as persuasive technology products are purposely designed in order to persuade [8][22], the use of e-mail and instant messages, which may well be involved in computer-mediated persuasion, is not part of human-computer persuasion.

Like earlier was mentioned, there are several approaches to attitude and behavior change. Some theories try to explain the relationship between attitudes and behavior, other theories explain the persuasion process more generally and some theories are concentrated on a narrower area of persuasion. All these theories have their own starting points and restrictions, and they often rely on earlier theories of human behavior and attitude change. See Table 1.

TABLE 1.
KEY APPROACHES TO HUMAN-COMPUTER PERSUASION.

| *References* | *Approach* | *Key idea* |
|---|---|---|
| McGuire [23] | Information processing theory | The persuasive impact of messages is multiplicative product of six information processing steps. |
| Fraser et al. [13] | Cognitive consistency theory | If attitudes and behavior are not consistent, people change their attitudes or behavior to achieve cognitive consistency. |
| Petty and Cacioppo [6] | Elaboration Likelihood Model | Person's motivation and ability decide whether (s)he will be persuaded through central route (rely on arguments) or through peripheral route (rely on cues). The ELM has integrated many persuasion theories. |
| Cialdini [25] | Influence techniques approach | Individuals respond automatically to one piece of information instead of reacting controlled and on the basis of thorough analysis of all the information. |
| Simons et al. [9] | Coactive approach to persuasion | The approach aims at helping bridge differences by reducing psychological distances to secure preferred outcomes. |
| Fogg [8] | Persuasive technology framework | The approach aims at showing how people are persuaded when interacting with computer technology. |

The key approaches for our human-computer persuasion research are information processing theory, consistency theory, the Elaboration Likelihood Model, the influence techniques suggested by Cialdini, the coactive approach, as well as Fogg's Persuasive technology framework.

McGuire's information processing theory reminds us that the attitude change process involves a number of components. Communication process involves five classes of variables: source, message, channel, receiver, and destination. In addition, there are six steps that a person must go through when being persuaded: 1) information presentation, 2) attention, 3) comprehension of the arguments, 4) yielding to the position presented, 5) retention for some time, and 6) action in compliance with the new position. From these steps we can see that this theory suggests that attitudes must be changed before the behavior can change. The theory treats the persuadee as an information processor, and the basic idea is that to be persuaded, a person has both to receive and understand the message and to accept or yield to it. [23] Thus, McGuire's information processing theory relies more on convincing receiver with understandable information rather than appealing his emotions.

The key idea of cognitive consistency is that people like their views about the world to be organized and consistent, whereas psychological inconsistency disturbs people and they feel obliged to reorganize their thinking and restore consistency [9], [13]. This theory suggest that it is plausible that people first do something (behave in some way) before they change their attitude changes. [13] People can achieve consistency for example through denial or ignoring, rationalization and excuses, separation of items, transcendence, changing item or persuasion.

Elaboration Likelihood Model [6] is a general theory of attitude change, in which the fundamental idea is that there are two routes to persuasion, a central and a peripheral route. An individual who carefully evaluates the content of the persuasive message may be persuaded by the central route, whereas an individual who is less thoughtful and uses a simple cue (e.g. the source or length of the message) or a rule of thumb (e.g. "more is better", "experts can be trusted", "consensus implies correctness") for evaluating the information may be persuaded through the peripheral route.

Cialdini [25] studied influence as a process of compliance, maintaining a narrow view to humans in which people need a trigger for their behaviour. They may respond in either an *automatic* or a *controlled* way to these triggers (either mechanically or based on a thorough analysis of all the information). Cialdini [25] has identified six explicit influence techniques that explain people's tendencies to comply with a request: reciprocation, commitment and consistency, social proof, liking, authority and scarcity.

Simons et al. [9] state that "persuasion is a process of bridging differences – reducing psychological distances – to secure preferred outcomes". One way to do this is coactive persuasion, which is an umbrella term for the ways that persuaders might move toward persuadees psychologically. Simon's conception of it is adapted from Aristotle's and others rhetoricians' thinking. Postulates of coactive persuasion are as follows [9]:

--It is receiver-oriented, taking place largely, although not entirely, on the message recipient's terms

--It iis situation sensitive, recognizing that receivers (e.g. audiences, persuadees) respond differently to persuasive messages in different situations

--It combines images of similarity between persuader and persuadee whereas promoting images of the persuader's unique expertise and trustworthiness

--It addresses controversial matters by appeals to premises the audience can accept

--It moves audiences from premises to desired actions or conclusions by both appearing reasonable and providing psychological income

--It makes full use of the resources of human communication.

Like the first postulate says, coactive approach is *receiver-oriented* approach to persuasion rather than *source-oriented.* Understanding the coactive approach and the difference between source- and receiver-oriented approaches to persuasion is useful, because they bring the persuader psychologically closer to the persuadee.

## III. KEY DIMENSIONS

This section aims at recognising dimensions and approaches for developing a practical conceptual framework for understanding and designing persuasion in information systems. It will define what a persuasive system is, discuss succesful outcomes of persuasion, describe the ideas of human information processing and cognitive consistency, discuss persuasive strategies and techniques, as well as the bridging of differences to secure preferred outcomes.

We define a persuasive system as *a computerized software or information system designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception.*

Three potential, succesful outcomes for a persuasive system are reinforcement, change or the shaping of attitudes and/or behaviours [12] (see Figure 1):

1. A reinforcing outcome means the reinforcement of current attitudes, making them more resistant to change.
2. A changing outcome means changes in a person's response to an issue, e.g. to social questions.
3. A shaping outcome means the formulation of a pattern for a situation when such one does not exist on beforehand.

Persuasion means ideally that individuals are induced to abandon one set of behaviors and to adopt another [12]. However, in many cases a shaping outcome may have a higher likelihood of success than communication that aims at behaviour change. It may happen with people who have limited prior learning histories or in situations where radically new and novel stimuli have been introduced into the environment. In any case, reinforced beliefs and forms of behaviour become the most resistant ones as time goes by.

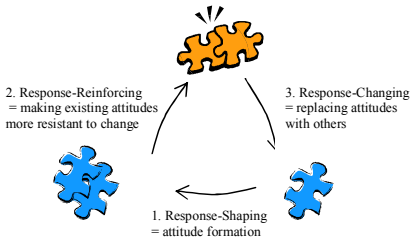



Fig. 1. Three potential, succesful outcomes for a persuasive system.

Different goals may imply the use of differing persuasion strategies and techniques.

### A. *Information processing*

Understanding a persuasive system requires a thorough analysis of the persuadee, message, channel, and context [6]. See Figure 2 (based on McGuire [23]).

Basically, a persuadee is a human information processor [23]. This information processing view emphasizes the role of attention and comprehension in the persuasion process. In order for a person to be persuaded information must be presented. Then the persuadee must to pay attention to the argument(s) presented, and comprehend it. After this the persuadee often yields to the position presented, and retents (at least for some time), but a succesful persuasion the persuadee takes action to comply with the new position [23]. Persuasion in full occurs only when attitude change takes place.

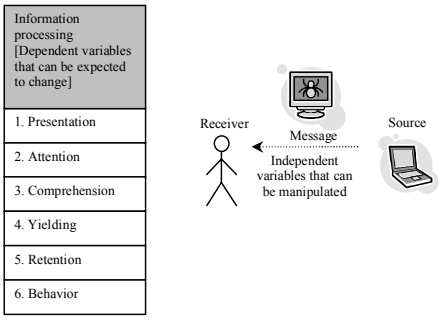



Fig. 2. Basic elements of persuasion.

In a persuasion situation the persuadee is ideally supposed to make optimal compromises among conflicting forces [23]. This principle has been criticized by Cialdini et al. [24], because it emphasises the rational processing of arguments. Nevertheless, this is a relatively large part of the whole picture. Since persuasion is defined as changing the attitudes and/or behaviour of others, the persuader is often trying to convince the persuadee of something. Drawing the line between convincing and persuasion is difficult. "Persuasion relies primarily on symbolic strategies that trigger the *emotions* of intended persuadees, whereas conviction is accomplished primarily by using strategies rooted in logical proof and that appeal to persuadees' *reason and intelligence*" [12].

### B. *Cognitive consistency*

Cognitive consistency means that people like their views about the world to be organized and consistent.[1] For example, if you have two friends that you like, you expect them to like each other [13]. Cognitive consistency is important, because inconsistency creates motivation for attitude change [9]. Psychological inconsistency disturbs people and they feel obliged to reorganize their thinking and restore consistency. Inconsistency may exist between attitudes and behaviour, attitudes towards other people, attitudes towards objects and other people's attitudes towards the same objects. Some kind of inconsistency must be represented and brought to the attention of the receiver. If a person finds the inconsistency unpleasant, he/she will accept personal responsibility for it, and then cognitive dissonance will occur. The dissonance has to be powerful enough, however, to motivate the person to engage in an attitude or behaviour change in order to restoring cognitive consistency. [13]

The idea of cognitive consistency is not free from criticism. Philosophically, people are not fully consistent in their actions but have to deal with minor inconsistencies every day. People also have to feel commitment before inconsistency creates dissonance. For example, if one feels that (s)he could reverse a decision at any time, (s)he is unlikely to experience dissonance. Also, if one believes that (s)he had no other choice but to behave inconsistently, (s)he can live with it.

The cognitive consistency approach differs from information processing approach by emphasizing that if people first change their behaviour, e.g. through legal constraints, their attitudes will change later, whereas the latter states that people first change their attitudes in order to produce a change in behaviour.

### C. *Persuasion strategies*

There are two strategies for persuasion, a direct and an indirect route [6, 14]. An individual who carefully evaluates the content of the persuasive message may be persuaded by the *direct route*, whereas an individual who is less thoughtful and uses a simple cue (e.g. the source or length of the message) or a rule of thumb (e.g. "more is better", "experts can be trusted", "consensus implies correctness") for evaluating the information may be persuaded through the *indirect route*. Direct and indirect processes may act simultaneously.

Persuasion through the direct route has turned out to be the more enduring of the two [6, 14]. However, as the information availability has increased through information digitalization in the Web era, people often have difficulties in sense-making

1 The idea of consistency is recognized in many theories/models, e.g. congruity, balance, consonance, or dissonance theories [13].

and decision-making. They are not able to easily process information through the diret route all the time, so they often use indirect heuristics to enable easier decision-making [9]. Indirect persuasion techniques are derived from experience and have some empirical validity [14]. These may also be called cognitive shorthands, rules of thumb, or, to put it simply, shortcuts. They are often socially shared, but they are still only available if there is a stored heuristic representation in the person's memory [14].

In the 1980's Petty and Cacioppo presented their Elaboration Likelihood Model (ELM) which integrated the literature on source, message, receiver, and context effects in persuasion. ELM is a general theory of attitude change and it "…provides a fairly comprehensive framework for organizing, categorizing, and understanding the basic processes underlying the effectiveness of persuasive communications" [6]. The model is developed for persuasive communications, but Petty and Cacioppo emphasize that the basic principles of the ELM may be applied to other attitude change situations. The term "elaboration" means the extent how well a person scrutinizes the persuasive message and its arguments and "the likelihood of elaboration will be determined by a person's motivation and ability to evaluate the communication presented." [6] "In the ELM, *arguments* are viewed as bits of information contained in a communication that are relevant to a person's subjective determination of the true merits of an advocated position". [6]

The direct and indirect routes of persuasion relate to this. Petty and Cacioppo's studies on attitude persistence suggest that if a person is motivated to carefully and thoughtfully consider the true merits of the information presented in support of an advocacy and (s)he has the ability to process, the elaboration likelihood is high [6]. Attitude change will be relatively enduring and resistant, and it will predict behavior. Attitude change may be either positive or negative. If favorable thoughts predominate during information processing, attitude change will be positive and unfavorable thoughts lead to negative attitude change. If thoughts are neutral during information processing, person relies on peripheral cues. That is the case also if the person does not have the motivation or ability to process the information.

Indirect persuasion is more likely to occur as a result of a simple cue in the persuasion context (e.g. attractive source) that induces change without necessitating scrutiny of the direct merits of the issue-relevant information presented [6]. If there are indirect cues present, attitudes may change, but the change will probably be temporary and not necessarily predictive of behavior. Indirect is here not synonymous with "automatic". When the elaboration likelihood is low, individuals will not utilize as much cognitive resources than when elaboration likelihood is high. This means that people often evaluate the message by relating incoming information to their prior knowledge through positive or negative cues. [6] Cognitive shorthands, triggers, are needed when people do not have time, ability or motivation to evaluate the arguments.

In the era of information overflow people are often forced to use indirect cues more often than before, because of the abundance of information to be handled. When an individual sees relevant cues, heuristics are triggered. They may also be called cognitive shorthands, rules of thumb, or shortcuts. Heuristics are normally derived from experience and may have some empirical validity. Often heuristics are socially shared, but still a heuristic is available only if there is a stored heuristic representation in one's memory [14].

Another model that separates direct and indirect persuasion is known as the Heuristic Systematic Model (HSM) [14]. As a process-oriented model this is conceptually similar to ELM. In HSM the direct route is called a systematic route and the indirect route a heuristic route. The difference between our approach and ELM concerns the simultaneity of the direct and indirect processes, in that the direct process in the ELM excludes the indirect process, whereas in our approach direct and indirect processes can act simultaneously, in a similar manner to HSM [14].

### *D. Persuasion techniques*

Direct persuasion puts emphasis on argumentation, consistency, and credibility, whereas indirect persuasion means using simple cues (or stereotypes), like "expensive=good" or "rare=valuable", to classify things based upon a few key features, after which they respond without or with little thinking. These techniques are said to be among society's unavoidable and most powerful cognitive shorthands [9]. Both indirect and direct persuasion may be supported through numerous persuasion techniques. Cialdini [25] lists reciprocation, commitment and consistency, liking, authority, social proof, and scarcity among key techniques.

*Reciprocation* means that people feel obliged to repay what others have given, such as gifts or invitations (or basically anything). The rule is so widespread that sociologists have reported that all human societies subscribe to it. *Commitment and consistency* means that people have a desire to be consistent with all the things they have done before. After making a choice people feel pressure to behave consistency with that commitment. [25] Quite interestingly, Guégen tested the "foot-in-the-door" commitment and consistency-based ploy by making a smaller request first, concerning how to save a document in rich text file format, and following it with a bigger request, to fill in a 40-item survey. 76% of the participants who complied with the first request also complied with the second, as compared with 44% in the control group [27]. *Liking* means that people feel pressured to say yes to someone they like, e.g. good-looking people succeed better in social relationships. This is because if a person has some good quality, such as good looks, other good qualities are automatically attached to him/her. *Authority* means that people feel obliged to do what is suggested by an authorized person. These tactics are often used in advertising, using a celebrity to promote make-up or a doctor to promote drugs [25]. For instance, people are more likely to answer an online survey if the request is presented by a professor than by a college student [26]. *Social proof* means that people often decide what is correct by finding out what other people think about it. Correctness is often determined by how other people perform

in a situation. *Scarcity* means that things seem more appealing if they are less available. This "limited number" ploy is widely used in business, and the "deadline" approach in which customers are pressured to make an immediate decision to buy is one variation of it, for instance [25].

Cialdini [25] acknowledges that even the best indirect persuasion techniques do not work every time, and in that case we probably accept the situation because we do not have any choice. Fogg [8] categorizes these kinds of techniques into three categories, which he calls tool, media, and social actor.

### *E. Getting closer to the persuadee*

Metaphorically persuasion is as a process of bridging differences or reducing psychological distances to secure preferred outcomes [9]. According to Simons et al. [9] *receiver-oriented*, rather than source-oriented, postulates regarding this kind of (coactive) persuasion are: (a) It is receiver-oriented, taking place largely, although not entirely, on the message recipient's terms. (b) It is situation-sensitive, recognizing that receivers (e.g. audiences, persuadees) respond differently to persuasive messages in different situations. (c). It evokes images of similarity between the persuader and persuadee, while promoting images of the persuader's unique expertise and trustworthiness. (d) It addresses controversial matters by appealing to premises that the audience can accept. (e) It moves audiences from premises to desired actions or conclusions by both appearing reasonable and providing psychological income. (f) It makes full use of the resources of human communication.

## IV. CONCLUSION

This paper has discussed key issues for information system persuasiveness. The analysis and enhancement of existing systems and designing of new systems seems very promising from this basis. In the future work, a more rigorous conceptual framework as well as experimentations will be needed.

## REFERENCES


[1] K.Y. Tam and S. Y. Ho, "Web personalization as a persuasion strategy: An elaboration likelihood model perspective," *Information systems research*, Vol. 16, No. 3, Institute for Operations Research and the Management Sciences, Linthicum, 2005, pp. 271-291.

[2] A. Marcus and E. Chen, "Designing the PDA of the future," *Interactions,* vol. 9, ACM, New York, 2002, pp. 34-44.

[3] J. Tester, B. J. Fogg and M. Maile, "CommuterNews: A prototype of persuasive in-car entertainment," in *CHI '00 Extended Abstracts on Human Factors in Computing Systems,* ACM Press, The Hague, 2000, pp. 24-25.

[4] R. Cheng and J. Vassileva, "User motivation and persuasion strategy for peer-to-peer communities," in *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS 2005), Track 7 - Volume 07,* IEEE Computer Society, 2005, pp. 193.1.

[5] Rawstorne, P., Jayasuriya, R., and Caputi, P., "An integrative model of information systems use in mandatory environments," *Proceedings of the international conference on Information systems*, Association for Information Systems, Helsinki, 1998, pp. 325-330.

[6] Petty, R.E., and Cacioppo, J.T., *Communication and Persuasion: Central and Peripheral Routes to Attitude Change*, Springer, New York, 1986.

[7] J. J. Dijkstra, W. B. G. Liebrand and E. Timminga, "Persuasiveness of expert systems," *Behaviour & Information Technology,* vol. 17, 1998, pp. 155-163.

[8] B.J. Fogg, *Persuasive Technology: Using Computers to Change What We Think and Do*, Morgan Kaufmann Publishers, San Francisco, 2003.

[9] H.W. Simons, J. Morreale and B. Gronbeck, *Persuasion in Society*, Sage Publications Inc, Thousand Oaks, 2001.

[10] M. M. Cassell, C. Jackson and B. Cheuvront, "Health Communication on the Internet: An Effective Channel for Health Behavior Change," *Journal of Health Communication*, vol. 3, 1998, pp. 71-79.

[11] S. S. Intille, "Ubiquitous computing technology for just-in-time motivation of behavior change," in *Proceedings of the UbiHealth 2003 Workshop,* 2003.

[12] G. R. Miller, "On being persuaded: Some basic distinctions," in *The Persuasion Handbook: Developments in Theory and Practice* J. P. Dillard and M. Pfau, Eds. Sage Publications, Thousand Oaks, California, 2002.

[13] C. Fraser, B. Burchell, and D. Hay, *Introducing social psychology*, Polity, Cambridge, 2001.

[14] A. Todorov, S. Chaiken and M. D. Henderson, "The heuristic-systematic model of social information processing," in *The Persuasion Handbook: Developments in Theory and Practice* J. P. Dillard and M. Pfau, Eds. Sage Publications, Thousand Oaks, California, 2002.

[15] J. L. Hale, B. J. Householder and K. L. Greene, "The theory of reasoned action," in *The Persuasion Handbook: Developments in Theory and Practice* J. P. Dillard and M. Pfau, Eds. Sage Publications, Thousand Oaks, California, 2002.

[16] M. Fishbein, and I. Ajzen, *Belief, attitude, intention, and behavior*, Addison-Wesley series in social psychology, Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, 1975.

[17] F. D. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly,* vol. 13, University of Minnesota, MIS Research Center, Minneapolis, 1989, pp. 319-340.

[18] E. V. Wilson, "Perceived effectiveness of interpersonal persuasion strategies in computer-mediated communication," *Computers in Human Behavior,* vol. 19, Elsevier, 2003, pp. 537-552.

[19] R. Guadagno and R. Cialdini, "Online persuasion and compliance: social influence on the Internet and beyond," in *The Social Net: Understanding human behavior in cyberspace*, Y. Amichai-Hamburger, Eds. Oxford University Press, Oxford, 2005.

[20] C. Nass, J. Steuer and E.R. Tauber, "Computers are social actors," *Proceedings of the SIGCHI conference on Human factors in computing systems: celebrating interdependence*, ACM Press, Boston, Massachusetts, 1994, pp. 72-78.

[21] B.J. Fogg and C. Nass, "Silicon sycophants: the effects of computers that flatter," *International Journal of Human Computer Studies*, Vol. 46, No. 5. Elsevier, 1997.

[22] B.J. Fogg, "Persuasive computers: perspectives and research directions," *Proceedings of the SIGCHI conference on Human factors in computing systems*, ACM Press/Addison-Wesley Publishing Co, Los Angeles, California, 1998, pp. 225-232.

[23] W.J. McGuire, "Persuasion," in *Communication, language, and meaning Psychological perspectives*, G.A. Miller, Eds. Basic Books, New York, 1973, pp. 242-255.

[24] R.B. Cialdini, R.E. Petty, and J.T. Cacioppo, Attitude and Attitude Change, *Annual Review of Psychology*, Vol. 32, 1981, pp. 357-404.

[25] R.B. Cialdini, *Influence - Science and Practice*, HarperCollins Publishers, 1988.

[26] R. Guadagno, and R. Cialdini, "Online persuasion and compliance: social influence on the Internet and beyond," *The Social Net: Understanding human behavior in cyberspace,* Y. Amichai-Hamburger, Eds.,University Press, Oxford, 2005.

[27] N. Guégen, Foot-in-the-door technique and computer-mediated communication, *Computers in Human Behavior*, Elsevier, 2002.

[28] M. Harjumaa and H. Oinas-Kukkonen, Persuasion Theories and IT Design. In: *Lecture Notes in Computer Science 4744*, Persuasive 2007, Y. de Kort et al. Eds., Springer-Verlag, Berlin Heidelberg, 2007, pp. 311-314.

[29] M. Fishbein and I. Ajzen, *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley, MA, 1975.

[30] I. Ajzen, "The Theory of Planned Behavior", *Organizational Behavior and Human Decision Processes*, Vol. 50, Elsevier, 1991, pp. 179-211.

[31] A. Bandura, *Social Foundations of Thought and Action. A Social Cognitive Theory*, New Jersey, Prentice Hall, Englewood Cliffs, 1986.

[32] A. Bandura, "Self-Efficacy: Toward a Unifying Theory of Behaviour Change." *Psychological Review*, Vol. 84, American Psychological Association, Washington, 1977, pp. 191-215.

PUBLICATION III

# Persuasive Systems Design
## Key Issues, Process Model, and System Features

In: Communications of the Association for Information Systems (24) Article 28, pp. 485–500.

**Communications of the Association for Information Systems**

Volume 24 | Number 1 Article 28

3-1-2009

# Persuasive Systems Design: Key Issues, Process Model, and System Features

Harri Oinas-Kukkonen
*University of Oulu*, harri.oinas-kukkonen@oulu.fi

Marja Harjumaa
*University of Oulu*

Communications of the Association for Information Systems

CAIS

# Persuasive Systems Design: Key Issues, Process Model, and System Features

Harri Oinas-Kukkonen

*University of Oulu, Department of Information Processing Science*

*Rakentajantie 3, FIN-90570 Oulu, Finland*

*Harri.Oinas-Kukkonen@oulu.fi*

Marja Harjumaa

*University of Oulu, Department of Information Processing Science*

*Rakentajantie 3, FIN-90570 Oulu, Finland*

Abstract:

A growing number of information technology systems and services are being developed to change users' attitudes or behavior or both. Despite the fact that attitudinal theories from social psychology have been quite extensively applied to the study of user intentions and behavior, these theories have been developed for predicting user acceptance of the information technology rather than for providing systematic analysis and design methods for developing persuasive software solutions. This article is conceptual and theory-creating by its nature, suggesting a framework for Persuasive Systems Design (PSD). It discusses the process of designing and evaluating persuasive systems and describes what kind of content and software functionality may be found in the final product. It also highlights seven underlying postulates behind persuasive systems and ways to analyze the persuasion context (the intent, the event, and the strategy). The article further lists 28 design principles for persuasive system content and functionality, describing example software requirements and implementations. Some of the design principles are novel. Moreover, a new categorization of these principles is proposed, consisting of the primary task, dialogue, system credibility, and social support categories.

**Keywords:** socio-technical system, behavioral outcomes, system features, development approach, conceptual research, persuasive technology

Volume 24 Article 28, pp. 485-500, March 2009

This manuscript was submitted on 9/22/2008 and has been with the authors for 2 months for 1 revision.

## I. INTRODUCTION

Interactive information technology designed for changing users' attitudes or behavior is known as persuasive technology [Fogg 2003]. Traditionally, persuasion has meant "human communication designed to influence the autonomous judgments and actions of others" [Simons et al. 2001]. The Web, Internet, mobile, and other ambient technologies create opportunities for persuasive interaction, because users can be reached easily. In addition, the Web and other Internet-based systems are optimal for persuasive communication, because they are able to combine the positive attributes of interpersonal and mass communication [Cassell et al. 1998]. There are certain areas where persuasive technology could be especially useful. For example, healthcare software applications may be developed to motivate people toward healthy behavior, and thereby possibly delay or even prevent medical problems as well as ease the economic situation in public healthcare [Intille 2003; Kraft et al. 2009].

Persuasive systems may be defined as "computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception" [Oinas-Kukkonen and Harjumaa 2008]. In this definition, there are three potential successful outcomes for a persuasive system: the voluntary *reinforcement*, *change* or *shaping* of attitudes and/or behaviors. A reinforcing outcome means the reinforcement of current attitudes or behaviors, making them more resistant to change. A changing outcome means changes in a person's response to an issue, e.g. to social questions. A shaping outcome means the formulation of a pattern for a situation when one does not exist beforehand. In many cases, communication that results in a shaping outcome may have a higher likelihood of success than communication that aims at a changing outcome [Lerbinger 1972]. Moreover, different goals may imply the use of differing persuasion strategies and techniques.

Persuasive systems may utilize either computer-human persuasion or computer-mediated persuasion [Oinas-Kukkonen and Harjumaa 2008]. Admittedly, the concept of a persuader is relatively complex with computer-human persuasion. As computers do not have intentions of their own, those who create, distribute, or adopt the technology are the ones who have the intention to affect one's attitudes or behavior [Fogg 1998]. Although computers cannot communicate in the same way as humans, there are studies that suggest that computer-human persuasion may utilize some patterns of interaction similar to social communication [Nass et al. 1994; Fogg and Nass 1997], whereas computer-mediated persuasion means that people are persuading others through computers, e.g. discussion forums, e-mail, instant messages, blogs, or social network systems.

Despite the fact that attitudinal theories from social psychology have been quite extensively applied to the study of user intentions and behavior, these theories have been developed for predicting user acceptance of the information technology rather than for providing systematic analysis and design methods to develop persuasive software solutions. The widely utilized framework developed by Fogg [2003] provides a useful means for understanding persuasive technology. However, it seems to be too limited to be applied directly to persuasive system development and/or evaluation [Harjumaa and Oinas-Kukkonen 2007]. This article, in spite of being conceptual and theory-creating by its nature, aims at discussing the process of developing and evaluating persuasive systems as well as describing what kind of content and software functionality may be found at the final product. The framework suggested in this article, the Persuasive Systems Design (PSD) model, is based upon our empirical work and conceptual analysis as well as other research.

The development of persuasive systems consists of three steps. See Figure 1 for an illustration of the development process. First, it is crucial to understand the fundamental issues behind persuasive systems before implementing the system. Only after obtaining a reasonable level of this understanding can the system be analyzed and designed. At the second phase, the context for persuasive systems needs to be analyzed, recognizing the intent, event, and strategies for the use of a persuasive system. Finally, actual system qualities for a new information system may be designed or the features of an existing system may be evaluated.

These steps provide the structure for this article. Section II will define the underlying assumptions behind persuasive systems. Section III will discuss how the persuasion context may be analyzed. Section IV will define and describe various techniques for designing the content and functionality of a persuasive system. Section V will provide an example of how to use the framework. Section VI will provide the conclusions of the article.

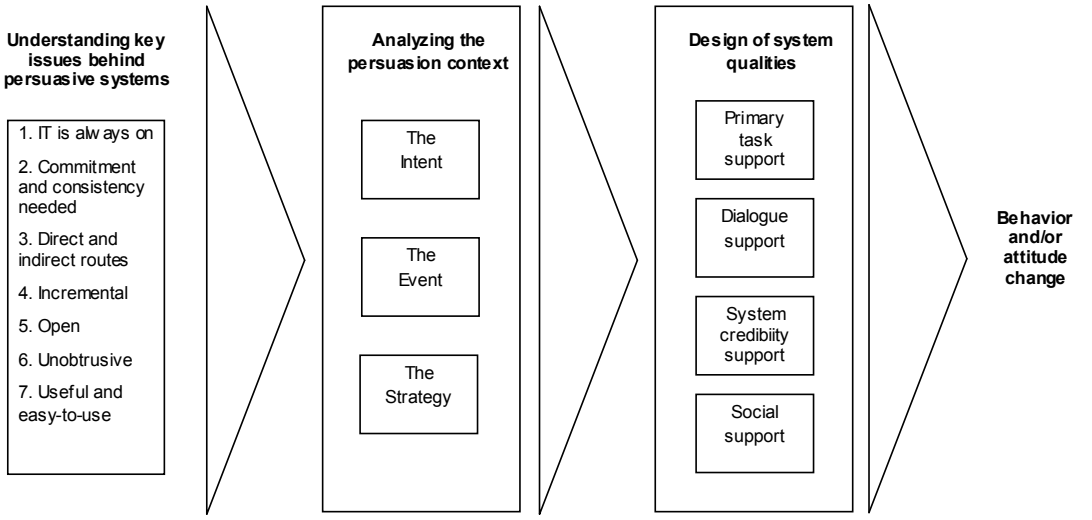



**Figure 1. Phases in Persuasive Systems Development**

## II. KEY ISSUES BEHIND PERSUASIVE SYSTEMS

Based upon our empirical work and conceptual analysis, as well as other research, we define seven postulates that need to be addressed when designing or evaluating persuasive systems. Two of these postulates relate to how we see the users in general, two of the postulates relate to persuasion strategies, and three of the postulates address actual system features. See Table 1 for a summary of the postulates.

| Table 1. Postulates behind Persuasive Systems | |
|---|---|
| 1. | Information technology is never neutral. |
| 2. | People like their views about the world to be organized and consistent. |
| 3. | Direct and indirect routes are key persuasion strategies. |
| 4. | Persuasion is often incremental. |
| 5. | Persuasion through persuasive systems should always be open. |
| 6. | Persuasive systems should aim at unobtrusiveness. |
| 7. | Persuasive systems should aim at being both useful and easy to use. |

Our first postulate is that *information technology is never neutral*. Rather it is "always on," influencing people's attitudes and behavior in one way or another. Moreover, people are constantly being persuaded in a manner similar to how teachers persuade students in schools, and there is nothing bad in it in itself. This also means that persuasion may be considered as a process rather than as a single act. Persuading a user is a multi-phased and complex task, and different factors, such as the user's goal, may change during the process. For instance, in the beginning of using a pedometer, a user might simply be interested in the number of steps taken but after using the device for a while (s)he may become more interested in burning calories. Persuasive systems should be able to adapt to these kinds of changes.

The second postulate is that *people like their views about the world to be organized and consistent*. This is based on the idea of commitment and cognitive consistency [Cialdini et al. 1981]. If systems support the making of commitments, users will more likely be persuaded. For example, a user may express greater confidence in his or her decision to exercise regularly after having bought a gym membership card. The idea of commitment also implies that persuasive systems could provide means to make private or public commitments to performing the target behavior. This can be implemented, for example, by offering an easy way to send a text message or email to one's relatives, friends, or colleagues.

Cognitive consistency becomes important, because inconsistency may motivate attitude change [Simons et al. 2001]. Psychological inconsistency disturbs people, and they easily want to reorganize their thinking and restore consistency, perhaps even feel obliged to do so. Inconsistency may exist between attitudes and behavior, attitudes toward other people, attitudes toward objects and other people's attitudes toward the same objects [Simons et al. 2001]. The inconsistency must be represented and brought to the attention of the receiver. If a person finds the

inconsistency unpleasant, (s)he will accept personal responsibility for it, and then cognitive dissonance will occur. The dissonance has to be powerful enough, however, to motivate the person to engage in an attitude or behavior change in order to restore cognitive consistency [Fraser et al. 2001]. The idea of cognitive consistency, admittedly, is subject to criticism. Philosophically, people are not fully consistent in their actions and have to deal with minor inconsistencies every day. People also have to feel commitment before inconsistency creates dissonance. For example, if one feels that (s)he could reverse a decision at any time, (s)he is unlikely to experience dissonance. Furthermore, in many cases, if one believes that (s)he has no other choice but to behave inconsistently, (s)he may live with the dissonance. Still, the idea of cognitive consistency can be used in persuasive designs in many ways, for example by offering information to a user that is inconsistent with his or her thinking. Should the behavior change, it will cause an inconsistency between one's attitudes and one's behavior and after a while (s)he may change his or her attitudes to better correspond with the behavior.

The third postulate states that *direct and indirect routes are key persuasion strategies* [Oinas-Kukkonen and Harjumaa 2008]. An individual who carefully evaluates the content of the persuasive message may be approached by the direct route, whereas an individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect route. Direct and indirect processes may act simultaneously, and both strategies may be supported through numerous software system features. Direct persuasion has turned out to be the more enduring of the two [McGuire 1973; Petty and Cacioppo 1986]. However, in the era of information overflow, people are often forced to use indirect cues more often than before, because of the abundance of information to be handled. When an individual sees relevant cues, heuristics are triggered. These may also be called *cognitive shorthands*, shortcuts, or rules of thumb. Heuristics are normally derived from experience and may have some empirical validity. Heuristics are often socially shared, but in practice a heuristic is available only if there is a stored representation of it in one's memory [Todorov et al. 2002]. This postulate implies that a user's personal background and the use situation have an influence on his or her information processing. When the user has a high motivation and a high ability, (s)he is more likely interested in the content of the persuasive message than when (s)he has a low motivation and a low ability. In challenging situations such as being in a hurry, it is highly likely that one will use heuristics for processing the information.

The fourth postulate states that *persuasion is often incremental*. In other words, it is easier to initiate people into doing a series of actions through incremental suggestions rather than a one-time consolidated suggestion [Mathew 2005]. This implies that a persuasive system should enable making incremental steps toward target behavior. For example, an application for healthier eating habits could first encourage users to eat at least some vegetables at their meals whereas the system could later suggest filling half of the plate with vegetables. Oftentimes, a system should also encourage users to make an immediate decision rather than postponing it for a later occasion. For example, Web sites for alcoholics could first provide stories from people who have suffered bad consequences, such as memory problems or brain damages, because of alcohol abuse and then encourage the user to make or keep a firm decision to abstain from alcohol use. From the ethical point of view, it is necessary that the overall goal is made clear at all steps of incremental persuasion.

The fifth postulate is that *persuasion through persuasive systems should always be open*. It is very important to reveal the designer bias behind of the persuasive system. For instance, simulations may bear great persuasive power, but if the designer bias remains unclear for the users the simulations may either lose some of their persuasiveness or they may end up misleading their users. Moreover, content that is based on untruthful or false information does not fit with the overall goal of users' voluntarily changing attitudes or behaviors.

The sixth postulate states that *persuasive systems should aim at unobtrusiveness*, i.e. they should avoid disturbing users while they are performing their primary tasks with the aid of the system. In this manner, the system is capable of fulfilling users' positive expectations. The principle of unobtrusiveness also means that the opportune (or inopportune) moments for a given situation should be carefully considered. The use of persuasive features at improper moments, e.g. a heart rate monitor suggesting one to exercise when being sick or getting a reminder to take medication for high blood pressure while giving a presentation at a meeting, may result in undesirable outcomes.

According to the seventh postulate, *persuasive systems should aim at being both useful and easy to use*, i.e. at really serving the needs of the user. This includes a multitude of components, such as responsiveness, ease of access, lack of errors, convenience, and high information quality, as well as positive user experience, attractiveness, and user loyalty. Quite understandably, if a system is useless or difficult to use, it is unlikely that it could be very persuasive. It should be noted, however, that the abovementioned aspects are general software qualities and not specific to persuasive systems only.

## III. PERSUASION CONTEXT

Analyzing the persuasion context requires a thorough understanding of what happens in the information processing event, namely understanding the roles of persuader, persuadee, message, channel, and the larger context [Oinas-Kukkonen and Harjumaa 2008]. Persuasive communication produces a complicated psychological event in a person's mind. Basically, the one being persuaded (persuadee), that is the user, is a human information processor [McGuire 1973]. This information processing view emphasizes the role of attention and comprehension in the persuasion process. In order for a person to be persuaded, information must be presented, and the persuadee must pay attention to the argument(s) presented and comprehend it. After this, the persuadee often yields to the position presented and retains it (at least for some time), but in a successful persuasion the persuadee takes action to comply with the new position [McGuire 1973].

In some cases, it is more fruitful to explain the persuasion context through the idea of cognitive consistency. This view differs from the one proposed by McGuire [1973], since he regards the cognitive consistency theory and the information processing approach as mutually exclusive. The idea of cognitive consistency implies that sometimes behavior change may be possible without systematically going through all information processing phases. Nevertheless, persuasion-in-full occurs only when attitude change takes place. Changing a previous attitude is harder than originating or reinforcing an attitude. Furthermore, if a user's existing attitudes are based on his/her personal experience (sometimes learned through a long socialization process), they are harder to change. In proportion, if a user's existing attitudes are recently learned from other people, they are easier to change [Lerbinger 1972].

Without carefully analyzing the persuasion context, it will be hard or even impossible to recognize inconsistencies in a user's thinking, discern opportune and/or inopportune moments for delivering messages, and effectively persuade. This context analysis includes recognizing the intent of the persuasion, understanding the persuasion event, and defining and/or recognizing the strategies in use. See Figure 2.

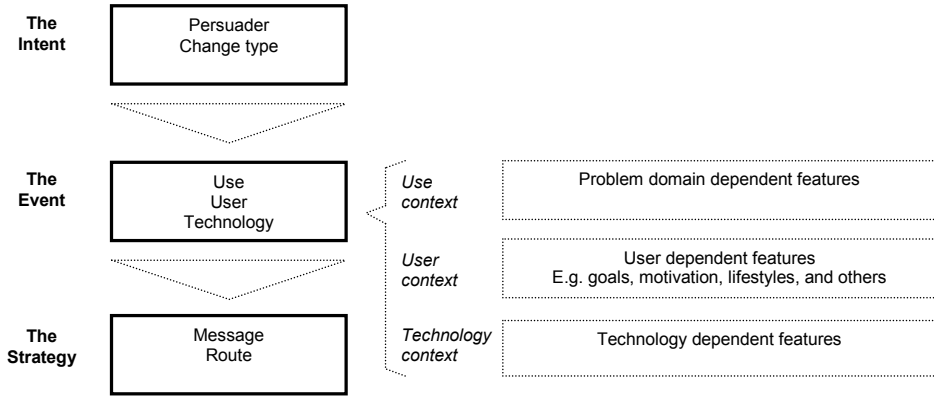



**Figure 2. Analyzing the Persuasion Context**

### The Intent

A serious consideration is needed to determine who is the *persuader*. As computers do not have intentions of their own, those who create, distribute, or adopt the technology have the intention to affect someone's attitudes or behavior. Fogg [1998] has recognized three different sources of intentions: Those who create or produce the interactive technology (endogenous); those who give access to or distribute the interactive technology to others (exogenous); and the very person adopting or using the interactive technology (autogenous). Autogenous technologies that people use to change their own attitudes or behaviors should emphasize that the user experience is rewarding enough for users to keep using the technology regularly over an extended period of time [Nawyn et al., 2006]. Exogenous technologies should provide means to personalize the assigned goals, because their effects are mediated by self-set goals that people choose in response to the assignment, even in organizational settings [Locke and Latham;, 2002]. Endogenous technologies should always be designed with respect to users' voluntariness toward attitude or behavior change. They should reveal the designer bias behind the system (cf. the fifth postulate in Section ii2 of this article).

A central feature of analyzing the intent is to consider the *change type*, in particular whether the persuasion aims at *attitude and/or behavior change*. One-time behavior change may be achieved more easily, whereas permanent

behavior change is much more difficult. An attitude change that directs behavior may be the most difficult to achieve. Attitudes can vary in many ways. They may be based on emotions, beliefs, or past experiences and behaviors, and they may be internally consistent or ambivalent [Petty and Wegener 1998]. Attitude change means that a person's evaluation is modified from one value to another. In our view, attitudes do not always predict or determine behavior. It is also possible to affect users' behavior with a persuasive system even if their attitudes toward the behavior are not favorable. This is supported by the theory of cognitive consistency. This theory suggests that one can often proceed more efficiently from behavior to attitudes [McGuire 1973]. If the behavior changes first, for example by legal constraints, it may be expected that the attitude change will follow.

There are also other theories which suggest that certain rules or conditions can be defined under which attitudes predict behavior. For instance, the theory of reasoned action, which aims at explaining volitional behavior, suggests that the strongest predictor of behavior is one's intention towards it [Fishbein and Ajzen 1975]. Intentions are a function of attitudes toward modes of behavior and subjective norms. Thus, this theory suggests that a person's attitudes toward behavior and subjective norms indicate how that person will behave in a situation. The attitude toward the behavior and subjective norms are the key elements in attitude change, because in order to change the behavior, the intention to perform that behavior should be influenced. These elements can be changed most effectively by influencing primary beliefs [Fishbein and Ajzen 1975]. The theory of reasoned action is widely used in information systems research for predicting user intentions and user behavior. Davis [1989] has employed it to create the widely used individual human technology acceptance model.

### The Event

A central facet analyzing the persuasion event is to consider the *use context*, in particular, the features arising from the problem domain. For instance, many persuasive systems have been developed for promoting health and well-being. It is characteristic of these applications that users often have the necessary information to act and, in many cases, they even have the proper attitudes, but they have problems in behaving in line with them. Bad habits or inappropriate behaviors have often been learned over a long period of time. For instance, addiction, whether physical, emotional, or social, may be a result of lengthy or heavy use of alcohol, nicotine, or other substances. In these cases, persuasive systems should aim at reinforcing proper attitudes and making them easier to stick with even in challenging, spontaneous situations.

In parallel with understanding the use context, the *user context* also needs to be analyzed. People have individual differences which influence their information processing. For example, some people have a high need for cognition whereas some have a low need for cognition. This is based on an individual's tendency to engage in and enjoy effortful cognitive endeavors [Cacioppo and Petty 1984]. A user's need for cognition has an influence on the persuasion strategy that will be successful. People who have a high need for cognition tend to follow the direct route to persuasion [Petty and Wegener 1998]. In addition to relatively straightforward information processing situations, such as learning, users may be approached through larger contexts in their lives, such as a middle-age crisis or the loss of a loved one. Whereas use analysis basically only focuses on the question of what information is relevant for a user in a given situation, the user may be approached in a more holistic manner as well. This context analysis in-the-large means analyzing a user's interests, needs, goals, motivations, abilities, pre-existing attitudes, commitment, consistency, compromises, life styles, persistence of change, cultural factors, deep-seated attitudes, social anchors, and perhaps even the whole personality.

One of the most essential facets of analyzing the user context is understanding the user's goals, including current progress toward achieving them, and potentially past performances. Users' goals and intentions can be studied from various perspectives. In their theory of reasoned action, Fishbein and Ajzen [1975] have discussed discrete intentions to take specific actions. In their theory of goal setting, Locke and Latham [2002] have focused on the relationship between conscious performance goals and the level of task performance. The goal-setting theory acknowledges the importance of conscious goals and self-efficacy, focusing on the core properties of an effective goal and on the motivation for work settings.

The goal setting theory [Locke and Latham 2002] explains that goals affect performance through directing attention and effort (toward goal-relevant activities and away from goal-irrelevant activities), energizing (high goals lead to greater effort than low goals), persistence (hard goals prolong effort, and tight deadlines lead to more rapid work pace than loose deadlines), and by leading to arousal and/or use of task-relevant knowledge and strategies. This theory states that (a) the highest and most difficult goals produce the highest levels of effort and performance; (b) specific, difficult goals consistently lead to higher performance than urging people to do their best; (c) when goals are self-set, people with high self-efficacy set higher goals than do people with lower self-efficacy; and (d) people with high self-efficacy are also more committed to the assigned goals and to finding and using better task strategies to attain the goals as well as to responding more positively to negative feedback. Thus, when users have the opportunity to set a goal, they will use their preexisting knowledge and earlier experience more effectively to achieve

their goals. Overall, persuasive systems should encourage users to set goals and to discover ways for achieving them in a systematic and effective way. It should be noted, however, that goal specificity in itself does not necessarily lead to high performance.

In computer-human and computer-mediated persuasion, the *technology context* also plays an important role. Information technologies are being developed with a great speed and new technologies become available rapidly. The strengths and weaknesses, as well as the risks and opportunities, of specific technological platforms, applications and features need to be thoroughly understood.

### The Strategy

A central feature for defining persuasion strategies is analyzing the *message*. A persuasion situation may be defined as an event in which the persuadee makes optimal compromises among conflicting forces [McGuire 1973]. This view has been criticized by Cialdini et al. [1981], because it emphasizes the rational processing of arguments. Nevertheless, this is a relatively large part of the whole picture of persuasion. Since persuasion may also be described as changing the attitudes and/or behavior of others, the persuader is often trying to convince the persuadee of something. Drawing the line between convincing and persuasion is difficult. Persuasion relies primarily on symbolic strategies that trigger the emotions, whereas conviction relies on strategies rooted in logical proof and appeals to persuadees' reason and intelligence [Miller 2002].

The second central question in defining persuasion strategies is considering the proper *route* to be used in reaching the user, in particular whether to choose a *direct or indirect* route for persuasion. Direct and indirect processes may act simultaneously, and both strategies may be supported through numerous software system features. The route selection depends on the user's potential to carefully evaluate the content of the persuasive message. If (s)he is able to do that, a direct route could be used. In many cases, this is advisable since direct persuasion has turned out to be the more enduring of the two [McGuire 1973; Petty and Cacioppo 1986]. In these cases, persuasion basically aims at convincing the user by appealing to reason and intelligence. However, in the era of information overflow people are often forced to use indirect cues more often than before, because of the abundance of information to be handled. An individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect route. When an individual sees relevant cues, heuristics are triggered.

## IV. DESIGN OF SYSTEM FEATURES

Fogg's [2003] functional triad and the design principles presented in it constitute the first and so far most utilized conceptualization of persuasive technology. A weakness of this model is that it does not explain how the suggested design principles can and should be transformed into software requirements and further implemented as actual system features. Yet, to be able to design and evaluate the persuasiveness of a software system, it becomes essential to understand both the information content and the software functionalities. Nevertheless, many of the design principles described below have been adopted and modified from Fogg [2003].

Requirements specification is one of the most important phases in software development. It covers the activities involved in discovering, documenting, and maintaining a set of requirements for the computer-based information system that will be designed and developed [Sommerville and Sawyer 1997]. Requirements are descriptions of how the system should behave (functional requirements), qualities it must have (nonfunctional requirements), and constraints on the design and development processes [Sommerville and Sawyer 1997; Robertson and Robertson2006]. A system's persuasiveness is mostly about system qualities.

The presented postulates already implicitly cover a multitude of aspects that need to be recognized when designing persuasive systems, including responsiveness, error-freeness, ease of access, ease of use, convenience, information quality, positive user experience, attractiveness, user loyalty, and simplicity, to name a few; however, more precise requirements for software qualities will have to be defined to be able to communicate the ideas from idea generators and/or management to software engineers. Similarly, in evaluating persuasive systems, software quality checklists will needed. The three steps necessary to make an idea become reality are summarized in Figure 3.

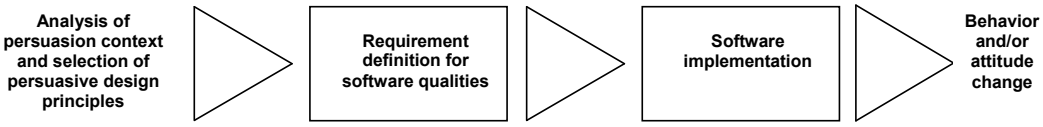



**Figure 3. Generic Steps in Persuasive System Development**

The categories for persuasive system principles suggested in this article are primary task, dialogue, system credibility, and social support.

The design principles in the primary task category support the carrying out of the user's primary task. The design principles in this category are reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal. See Table 2.

**Table 2. Primary Task Support**

| Principle | Example requirement | Example implementation |
|---|---|---|
| **Reduction**<br>A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior. | System should reduce effort that users expend with regard to performing their target behavior. | Mobile application for healthier eating habits lists proper food choices at fast food restaurants [Lee et al. 2006].<br><br>Smoking cessation Web site provides an interactive test that measures how much money a user will save with quitting. |
| **Tunneling**<br>Using the system to guide users through a process or experience provides opportunities to persuade along the way. | System should guide users in the attitude change process by providing means for action that brings them closer to the target behavior. | Smoking cessation Web site offers information about treatment opportunities after a user has taken an interactive test about how addicted (s)he is on tobacco. |
| **Tailoring**<br>Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group. | System should provide tailored information for its user groups. | Personal trainer Web site provides different information content for different user groups, e.g. beginners and professionals.<br><br>Web site for recovering alcoholics presents stories that are close to the user's own story. |
| **Personalization**<br>A system that offers personalized content or services has a greater capability for persuasion. | System should offer personalized content and services for its users. | Arguments most likely to be relevant for the user presented first on a professional Web site rather than in random order. |
| **Self-monitoring**<br>A system that keeps track of one's own performance or status supports the user in achieving goals. | System should provide means for users to track their performance or status. | Heart rate monitor presents a user's heart rate and the duration of the exercise.<br><br>Mobile phone application presents daily step count [Consolvo et al. 2006]. |
| **Simulation**<br>Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect. | System should provide means for observing the link between the cause and effect with regard to users' behavior. | Before-and-after pictures of people who have lost weight are presented on a Web site. |
| **Rehearsal**<br>A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world. | System should provide means for rehearsing a target behavior. | A flying simulator to help flight pilots practice for severe weather conditions. |

Any interactive system provides some degree of system feedback to its users, potentially via verbal information or other kinds of summaries. There are several design principles related to implementing computer-human dialogue support in a manner that helps users keep moving towards their goal or target behavior. They include praise, rewards, reminders, suggestion, similarity, liking, and social role. See Table 3.

**Table 3. Dialogue Support**

| Principle | Example requirement | Example implementation |
|---|---|---|
| **Praise**<br>By offering praise, a system can make users more open to persuasion. | System should use praise via words, images, symbols, or sounds as a way to provide user feedback information based on his/her behaviors. | Mobile application that aims at motivating teenagers to exercise praises user by sending automated text-messages for reaching individual goals. [Toscos et al. 2006] |
| **Rewards**<br>Systems that reward target behaviors may have great persuasive powers. | System should provide virtual rewards for users in order to give credit for performing the target behavior. | Heart rate monitor gives users a virtual trophy if they follow their fitness program.<br><br>Game rewards users by altering media items, such as sounds, background skin, or a user's avatar according to user's performance. [Sohn and Lee 2007] |
| **Reminders**<br>If a system reminds users of their target behavior, the users will more likely achieve their goals. | System should remind users of their target behavior during the use of the system. | Caloric balance monitoring application sends text-messages to its users as daily reminders. [Lee et al. 2006] |
| **Suggestion**<br>Systems offering fitting suggestions will have greater persuasive powers. | System should suggest that users carry out behaviors during the system use process. | Application for healthier eating habits suggests that children eat fruits instead of candy at snack time. |
| **Similarity**<br>People are more readily persuaded through systems that remind them of themselves in some meaningful way. | System should imitate its users in some specific way. | Slang names are used in an application which aims at motivating teenagers to exercise. [Toscos et al. 2006] |
| **Liking**<br>A system that is visually attractive for its users is likely to be more persuasive. | System should have a look and feel that appeals to its users. | Web site that aims at encouraging children to take care of their pets properly has pictures of cute animals. |
| **Social role**<br>If a system adopts a social role, users will more likely use it for persuasive purposes. | System should adopt a social role. | E-health application has a virtual specialist to support communication between users and health specialists. [Silva et al. 2006] |

The design principles in the system credibility category describe how to design a system so that it is more credible and thus more persuasive. The category of system credibility consists of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. See Table 4.

The design principles in the social support category describe how to design the system so that it motivates users by leveraging social influence. The design principles that belong into this category are social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition. See Table 5.

**Table 4. System Credibility Support**

| Principle | Example requirement | Example implementation |
|---|---|---|
| **Trustworthiness**<br>A system that is viewed as trustworthy will have increased powers of persuasion. | System should provide information that is truthful, fair and unbiased. | Company Web site provides information related to its products rather than simply providing biased advertising or marketing information. |
| **Expertise**<br>A system that is viewed as incorporating expertise will have increased powers of persuasion. | System should provide information showing knowledge, experience, and competence. | Company Web site provides information about their core knowledge base.<br><br>Mobile application is updated regularly and there are no dangling links or out-of-date information. |
| **Surface credibility**<br>People make initial assessments of the system credibility based on a firsthand inspection. | System should have competent look and feel. | There are only a limited number of, and a logical reason for, ads on a Web site or mobile application. |
| **Real-world feel**<br>A system that highlights people or organization behind its content or services will have more credibility. | System should provide information of the organization and/or actual people behind its content and services. | Company Web site provides possibilities to contact specific people through sending feedback or asking questions. |
| **Authority**<br>A system that leverages roles of authority will have enhanced powers of persuasion. | System should refer to people in the role of authority. | Web site quotes an authority, such as a statement by government health office. |
| **Third-party endorsements**<br>Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility. | System should provide endorsements from respected sources. | E-shop shows a logo of a certificate that assures that they use secure connections.<br><br>Web site refers to its reward for high usability. |
| **Verifiability**<br>Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources. | System should provide means to verify the accuracy of site content via outside sources. | Claims on a Web site are supported by offering links to other web sites. |

Even if the design principles in the primary task support category are based on the works of Fogg [2003], there are also many differences from them. The key benefit of suggestion is meaningful content for the user rather than providing support for carrying out a process or making a task simpler to do. For this reason, it is tackled in the dialogue support category. In our view, surveillance and conditioning are not acceptable means for persuasive systems. Oftentimes people cannot choose whether they may be observed or not, which easily leads to covert approaches. In a similar manner, operant conditioning oftentimes is not open. Moreover, we also think that users act more or less rationally in how they form and modify attitudes, on the basis of beliefs and values rather than performing behavior as a result of conditioning.

The design principles related to dialogue support are partly adopted from Fogg's ideas on social actors (attractiveness, similarity, and praise) and media (virtual rewards). Reminders and social role suggest new design principles, whereas the idea of reciprocity was excluded from this framework because it is a characteristic of a user rather than a system feature.

The differences between the design principles in the system credibility category and the functional triad are that this category excludes the system fulfilling users' positive expectations as well as the ideas of responsiveness, ease-of-use, and error-freeness, because they belong to the postulates. Since personalization is very closely related to

tailoring, it can be found at the primary task category. On the other hand, the key benefit of referring to an authority is to increase system credibility in a manner similar to other principles in this category. Presumed credibility, reputed credibility, and earned credibility influence users, doubtless even more than many of the abovementioned principles much of the time, but since these can not really be represented as system features, they are excluded.

**Table 5: Social support**

| Principle | Example requirement | Example implementation |
|---|---|---|
| **Social learning**<br>A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behavior. | System should provide means to observe other users who are performing their target behaviors and to see the outcomes of their behavior. | A shared fitness journal in a mobile application for encouraging physical activity [Consolvo et al. 2006]. |
| **Social comparison**<br>System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others. | System should provide means for comparing performance with the performance of other users. | Users can share and compare information related to their physical health and smoking behavior via instant messaging application [Sohn and Lee 2007]. |
| **Normative influence**<br>A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior. | System should provide means for gathering together people who have the same goal and make them feel norms. | A smoking cessation application shows pictures of newborn babies with serious health problems due to the mother's smoking habit. |
| **Social facilitation**<br>System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them. | System should provide means for discerning other users who are performing the behavior. | Users of a computer-based learning environment can recognize how many co-students are doing their assigned homework at the same time as them. |
| **Cooperation**<br>A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate. | System should provide means for co-operation. | The behavioral patterns of overweight patients are studied through a mobile application, which collects data and sends it to a central server where it can be analyzed at the group level in more detail [Lee et al. 2006]. |
| **Competition**<br>A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete. | System should provide means for competing with other users. | Online competition, such as Quit and Win (stop smoking for a month and win a prize). |
| **Recognition**<br>By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behavior. | System should provide public recognition for users who perform their target behavior. | Names of awarded people, such as "stopper of the month," are published on a Web site.<br><br>Personal stories of the people who have succeeded in their goal behavior are published on a smoking cessation Web site. |

The design principles in the social support category have been adopted from Fogg's principles on mobility and connectivity. The opportune and inopportune moment and the ideas behind information quality, convenience, and simplicity have been covered in the postulates in other categories.

## V. EXAMPLE

In this section, we will demonstrate the feasibility of the suggested conceptual framework through discussing a contemporary, commercial system that incorporates several distinct persuasive techniques in its functionality. The four described functionalities belong to the four different categories.

The Nike+ running system comprises a pair of running shoes with a built-in pocket for a running sensor, an mp3 player or a sport band, and a web service [Nike+ 2008]. See Figure 4. The sensor tracks running information and sends the data to the mp3 player or a special sport band on the runner's wrist. While running, the user can hear summary feedback such as his or her pace, time, distance, and calories burned. After running, the user can download his or her training information to the web service [Nike+ 2008] and see the full run data.

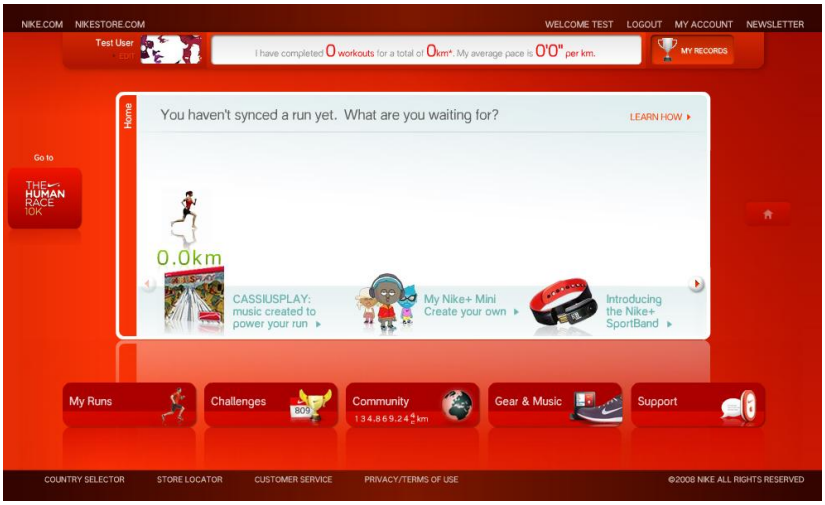



**Figure 4. The Nike+ Web Service**

The Nike+ system supports users' primary task by reducing the complexity of planning the exercises via suggesting training programs. These have been categorized according to the runner's goals, e.g. "walk to run," "5k," "10k," "half marathon," "marathon," or "build your own." When the build your own feature is selected, the application works like an electronic calendar where the user can add his or her own runs and distances per day. See Figure 5. The system also leverages the principle of personalization by enabling the adding of one's own name and picture to the screen. Naturally, self-monitoring is utilized by providing a means to track the running information.


**Figure 5. Leveraging the Reduction Principle: The Creation of a Training Program**

The computer-human dialogue is supported by praise and rewards. The user is able to set challenges at individual or team levels. After achieving the goals that have been set, the user receives a reward and the system praises him or her, for instance, by saying “Congratulations! You achieved your goal.” See Figure 6.

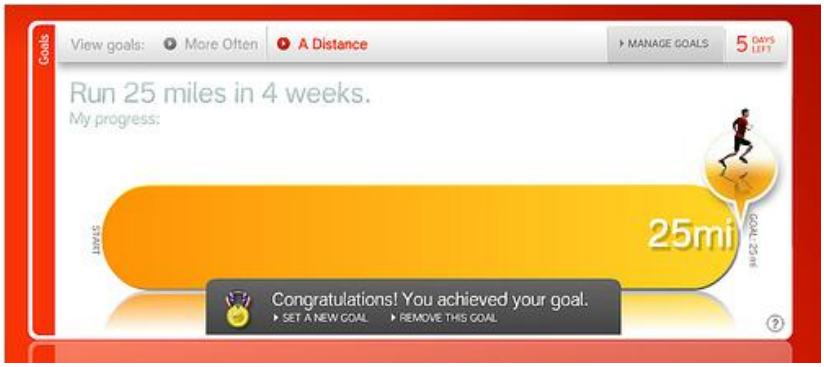



**Figure 6. Leveraging Praise and Rewards: The Positive Feedback after Goal Attainment**

The system credibility emphasizes expertise behind the system. For instance, when a user tries to create his or her own training program, the system brings its expertise to the fore, suggesting one of its offerings by saying: “Nike+ training programs were exclusively developed by Nike elite trainers for a range of goals and experience levels.” It also uses the expression “coach” with its training program offerings. See Figure 7.


**Figure 7. Showing Expertise by Providing Background Information**

The system also motivates users by leveraging social support. Besides individual challenges, it provides opportunities to define team challenges. A team goal can be a distance race (e.g. “the first team to run 100 miles”), the most miles (e.g. “the team that runs the most miles in 30 days”), or a distance goal (e.g. “every team has to run 500 miles this season”). See Figure 8. Challenges or goals that are shared by team members are supposed to leverage human beings’ natural drive to cooperate via achieving the goal together. Users may also be influenced by normative influence (i.e. peer pressure) as a consequence of the pressure of achieving one’s own part of the shared goal. Furthermore, the system utilizes other principles from the social support category. An individual user’s profile can be “public” so that all of one’s running data (as well as home towns, “power songs,” usernames, and pictures) will be shared with other users as well. In doing this, the system leverages the principles of social learning by providing means for observing others performing the same behavior and social comparison by offering means for comparing their performance with the performance of others. The system also provides means for public recognition. For instance, there is the fastest run challenge (e.g. “the person with the fastest 5k run by September 30 wins”), in which the winner gets public recognition in front of other runners.

The aforementioned functionalities by no means cover all of the persuasive qualities of the referred system, but they help demonstrate the practicality of the theoretical framework put forth in this article.


**Figure 8. Leveraging the Principle of Co-Operation: Creation of a Group Challenge**

## VI. CONCLUSION

This article has presented a framework for designing and evaluating persuasive systems, known as the Persuasive Systems Design (PSD) model. The underlying postulates behind persuasive systems were defined and the importance for a thorough analysis of the intent, event, and strategy was brought to attention. Although this article is conceptual and theory-creating by its nature, it has practical implications. It was proposed that persuasion principles should be considered mainly as requirements for software qualities. Twenty-eight design guidelines, mostly based on Fogg's functional triad, were defined with software requirement and implementation examples. A new categorization of the principles was based on their key benefits, which makes them more practical for actual systems development. In future research, experimental work will be needed to demonstrate the framework's applicability in various real-life design and usage situations. The suggested postulates, means for analyzing the persuasion context, new categorization, and design principles may become especially useful in motivating and persuading users to reach their own personal goals.

## ACKNOWLEDGEMENTS

We wish to thank the anonymous reviewers of this article for their constructive comments.

## REFERENCES

*Editor's Note*: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. The author(s) of the Web pages, not AIS, is (are) responsible for the accuracy of their content.
4. The author(s) of this article, not AIS, is (are) responsible for the accuracy of the URL and version information.

Cacioppo, J. T. and R. E. Petty. (1984). "The Efficient Assessment of Need for Cognition," *Journal of Personality Assessment* (48)3, pp. 306-307.

Cassell, M. M., C. Jackson, and B. Cheuvront. (1998). "Health Communication on the Internet: An Effective Channel for Health Behavior Change," *Journal of Health Communication* (3)1, pp. 71-79.

Cialdini, R. B., R. E. Petty, and J. T. Cacioppo. (1981). "Attitude and Attitude Change," *Annual Reviews in Psychology* (32), pp. 357-404.

Consolvo, S. et al. (2006). "Design Requirements for Technologies that Encourage Physical Activity" in *Proceedings of ACM CHI 2006 Conference on Human Factors in Computing Systems*, New York: ACM Press, pp. 457-466.

Davis, F. D. (1989). "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13)3, pp. 319-340.

Fishbein, M. and I. Ajzen. (1975). *Belief, Attitude, Intention, and Behavior*. Reading: Addison-Wesley Publishing Company, Inc.

Fogg, B. J. (1998). "Persuasive Computers: Perspectives and Research Directions" in *Proceedings of the CHI 98 Conference on Human Factors in Computing Systems*. Los Angeles: ACM Press/Addison-Wesley Publishing Co, pp. 225-232.

Fogg, B. J. (2003). *Persuasive Technology: Using Computers to Change What We Think and Do*. San Francisco: Morgan Kaufmann Publishers.

Fogg, B. J. and C. I. Nass. (1997). "Silicon Sycophants: The Effects of Computers that Flatter," *International Journal of Human Computer Studies* (46)5, 551-561.

Fraser, C. and B. Burchell. (eds.) (2001). *Introducing Social Psychology*. Cambridge: Polity.

Harjumaa, M. and H. Oinas-Kukkonen. (2007). "An Analysis of the Persuasiveness of Smoking Cessation Web Sites" in *Proceedings of the Second International Symposium on Medical Information and Communication Technology*, Oulu: CWC, University of Oulu, electronic publication.

Intille, S. S. (2003). "Ubiquitous Computing Technology for Just-in-Time Motivation of Behavior Change" in *Proceedings of the UbiHealth 2003: The 2nd International Workshop on Ubiquitous Computing for Pervasive Healthcare Applications*, http://www.healthcare.pervasive.dk/ubicomp2003/papers/ (current Sep 19, 2008).

Kraft, P., F. Drozd, and E. Olsen. (2009). "Digital Therapy: Addressing Willpower as Part of the Cognitive-Affective Processing System in the Service of Habit Change," *Communications of the Association for Information Systems*, in this issue.

Lee, G., C. Tsai, W. G. Griswold, F. Raab and K. Patrick. (2006). "PmEB: A Mobile Phone Application for Monitoring Caloric Balance" in *Proceedings of ACM CHI 2006 Conference Extended Abstracts on Human Factors in Computing Systems*, New York: ACM Press, pp. 1013-1018.

Lerbinger, O. (1972). *Designs for Persuasive Communication*. New Jersey: Englewood Cliffs.

Locke, E. A. and G. P. Latham. (2002). "Building a Practically Useful Theory of Goal Setting and Task Motivation," *American Psychologist* (57)9, pp. 705-717.

Mathew, A. P. (2005). "Using the Environment as An Interactive Interface to Motivate Positive Behavior Change in a Subway Station" in *Proceedings of ACM CHI 2005 Extended Abstracts on Human Factors in Computing Systems*, New York: ACM Press, pp. 1637-1640.

McGuire, W. J. (1973). "Persuasion" in G. A. Miller (ed.) *Communication, Language, and Meaning Psychological Perspectives*, New York: Basic Books, pp. 242-255.

Miller, G. R. (2002). "On Being Persuaded: Some Basic Distinctions" in Dillard J.P. and M. Pfau (eds.) *The Persuasion Handbook: Developments in Theory and Practice*. Thousand Oaks, California: Sage Publications, pp. 3-16.

Nass, C. I., J. Steuer, and E. R. Tauber. (1994). "Computers Are Social Actors" in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Celebrating Interdependence*, New York: ACM Press, pp. 72-78.

Nawyn J., S. S. Intille, and K. Larson. (2006). "Embedding Behavior Modification Strategies into a Consumer Electronic Device: A Case Study" in Dourish P. and A. Friday (Eds.) *Proceedings of the Eight International Conference on Ubiquitous Computing*, Springer Verlag, pp. 297-314.

Nike+ Web Service. (2008). http://nikeplus.nike.com (current Sep. 19, 2008).

Oinas-Kukkonen, H. and M. Harjumaa. (2008). "Towards Deeper Understanding of Persuasion in Software and Information Systems" in *Proceedings of The First International Conference on Advances in Human-Computer Interaction (ACHI 2008)*, electronic publication, ISBN 978-0-7695-3086-4, pp. 200-205.

Petty, R. E. and J. T. Cacioppo. (1986). *Communication and Persuasion: Central and Peripheral Routes to Attitude Change,* New York: Springer-Verlag.

Petty, R. E. and D. T. Wegener. (1998). "Attitude Change: Multiple Roles for Persuasion Variables," in Gilbert D., Fiske, S. and G. Lindzey (eds.) *The Handbook of Social Psychology*. Boston: The McGraw-Hill Companies, pp. 323-390.

Robertson, S. and J. Robertson. (2006). *Mastering the Requirements Process*, Upper Saddle River, N.J: Addison-Wesley London.

Silva, J. M., S. Zamarripa, E. B. Moran, M. Tentori and L. Galicia. (2006). "Promoting a Healthy Lifestyle through a Virtual Specialist Solution" in *Proceedings of ACM CHI 2006 Conference Extended Abstracts on Human Factors in Computing Systems*, New York: ACM Press, pp. 1867-1872.

Simons, H. W., J. Morreale, and B. Gronbeck. (2001). *Persuasion in Society*. Thousand Oaks London New Delhi: Sage Publications, Inc.

Sohn, M. and J. Lee. (2007). "UP Health: Ubiquitously Persuasive Health Promotion with an Instant Messaging System" in *Proceedings of ACM CHI 2007 Conference Extended Abstracts on Human Factors in Computing Systems*, New York: ACM Press, pp. 2663-2668.

Sommerville, I. and P. Sawyer. (1997). *Requirements Engineering: A Good Practice Guide*, Chichester: John Wiley.

Todorov, A., S. Chaiken, and M. D. Henderson. (2002). "The Heuristic-Systematic Model of Social Information Processing" in Dillard J. P. and M. Pfau (eds.) *The Persuasion Handbook: Developments in Theory and Practice*. Thousand Oaks, California: Sage Publications, pp. 195-212.

Toscos, T., A. Faber, S. An and M. P. Gandhi. (2006). "Chick Clique: Persuasive Technology to Motivate Teenage Girls to Exercise" in *Proceedings of ACM CHI 2006 Conference Extended Abstracts on Human Factors in Computing Systems*, New York: ACM Press, pp. 1873-1878.

## ABOUT THE AUTHORS

**Harri Oinas-Kukkonen**, Ph.D., is Professor of information systems at the University of Oulu, Finland. His current research interests include the next generation of the Web, human attitude and behavior change, and social and organizational knowledge management. His research has been published in journals such as *ACM Computing Surveys, Communications of the ACM, The DATA BASE for Advances in Information Systems, European Journal of Information Systems, Information and Software Technology, Information Technology and Management, International Journal of Healthcare Information Systems and Informatics, International Journal of Human-Computer Studies, International Journal of Networking and Virtual Organizations, Journal of Digital Information, Journal of Healthcare Information Management, Netnomics,* and *Software Process Improvement and Practice*. In 2005, he was awarded The Outstanding Young Person of Finland award by the Junior Chamber of Commerce.

**Marja Harjumaa**, M.Sc., is a doctoral student at the Department of Information Processing Science, University of Oulu, Finland. She studies information systems with social psychology as a reference discipline for persuasion. She is interested in the design of persuasive applications and systems, incorporating distinct persuasive techniques into software functionality. She emphasizes the social aspect of information systems, stating that information technology is not the only important part of an information system, but the interactions between the technology, user, community, and organizations are as important, as well as the culture, and they should be carefully considered in the design of persuasive systems.

Communications of the Association for Information Systems

ISSN: 1529-3181

PUBLICATION IV

# Building Persuasiveness into Information Systems

In: Electronic Journal of Information Systems Evaluation (EJISE) 17(1), pp. 023–035.

# Building Persuasiveness into Information Systems

**Marja Harjumaa and Salla Muuraiskangas**
**VTT Technical Research Centre of Finland, Oulu, Finland**
marja.harjumaa@vtt.fi
salla.muuraiskangas@vtt.fi

**Abstract**: Often the purpose of personal health and well-being systems is to change users' behaviour. Many theoretical frameworks have been developed to support the design and evaluation of these persuasive systems for behaviour change, but their design remains challenging. No systematic way yet exists by which to put the information into practice and build in persuasiveness effectively. The aim of this study is to investigate how the Persuasive Systems Design (PSD) model can be utilised so as to support the development of personal health and well-being systems. To do this, the study discusses and analyses related research and also integrates the PSD model into the development of two health-related behaviour change support systems. In Case 1, the purpose of using the PSD model was to identify new persuasive functionality within a fall risk assessment and fall prevention system. In Case 2, the purpose of using the PSD model was to identify new persuasive functionality and new service concepts within an existing smartphone application for mental wellbeing. The study shows that the PSD model has been used in the development of BCSSs to describe the overall process, analyse the persuasion context and design system qualities. It has also been applied in the evaluation of the existing systems by providing heuristics for expert evaluations and systematic ways to analyse user experience data. The study also reveals that the PSD model can be successfully applied during the user requirements analysis and concept design phases to identify new potential persuasive functionalities. In both Case 1 and 2, this resulted in having more variety in persuasive functionalities compared to those in the initial user requirements or existing application. The PSD model provides support for designing and evaluating BCSSs, but some future directions of development of the model can be recognised.

**Keywords:** behaviour change support systems, persuasive systems design, design process, evaluation, framework, health, well-being

## 1. Introduction

Huge challenges exist in treating a large population using traditional reactive healthcare. Therefore a need exists to develop more proactive patient-centred models. Personal health technology can be delivered at low-cost to large groups of people and it can be a competitive alternative to traditional care (Murray, 2012). Often the purpose of personal health and wellbeing systems is to change users' behaviour. Behaviour change support system (BCSS) provides content and functionalities that engage users with new behaviours, make them easy to perform and support users in their everyday lives. A BCSS can be defined as "a sociotechnical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception" (Oinas-Kukkonen, 2012). There already exist a number of theoretical and practical approaches to the design and evaluation of persuasive systems for behaviour change. Regardless of the abundance of various approaches, however, designers and researchers struggle with limited understanding of how BCSSs should be designed. There is therefore room for a study that addresses how to integrate persuasive design approaches into the development of personal health and wellbeing systems.

The concept of BCSS suggests that information systems (IS) can be treated as the core of research into persuasion, influence, nudge and coercion, whether they are web-based, mobile, ubiquitous applications, or more traditional information systems (Oinas-Kukkonen, 2012). One of the key constructs of the BCSS concept is the Persuasive Systems Design (PSD) model (Oinas-Kukkonen and Harjumaa, 2009) which can be used to analyse the persuasive potential of the system. It is a framework which discusses the process of designing and evaluating persuasive systems, i.e. systems designed for changing users' attitudes, behaviour or both.

This study discusses and analyses related research considering the use of the PSD model and describes experiences from two health-related system design cases. The objective of both of these systems is to deliver an intervention which seeks to make positive change in the health behaviour of the users. Case 1 involves a fall risk assessment and fall prevention system to deliver an intervention designed to reduce fall risk. Case 2 involves an existing smartphone application designed to increase mental well-being by teaching skills that boost psychological flexibility and mental wellness. Web-based and mobile technologies provide opportunities for persuasive interaction and open a whole new world for delivering an intervention. Barak et al (2009) define such web-based intervention as: "...a primarily self-guided intervention program that is executed by means of

a prescriptive online program operated through a website and used by consumers seeking health- and mental health–related assistance. The intervention program itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive web-based components." It is important to plan interventions carefully in order to ensure the information system becomes a successful intervention.

*The aim of this study is to investigate how the Persuasive Systems Design (PSD) model can be utilised to support the development of personal health and well-being systems and, more specifically, the identification of persuasive aspects in the early stages of iterative, user-centred IS development.*

The PSD model and a Persuasive Technology Design Canvas, which was created especially for this study based on the PSD model, were used as theoretical frameworks in both cases. The PSD model provides 28 design principles for persuasiveness under four categories: primary task, dialogue, system credibility and social support. The model was selected since it is a holistic model, but it also provides concrete instructions on how to develop a system that is more persuasive.

## 2. Background

### 2.1 Approaches to the design of persuasive systems

Development of personal health and wellbeing systems is often characterised by a multidisciplinary design team, customer orientation, and iterative development. In the past when traditional, sequential waterfall-oriented process was used, it led to a long development cycle. Customers and users were very often involved only in the beginning to write the requirements and then at the end to accept the software, which did not work very well (Cohn, 2004). In agile software development methods, such as Extreme Programming and Scrum, the process is iterative and customers and users remain involved throughout the duration of the project. The benefits of this kind of approach are that it helps to prioritize the functionalities and to describe the intended behaviour of the product. (Cohn, 2004) However, when the product is designed for health behaviour change, also its persuasive aspects should be considered.

There are many approaches to the design of persuasive systems. These approaches can be roughly grouped based on their focus on 1) users, 2) technology or 3) the whole design and evaluation process (i.e. holistic approaches). In a design process, it is possible and even favourable to use a combination of guidelines and principles from each approach to form a successful persuasive system.

When the focus is on the users and their behaviour change processes, there are plenty of theories addressing this aspect of human behaviour. These include the Theory of Reasoned Action (Fishbein and Ajzen, 1975), Theory of Planned Behavior (Ajzen, 1991), Self-efficacy Theory (Bandura, 1977) and Elaboration Likelihood Model (Petty and Cacioppo, 1986).

More recent approaches include the Fogg Behaviour Model (FBM) which states that the behaviour is a product of three factors: motivation, ability and triggers (Fogg, 2009). There are also models for understanding general health behaviour. Ryan et al. (2008) have also adapted self-determination theory into the health context and have formulated health behaviour to be determined by the autonomous motivation, perceived competence to make the change and practitioner-patient relationship (relatedness), which is similar to Fogg's model. According to the Health Belief Model (also known as the Health Action Model), a person takes action to alter their health-related behaviour for specific reasons: if they regard themselves as being susceptible to a particular condition; if they believe it to have serious consequences; if they believe that the anticipated barriers to (or costs of) taking the action are outweighted by its benefits (Strecher and Rosenstock, 1997).

There are also approaches that distinguish different stages of behaviour change. They can be used for adapting the system to react in the most beneficial way in relation to the present *behaviour change stage* the person is in. Examples include the Transtheoretical Model which describes six stages of health behaviour change (Prochaska and Velicer, 1997). Recently, Li et al (2010) have presented a five stage process of behaviour change when people turn from passive into active behaviours.

When the focus is on the technology, designing the product and its features are at the core. Most design principles and heuristics fall into this category. Fogg (2003) defines three roles for persuasive computer technology; they serve as tools, media or social actors. The Design With Intent Method provides 101 ideation cards with questions to induce ideas for the design, keeping the intent in mind (Lockton et al., 2010). Many others have also presented design principles, guidelines or strategies to design technology for behaviour change. Nawyn et al. (2006) list three types of strategies for behaviour modification: user experience strategies, activity transition strategies and proactive interface strategies.

When the focus is on the whole process, the objective is to analyse the big picture and guide the entire process from idea creation to the final product. The approach described by Oinas-Kukkonen and Harjumaa (2009) provides an overview of the stages in persuasive systems development (described in the next chapter in more detail). Van Gemert-Pijnen et al. (2011) describe six principles for a participatory eHealth development process. According to these principles eHealth technology development is one that: 1) is a participatory process, 2) involves continuous evaluation cycles, 3) is intertwined with implementation, 4) changes the organization of health care, 5) should involve persuasive design techniques and 6) needs advanced methods to assess impact.

## 2.2 The PSD model

The PSD model (Oinas-Kukkonen and Harjumaa, 2009) provides an overview of the stages in persuasive systems development. The steps include: 1) analysis of the persuasion context and selection of persuasive design principles, 2) requirement definition for system qualities, and 3) software implementation. The PSD model does not specify how these steps should be implemented; the process can be sequential or iterative. The *analysis of the persuasion context* requires a thorough understanding of what happens in the information processing event, namely understanding the roles of persuader, persuadee, message, channel, and the larger context (Oinas-Kukkonen and Harjumaa, 2008). Thorough analysis will help to recognize inconsistencies in a user's thinking, discern opportune and/or inopportune moments for delivering messages, and effectively persuade. In order to support the *requirement definition for persuasive system qualities and software implementation*, the PSD model lists 28 design principles for persuasive system content and functionality, and describes example software requirements and implementations. The principles are categorised in four categories depending on whether they support the user's primary task, human-computer interaction, the system's credibility or whether they leverage social influence. The model also presents some of the key issues behind persuasive systems, which are formulated as seven postulates.

The PSD model has been used in the development of BCSSs in order to describe the overall process (Alahäivälä et al., 2013), to analyse the persuasion context (Purpura et al., 2011; Young, 2010) and to design system qualities (Derrick et al., 2011; Langrial et al., 2012; Pribik and Felfernig, 2012; Stibe and Oinas-Kukkonen, 2012).

Related research shows that the PSD model has been applied in the evaluation of existing systems by providing heuristics for expert evaluations (Chang et al., 2013; Myneni et al., 2013; Lehto and Oinas-Kukkonen, 2011) and systematic ways to analyse user experience data (Basic et al., 2013; Segerståhl et al., 2010).

## 2.3 Impact of PSD principles

Overview of the studies exploring the relation between certain principles or the entire PSD categories (groups of related principles inspected as a whole) in the PSD model and actual health behaviour shows that applying the principles actually has an effect on users' behaviour. Some examples are mentioned below.

**Primary task support** category includes principles related to reduction, tunnelling, tailoring, personalization, self-monitoring, simulation and rehearsal. The effects of primary task support have been extensively studied from the *personalization and tailoring* perspectives. Oinas-Kukkonen and Harjumaa (2009) define personalization as the adjustment of content to individual users, and tailoring as the adjustment to different user groups (e.g. certain nationalities). However, there are other definitions. As an example, Kreuter's definition of tailoring being an individual adjustment of the context and targeting the higher level adjustment (Kreuter, 2003). The literature implies that *personalization* is indeed significant for behaviour change. In a meta-analysis by Noar et al. (2007), smoking cessation, diet and mammography screening were the most studied domains where personalised print messages were used. In addition to providing evidence for the

effectiveness of the personalisation, the meta-analysis also revealed that the contents should be modified based on the behaviour, demographics and 4-5 different theoretical behaviour concepts, for example. *Self-monitoring* has been proven to be an effective method for controlling blood pressure (Glynn et al., 2012) and blood glucose (St John et al., 2010)). This is no surprise, since the treatment of those conditions is greatly dependent on these measurements. Self-monitoring has also been shown to be effective in increasing physical activity (Conn et al., 2011; Ferrier et al., 2012).

**Dialogue support** includes principles of praise, rewards, reminders, suggestion, similarity, liking and social role. A more extensive use of dialogue support seemed to predict better adherence which is frequently one major reason why some interventions are not effective (Kelders et al., 2012). The behaviours present in this study were behaviours related to chronic conditions (diabetes, arthritis, etc.), lifestyle (weight management, nutrition, smoking cessation, physical activity) and mental health (anxiety, alcohol, depression, panic disorder, social phobia, etc.).

**Credibility support** includes principles for trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements and verifiability. The effects of credibility support are studied in a dissertation by Nind (2012). The dissertation includes two studies, one of web-pages related to increasing physical activity and the other of registration as an organ donor through a website. In the studies presented no difference was detected in the self-reported physical activity or the registration rates. But, as Lehto and Oinas-Kukkonen (2013) conclude in their study, credibility is perhaps more related to use continuance than to the behaviour itself. Therefore, it is indirectly crucial for effectiveness.

**Social support** category includes principles for social learning, social comparison, normative influence, social facilitation, cooperation, competition and recognition. There is evidence that the changing *social norms* affect behaviour change, e.g. in smoking-related behaviours (Dohnke et al., 2011; Zhang et al., 2012). Dohnke et al. (2011) found that intention was dependent on significant others' quitting, significant others' attitudes towards quitting and partners' smoking. In addition, they discovered that the behaviour was slightly different in men and women. Social media has had a strong impact on current applications. This offers also health and wellness applications new possibilities for social support, even though it should be noted that social support is not created simply by adding the Facebook possibility into the system. At least, this kind of solution did not seem to have any effect on increasing physical activity (Cavallo et al., 2012). Reviews of the studies of the health behaviour effects in this field do not exist yet.

There is recent research testing a model for predicting the perceived effectiveness and use continuance including all the PSD categories (Lehto and Oinas-Kukkonen, 2013). According to their study in the weight loss domain, primary task support, computer-human dialogue and social support affect perceived effectiveness. Computer-human dialogue has significant impact on the other three PSD categories. As mentioned earlier, perceived credibility rather affects continuance intention, which in turn is important for possible behaviour change.

## 3. Research setting

### 3.1 Research method

In order to integrate the PSD model into the systems development it was necessary to select real life practice-based problems where this kind of design approach was needed and to use the PSD model in them. Thus, the case research strategy was selected as the research method. The selected cases represent typical, information-rich cases from which it is possible to learn from the persuasive system's development.

According to Yin (2009) case study is an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. In case study there can be many variables of interest, it relies on multiple sources of evidence, and it benefits from the prior development of technological propositions to guide data collection and analysis. If the same study contains more than a single case, it is defined as a multiple-case study. It can be considered that single- and multiple-case designs are variants within the same methodological framework and no broad distinction is made between them. The advantage of multiple-case designs is that they are often

considered more compelling than single-case designs. It should be noted however, that single-case designs have their place in solving research problems related to unusual or rare cases, as an example. (Yin, 2009)

The goal of the multiple-case study was to find out how the PSD model can be utilised to support the identification of persuasive functionalities that would increase the persuasiveness of the system. Because one of the objectives of the PSD model is to show examples of how the suggested persuasive design principles can be transformed into software requirements and further implemented as actual system features (Oinas-Kukkonen and Harjumaa, 2009), the PSD model was applied during the user requirements analysis and concept design phases. In practise this meant that a co-creation session was organised for the people working in the two selected cases. In a co-creation session people work in collaboration and aim to explore potential directions and gather a wide range of perspectives in the process to be used as inspiration of the core design team (Stickdorn and Schneider 2011).

The first co-creation session was organised in November 2012 (Case 2) and the second in February 2013 (Case 1). In total nine people participated in the co-creation sessions and they all were working as researchers in their respective projects. Their expertise ranged from psychology to engineering. The material from the co-creation sessions was subsequently analysed. It included the notes of the two researchers who facilitated the designs of each project, and adhesive notes which contained new functionalities envisioned by the participants during the co-creation sessions. Individual case reports were written after the analysis and cross-case conclusions were drawn and reported.

### 3.2 Case 1: Fall risk assessment and fall prevention system

Case 1 is a fall risk assessment and fall prevention system for elderly care. It is called Aging in Balance system and it is aimed at preventing falls amongst older people by assessing the fall risk probability and providing *a personalised care plan* to reduce the likelihood of a fall. The target user group of the system includes older people, their possible carers and health care professionals (Immonen et al., 2012).

The system has several components, partly grounded on existing components used by the various stakeholders developing the system together. The requirements analysis and concept design of the whole system included the creation of five scenarios for the use of the prospective system and their evaluation via focus group interviews with older people in Finland and Spain. In this study, the design work analysed is limited to a home exercise programme which will form part of the overall system (see Figure 1). Before the co-creation session one of the designers defined a preliminary list of the user requirements which was intended to describe the most important functionalities of the system.

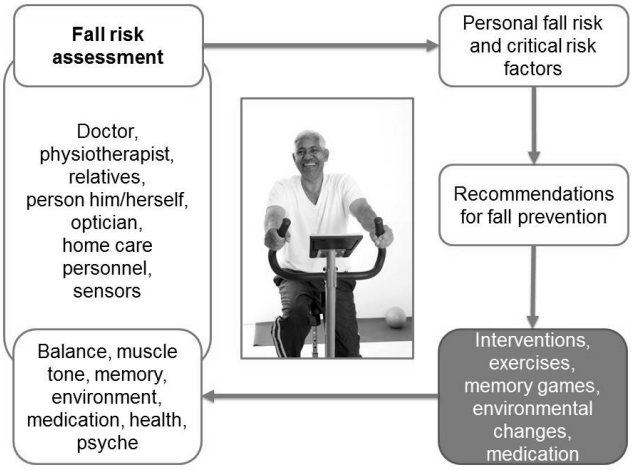



**Figure 1**: The aging in balance system

### 3.3 Case 2: Smartphone application for mental wellbeing

Case 2 is a smartphone application for learning skills related to psychological flexibility and wellbeing (Ahtinen et al., 2012). It is called Oiva and is targeted at working age people who suffer from stress and declined mental and physical well-being. The application has been created with the cooperation of experts in psychology, user-centred design and technology, and it delivers an intervention program in bite-sized daily sessions. The intervention program is based on Acceptance and Commitment Therapy (ACT), which aims to increase psychological flexibility: "the ability to contact the present moment more fully as a conscious human being, and to change or persist in behaviour when doing so serves valued ends" (Hayes et al., 2006). The application contains four intervention modules called "paths". Three of the paths are aimed at teaching the user the six core processes of ACT (see Figure 2).

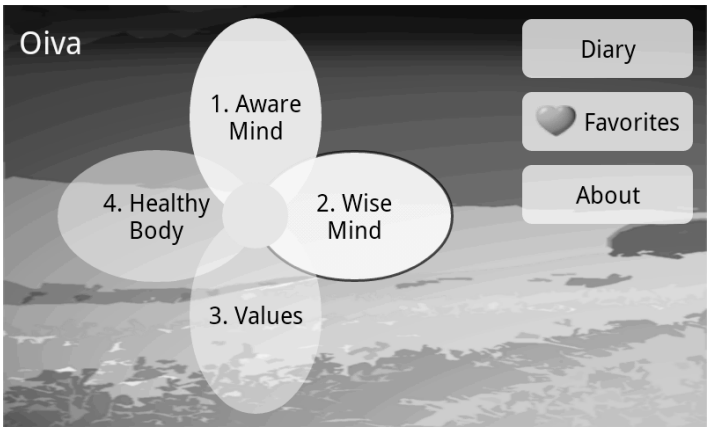



**Figure 2**: The main menu of Oiva

The design process had already included many iterative cycles. The initial idea of the application had been created based on a needs assessment with a multidisciplinary team, and a model of the therapy process had been created and used to define the structure of the application. ACT-based content and exercises were adapted for the mobile phone by creating audio and video versions of exercises and abbreviating textual content in order to support short daily usage sessions. Users were involved in several phases of the design to ensure that the application would be easy to operate and engage them in its use across several weeks (Ahtinen et al., 2012)

## 4. Results

### 4.1 Integrating the PSD model into the development process

In both Cases, the human-centred design process was implemented according to a prototyping paradigm where 'quick design' occurs after a requirements analysis. It aims to represent those functionalities that will be visible to the user and leads to the construction of a prototype. The prototype is evaluated by the user and is used to refine requirements. This iterative cycle is repeated until the prototype satisfies the requirements. During the iterative process the designers are able to develop a better understanding what needs to be done (Pressman, 2000).

The PSD model was integrated into the process by using it in the requirements analysis and concept design phases. In Case 1, there were no existing prototypes of the software. In Case 2, the design process was already much further advanced. There was an existing prototype, a smartphone application, which already had the basic functionality implemented and it was under validation in randomized controlled trials to prove the effectiveness of the intervention when delivered via the mobile channel. Figure 3 describes the development processes of the two Cases (darker colours represent the completed phases).

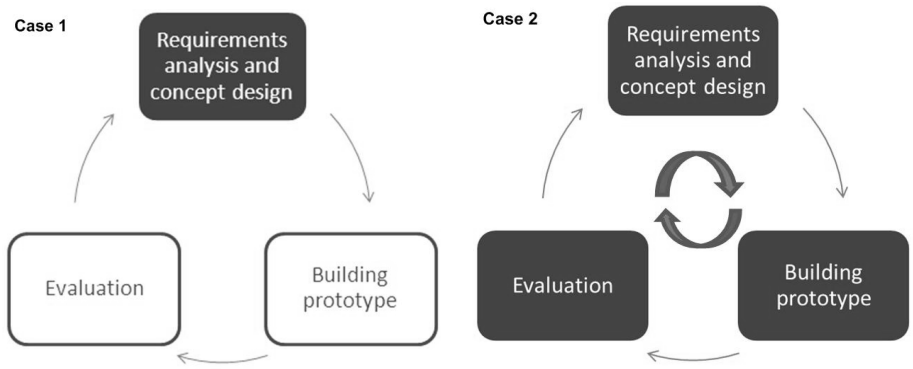



**Figure 3:** Development processes of cases 1 and 2

In this study the PSD model was integrated into the development work by organising a co-creation session for the people working in both of the projects. The PSD model was brought closer to practice by outlining a design canvas which aimed at facilitating the ideation work. The basic building blocks of the resulting Persuasive Technology Design Canvas are: 1) Analysis of the intention, 2) Design of the content and 3) Design of the functionalities (see Figure 4). To analyse the intention, it is useful to ask: "who, what, when, where and why". To design the content it is useful to ask "what", i.e. what theories, methods or assumptions the technology relies on, what kind of content is provided and what kind of content could be provided. To design the functionalities it is useful to ask: "how", i.e. how the technology has been implemented and how the technology could be implemented. The four categories under the functionalities contain the design principles of the PSD model. The Persuasive Technology Design Canvas is not limited to any particular theoretical model of behaviour change; it can be used across many kinds of design work.

Overview of the design process is illustrated in Figure 5. At the start of both co-creation sessions, the PSD model was introduced to the participants and the original article including detailed descriptions of the design principles was distributed to them. The Persuasive Technology Design Canvas was drawn on a large board. The researchers discussed and created a shared understanding of the intention and content of the behaviour change support system and wrote it down on the board. As an example, in Case 2 *the intention* was to increase the psychological flexibility of people who suffer from stress and depression, to be used in everyday life and *the content* was a coaching program based on ACT. Then they worked independently to envision new functionalities based on the design principles and wrote their ideas on adhesive notes. In Case 2, the participants identified first the existing persuasive functionalities using the Persuasive Technology Design Canvas, and then potential future functionalities. After the participants had gone through all categories, the adhesive notes were grouped and analysed. The result was an affinity diagram comprised of all of the new potential functionalities that could be included in the design of the system.

<table>
<tr><td rowspan="2">Analysis</td><td colspan="3">1. Intention</td></tr>
<tr><td rowspan="3">Design</td><td>2. Content</td><td colspan="2">3. Functionalities</td></tr>
<tr><td rowspan="2"></td><td>Primary task</td><td>Dialogue</td></tr>
<tr><td>Credibility</td><td>Social support</td></tr>
</table>

**Figure 4:** The persuasive technology design canvas

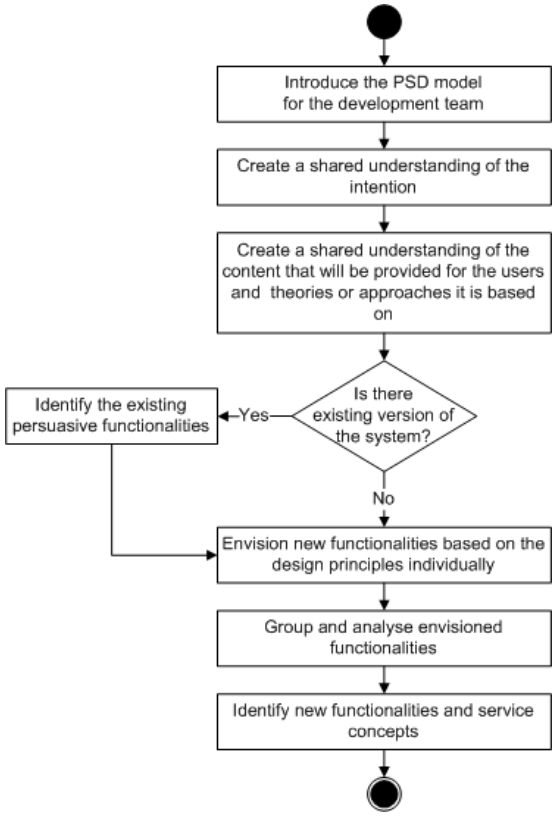



**Figure 5:** Overview of the design process

Because there was empirical material collected from a previous small-scale field study in Case 2, this was also used to identify new functionalities and create new concept ideas for further discussion and development. This material was already analysed and reported but not published. After participants had identified existing and future persuasive functionalities with the Persuasive Technology Design Canvas, they used this empirical material to identify new functionalities and create new service concepts.

### 4.2 The outcome of the integrated process

Material from the co-creation sessions was analysed afterwards. The adhesive notes from Case 1 were written up and the quantity of new persuasive functionalities envisioned by the participants was compared with the quantity of persuasive functionalities in the initial user requirements document. Initially there were 15 different persuasive functionalities applying principles from three categories: 1) primary support, 2) dialogue support and 3) social support. After the co-creation workshop there were 39 different functionalities from applying principles from the four PSD model categories (see Table 1).

Adhesive notes from Case 2 were also written up and the quantity of new persuasive functionalities envisioned by the participants was compared with the quantity of the existing persuasive functionalities. Participants in the co-creation session identified that in the current application there were 17 different persuasive functionalities applying principles from three categories: 1) primary support, 2) dialogue support and 3) credibility support. After the co-creation workshop there were 27 different functionalities applying principles from the four PSD model categories (see Table 1). In addition, dozens of new ideas were identified based on the empirical data. These included not only new requirements but also improvement ideas and service concepts. Overlapping items were removed in both Cases.

**Table 1:** Quantity of the persuasive functionalities before and after the co-creation session

| | Before | After | Increase |
|---|---|---|---|
| Case one | 15 | 39 | 160 % |
| Case two | 17 | 27 | 60 % |

#### *4.2.1 Case 1: Fall risk assessment and fall prevention system: persuasive functionalities*

In Case 1 the basic functionality of the personalised training program had many similarities with the initial user requirements, which had been defined earlier. It was expected that a personalised training programme with goal-setting, self-monitoring and feedback features would motivate older users to exercise and thus, the likelihood of fall would be reduced. A concrete plan and schedule of performing the intended balance exercises should be provided for the users and they should be reminded at opportune moments to perform the exercises. The system should offer instructions for how to perform the intended behaviour in practice, provide motivational information related to the exercises and give positive feedback when users reached their goals.

As a consequence of using the PSD model new functionalities were identified. It was discovered that simulations of the consequences of exercising (or not exercising) should be used to increase exercise motivation. The system should provide links to external websites providing useful and trustworthy information. It was also found that the exercise instructions should adapt over time as users would require more challenging exercises.

Regarding the four categories within the PSD model, the credibility and social support categories were the least taken into account in the initial user requirements. It was found that the system should provide information about the validity of the training program, show third party endorsements and logos in order to increase the credibility. The end-users should be provided an opportunity to send feedback to the developers of the solution. The potential for including group functionalities was recognised to be important, although in the first phase the system was targeted for individuals. End-users could have a club, as they might in real life, and they should have shared goals. The system should monitor the group's progress and give feedback accordingly. Club members should have an opportunity to send suggestions about useful exercises to other club members, discuss with the others, share their exercises with the others, have public recognition of their achievements, know when the others are performing their exercises, and to volunteer to help others to achieve their goals.

New, non-functional requirements were also identified in addition to the persuasive functionalities mentioned above. To list a few, the system should be error free, easy to use, and the user interface should be "pleasant and credible looking" from an older person's viewpoint. Although one of the postulates of the PSD model states that the system should aim at being both useful and easy to use (Oinas-Kukkonen and Harjumaa 2009), these aspects are general software qualities and not specific to persuasive systems only.

#### *4.2.2 Case 2: Smartphone application for mental wellbeing: persuasive functionalities*

In Case 2, the existing application already followed many persuasion principles. It provided thorough opportunities to rehearsal, which can enable people to change their attitudes or behaviour. Exercises were in both textual and audio format and users had self-monitoring potential through keeping a diary and activity log showing how many exercises were carried out. It suggested a program, "a path", to follow, had reminders of exercises, and reduced barriers to the user performing the exercises when compared for example to a book with written instructions. It provided expertise by showing video presentations by a real therapist and stated the evidence-based theory behind the application. It motivated users by giving a virtual reward for performing an exercise.

As a consequence of using the PSD model, new functionalities were identified. The system should provide feedback on the user's progress with regards to their goals, skills and committed actions. It should also give recognition via praise for performing the target behaviour. The system should adopt the role of a therapist, or virtual coach, who is always available to help. The content should be tailored to the interests and needs of the user, and the users should be provided with testimonials from other users who have been helped by using the application.

Many of the functionalities related to creating a more engaging user experience, such as providing a more attractive look and feel. The system should also provide opportunities to rehearse difficult situations in role play and provide animations, pictures or mini movies to emphasize of the benefits of the exercises. Similarly to Case 1, the credibility and social support categories of the PSD model were the least taken into account in the existing design. To increase credibility, the system should provide information on who provides the application, evidence of the effectiveness of the therapy method, third party endorsements and logos as well as the means to verify the accuracy of the content. Regarding "social functionalities" it was discovered early in the design session that although it is possible to identify them, they might not be applicable in the context of mental wellbeing. As an example, "competing with others in performing exercises" is not useful, but on the other hand, it could be useful to provide opportunities to follow other users' progress at some level, because this might encourage people to perform their own exercises.

In Case 2, new improvement ideas and functionalities were identified also based on the empirical material collected from a previous study. Many of them concerned ways to better integrate the solution into the everyday lives of the users, where a typical barrier amongst the field trial users was being too busy to carry out the exercises. Similarly to the requirements gathered using the PSD model, the need for a virtual coach and a more engaging user experience were suggested. While the principles of the social support category were not earlier considered especially applicable, it was identified that supporting communication or sharing exercises with friends and family could be useful.

### 4.3 Observations from the process

When participants began the co-creation session looking at the definition of intention, it was found that the intention part of the Persuasive Technology Design Canvas was not self-explanatory. One participant commented that there can be different kinds of intentions, such as theory-driven or more practical ones, and it was not clear what was meant in the Canvas. In persuasive design, 'intention' refers less to the 'design objectives' in general, than to a focus on the intent to change attitudes or behaviours. Fogg (1998) has stated that persuasion requires intentionality, i.e. intent to change attitudes or behaviours.

It was observed that the PSD model was more useful in Case 1 than Case 2, which may be due to the fact that in Case 1 the participants had less understanding and experience of the users and use context and thus, the participants were more open to new ideas. In Case 2, the designers had already had frequent contacts with the potential end-users and were armed with findings from a prior field trial, and thus, their experience was more evident when making comparisons using the PSD model.

In both Cases it was observed that some principles were overlapping, and participants found these somewhat confusing. They also commented that there were many principles in credibility and social support categories that overlapped. In both Cases participants doubted the efficacy of virtual rewards. They stated that improvements in health are the best motivation for continuing the suggested behaviours and the system should make these improvements more obvious, e.g. by providing more personalised feedback rather than virtual rewards or praise.

In Case 2 it was identified that the application could provide more guidance, but it was difficult to include this in any of the four categories of the PSD model. The ability to adapt was also considered to be important for the persuasiveness of the system, but it was difficult to find a corresponding principle from the PSD model.

## 5. Discussion and conclusions

The aim of this study was to investigate how the Persuasive Systems Design (PSD) model can be utilised to support the development of personal health and well-being systems. The related research showed that the PSD model has been used in the development of BCSSs to describe the overall process, analyse the persuasion context and design system qualities. It has also been applied in the evaluation of existing systems by providing heuristics for expert evaluations and systematic ways to analyse user experience data. The more specific objective of this study was to discover how the PSD model can be utilised to support the identification of persuasive aspects in the early stages of iterative, user-centred IS development. The PSD model was integrated into the development process by using it in the requirements analysis and concept design phases through organising a co-creation session where a Persuasive Technology Design Canvas was used.

It was found that where the PSD model was utilized, participants of the co-creation sessions were able to identify more persuasive functionalities compared to their existing preliminary user requirements or designs. This is a positive result, since the PSD model suggests that a systematically designed persuasive system has software requirements that apply persuasion principles. It should be pointed out, however, that the large number of persuasive functionalities does not necessarily guarantee an effective system nor the users' adherence to the intervention delivered through the system, but the way in which they are implemented also matters. Overall, recent studies show evidence of the effectiveness of the principles.

The most important result of the co-creation sessions was, however, the increased awareness of the features needed to accomplish a personal health and wellbeing system that changes users' behaviour. The earlier the different requirements are identified and communicated to the development team the easier and cheaper it is to integrate them into the final system.

The PSD model provides support for designing and evaluating BCSSs, but some future directions of development of the model can be recognised. The PSD model suggests that it is important to understand the meaning of intentionality in the persuasion process. However, the researchers' observations showed that the intention part of the Persuasive Technology Design Canvas was not self-explanatory for the workshop participants. In the information systems field, the intention or motivation behind the technology is often difficult to identify and thus there is a need to understand intentionality in a more thorough way. This issue has been tackled in further studies of e.g. Oinas-Kukkonen (2012) and Wiafe et al. (2012). In both cases, some principles were considered to overlap by the participants of the co-creation session, and it made them somewhat confused. Thus, clarifications to the principle descriptions and examples would be needed. In general, it can be mentioned that the PSD model comprises many components and it might seem to be a complicated model when compared to some other approaches. The PSD model has also received some criticism for being too high a level model, because it does not provide a sufficient guide to the designer on how to perform the activities mentioned in the model (Wiafe et al. 2012). To summarize, there is a need to simplify the process, but more guidance should be provided for the designer.

Although the PSD model proposes how persuasive systems should be developed in a very holistic manner, its disadvantage is that it does not explicitly give advice on how to include 1) a framework or theory into the development of the content delivered via the system, or 2) customers or users in the development process. In practice, especially when BCSSs are developed in a health context, it is recommended that the content is based on a theory (e.g. in case 2 ACT was used). Regarding user involvement, one of the new design practices analysing the persuasion context states that it is important to understand the user. However, actual user participation is not explicitly suggested although its importance has been acknowledged (e.g. ISO, 2010). In future work, the content creation and users' role in the design should be described at a more detailed level.

This study has some limitations. Although the research approach was a multiple-case study and thus, the study was once replicated, it is not guaranteed that the use of the PSD model would lead to a larger set of persuasive functionalities in every case. The scope of the project and the characteristics of the workshop participants might influence on the results as well as the starting point where the process outcome is compared.

This study contributes to the IS field by demonstrating how persuasiveness can be built into systems. It also specified the purpose of the PSD model; it clearly helps to identify new requirements for persuasive systems.

## Acknowledgments

We want to thank our colleagues who took part in the co-creation sessions, people who kindly provided their comments to the manuscript, the Finnish Funding Agency for Technology and Innovation and AAL JP for financially supporting this research.

## References

Ahtinen, A., Välkkynen, P., Mattila, E., Kaipainen, K., Ermes, M., Sairanen, E., Myllymäki, T. and Lappalainen, R. (2012) 'Oiva: A mobile phone intervention for psychological flexibility and wellbeing', Proceedings of NordiCHI 2012 Workshop on Designing for Wellness and Behavior Change, Copenhagen, Denmark, October 2012.

Alahäivälä, T., Oinas-Kukkonen, H. and Jokelainen, T. (2013). 'Software Architecture Design for Health BCSS: Case Onnikka', Proceedings of the 8th International Conference on Persuasive Technology, pp. 3–14.

Ajzen, I. (1991) 'The theory of planned behaviour', Organizational Behavior and Human Decision Processes, vol. 50, no. 2, pp. 179–211.

Bandura, A. (1977) 'Self-efficacy: toward a unifying theory of behavioral change', Psychological Review, vol. 84, pp. 191–215.

Barak, A., Klein, B. and Proudfoot J.G. (2009) 'Defining internet-supported therapeutic interventions', Annals of Behavioral Medicine, vol. 38, no.1, pp. 4–17.

Basic, J., Yadamsuren, B., Saparova, D. and Ma, Y. (2013) 'Persuasive Features in a Web-Based System for Weight-Loss Team Competition', in C. Stephanidis (ed.) HCI International 2013 - Posters' Extended Abstracts CCIS, vol. 374, pp. 125–129).

Cavallo, D. N., Tate, D. F., Ries, A. V., Brown, J. D., DeVellis, R. F. and Ammerman, A. S. (2012) 'A social media–based physical activity intervention: a randomized controlled trial', American journal of preventive medicine, vol. 43, no. 5, pp. 527-532.

Chang, T. R., Kaasinen, E. and Kaipainen, K. (2013) 'Persuasive Design in Mobile Applications for Mental Well-Being: Multidisciplinary Expert Review', Wireless Mobile Communication and Healthcare, Social Informatics and Telecommunications Engineering, LNCS, vol. 61, pp. 154-162.

Cohn, M. (2004) User Stories Applied for Agile Software Development. Addison-Wesley, Boston.

Conn, V. S., Hafdahl, A. R. and Mehr, D. R. (2011) 'Interventions to increase physical activity among healthy adults: meta-analysis of outcomes', American journal of public health, vol. 101, no. 4, pp. 751-758.

Derrick, D. C., Jenkins, J. L. and Nunamaker Jr., J. F. (2011) 'Design principles for special purpose, embodied, conversational intelligence with environmental sensors (SPECIES) agents', AIS Transactions on HumanComputer Interaction, vol. 3, no. 2, pp. 62–81.

Dohnke, B., Weiss-Gerlach, E. and Spies, C. D. (2011) 'Social influences on the motivation to quit smoking: Main and moderating effects of social norms', Addictive Behaviors, vol. 36, no. 4, pp. 286-293.

Ferrier, S., Blanchard, C. M., Vallis, M. and Giacomantonio, N. (2011) 'Behavioural interventions to increase the physical activity of cardiac patients: a review', European Journal of Cardiovascular Prevention & Rehabilitation, vol. 18, no. 1, pp. 15-32.

Fishbein, M. and Ajzen, I. (1975) Belief, attitude, intention, and behavior: an introduction to theory and research. Reading: Addison-Wesley.

Fogg, B.J. (1998) 'Persuasive Computers: Perspectives and Research Directions', Proceedings of CHI '98, Los Angeles, April 1998, pp. 225-232.

Fogg, B.J. (2003) Persuasive Technology: Using Computers to Change what we Think and do, San Francisco: Morgan Kaufmann Publishers.

Fogg, B.J. (2009) 'A Behavior Model for Persuasive Design', Proceedings of Persuasive ´09, Claremont, April 2009, Article no. 40.

Glynn, L. G., Murphy, A. W., Smith, S. M., Schroeder K. and Fahey, T. (2010) 'Interventions used to improve control of blood pressure in patients with hypertension', Cochrane Database of Systematic Reviews 2010, no. 3., article.: CD005182. DOI:10.1002/14651858.CD005182.pub4.

Hayes, T. L., Hagler, S., Austin, D., Kaye, J. and Pavel, M. (2009) 'Unobtrusive assessment of walking speed in the home using inexpensive PIR sensors', Proceedings of the International Conference of IEEE Engineering in Medicine and Biology Society, Minneapolis, September 2009, pp. 7248–7251.

Immonen, M., Eklund, P. Similä, H. and Petäkoski-Hult, T. (2012) 'Ageing in balance – Working towards less falls among older adults', presentation and video at AAL Forum, Eindhoven, September 2012.

ISO 9421-210:2010 Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems.

Kelders, S. M., Kok, R .N., Ossebaard, H. C. and Van Gemert-Pijnen, J. E. (2012) 'Persuasive system design does matter: a systematic review of adherence to web-based interventions', Journal of medical Internet research, vol. 14, no.6, article e152.

Kreuter, M. W. and Wray, R. J. (2003) 'Tailored and targeted health communication: strategies for enhancing information relevance', American Journal of Health Behavior, vol. 27, supplement 3, pp. S227-S232.

Langrial, S., Oinas-Kukkonen, H. and Wang, S. (2012) 'Design of a Web-based Information System for Sleep Deprivation - A Trial Study', Communications in Computer and Information Science, vol. 313, pp. 41-51, DOI: 10.1007/978-3-642-32850-3_4.

Lehto, T. and Oinas-Kukkonen, H. (2011)' Persuasive Features in Web-Based Alcohol and Smoking Interventions: A Systematic Review of the Literature', Journal of Medical Internet Research, vol. 13, no. 3, article e46.

Lehto, T. and Oinas-Kukkonen, H. (2013) 'Explaining and Predicting Perceived Effectiveness and Use Continuance Intenton of a Behaviour Change Support System for Weight Loss', Behaviour & Information Technology, DOI:10.1080/0144929X.2013.866162.

Li, I., Dey, A. and Forlizzi, J. (2010) 'A Stage-Based Model of Personal Informatics Systems', Proceedings of CHI 2010, Atlanta, April 2010, pp. 557-566.

Lockton, D., Harrison, D. and Stanton, N. (2010) 'The Design with Intent Method: A design tool for influencing user behaviour', Applied Ergonomics, vol. 41, no. 3, pp. 382–392.

Murray, E. (2012) 'Web-Based Interventions for Behavior Change and Self-Management: Potential, Pitfalls, and Progress', MEDICINE 2.0, vol. 1, no. 2, article e3.

Myneni, S., Iyengar, S., Cobb, N. K. and Cohen, T. (2013) 'Identifying persuasive qualities of decentralized peer-to-peer online social networks in public health', Persuasive Technology, LNCS, vol. 7822, pp. 155-160.

Nawyn, J., Intille, S. and Larson, K. (2006) 'Embedding Behavior Modification Strategies into a Consumer Electronic Device: A Case Study', UbiComp 2006: Ubiquitous Computing, LNCS, vol. 4206, pp. 297-314.

Nind, T. (2012) Can increasing surface credibility improve e-health intervention effectiveness?, dissertation, Dundee: University of Dundee.

Noar, S. M., Benac, C. N. and Harris, M. S. (2007) 'Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions', Psychological bulletin, vol. 133, no. 4, pp. 673-693.

Oinas-Kukkonen, H. and Harjumaa, M. (2009) 'Persuasive Systems Design: Key Issues, Process Model, and System Features', Communications of the Association for Information Systems, vol. 24, no. 1, pp. 485–500.

Oinas-Kukkonen, H. (2012) 'A Foundation for the Study of Behavior Change Support Systems', Personal and Ubiquitous Computing, vol. 17, no. 6, pp. 1223-1235.

Petty, R.E. and Cacioppo, J.T. (1986) Communication and persuasion: central and peripheral routes to attitude change, New York: Springer.

Purpura, S., Schwanda, V., Williams, K., Stubler, W. and Sengers, P. (2011) 'Fit4Life : The Design of a Persuasive Technology Promoting Healthy Behavior and Ideal Weight', Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 423–432.

Pressman, R.S. (2000) Software Engineering: a practitioner's perspective, New York: McGraw-Hill Publishing Company.

Pribik, I. and Felfernig, A. (2012) 'Towards Persuasive Technology for Software Development Environments: An Empirical Study', Proceedings of the 7th International Conference on Persuasive Technology: Design for Health and Safety, pp. 227–238.

Prochaska, J.O. and Velicer, W.F. (1997) 'The transtheoretical model of health behavior change', American Journal of Health Promotion, vol. 12, no. 1, pp. 38-48.

Ryan, R. M., Patrick, H., Deci, E. L. and Williams, G. C. (2008) 'Facilitating health behaviour change and its maintenance: Interventions based on self-determination theory', The European Health Psychologist, vol. 10, no. 1, pp. 2-5.

Segerståhl, K., Kotro, T. and Väänänen-Vainio-Mattila, K. (2010) 'Pitfalls in Persuasion: How Do Users Experience Persuasive Techniques in a Web Service?', in T. Ploug, P. Hasle, and H. Oinas-Kukkonen (eds.) Persuasive Technology, LNCS, vol. 6137, pp. 211-222.

St John, A., Davis, W. A., Price, C. P. and Davis, T. M. (2010) 'The value of self-monitoring of blood glucose: a review of recent evidence', Journal of Diabetes and its Complications, vol. 24, no.2, pp. 129-141.

Stibe, A. and Oinas-Kukkonen, H. (2012) 'Comparative Analysis of Recognition and Competition as Features of Social Influence Using Twitter', Persuasive Technology, Design for Health and Safety, LNCS, vol. 7284, pp. 274-279.

Stickdorn, M. and Schneider, J. (2011) This is Service Design Thinking. Amsterdam: BIS Publishers.

Strecher, V. and Rosenstock, I. (1997) 'The health belief model', in Baum, A., Newman, S., Weinman, J., West, R. and McManus, C (eds.) Cambridge Handbook of Psychology, Health, and Medicine, Cambridge: Cambridge University Press.

Van Gemert-Pijnen, J.E.W.C., Nijland, N., Van Limburg, M., Ossebaard, H.C., Kelders, S.M., Eysenbach, G. and Seydel, E.R. (2011) 'A holistic framework to improve the uptake and impact of eHealth technologies', Journal of Medical Internet Research, vol. 13, no. 4, article e111.

Yin, R.K. (2009) Case Study Research – Design and Methods, 4th edition. London: Sage.

Young, M. M. (2010) 'Twitter Me : Using Micro-blogging to Motivate Teenagers to Exercise', in Winter, R., Zhao, J. L. and Aier, S. (eds.) Global Perspectives on Design Science Research, LNCS, vol. 6105, pp. 439–448.

Zhang, X., Cowling, D. W. and Tang, H. (2010) 'The impact of social norm change strategies on smokers' quitting behaviours', Tobacco Control, vol. 19, supplement 1, pp. i51-i55.

PUBLICATION V

# Understanding Persuasive System Functionality in Practice: a Field Trial of Polar FT60

In: Proceedings of the Fourth International Conference on Persuasive Technology. April 26–29, Claremont, CA, USA. 9 p.

# Understanding Persuasive Software Functionality in Practice: A Field Trial of Polar FT60

Marja Harjumaa
University of Oulu
P.O. Box 3000
FIN-90014 Oulu, Finland
+358 (0)8 553 1985
marja.harjumaa@oulu.fi

Katarina Segerståhl
University of Oulu
P.O. Box 3000
FIN-90014 Oulu, Finland
+358 (0)8 553 1900
katarina.segerstahl@oulu.fi

Harri Oinas-Kukkonen
University of Oulu
P.O. Box 3000
FIN-90014 Oulu, Finland
+358 (0)8 553 1900
harri.oinas-kukkonen@oulu.fi

## ABSTRACT
Many software applications today aim at changing the behaviors and/or attitudes of their users. Some of these persuasive systems are targeted to support healthier lifestyles through motivating exercise. Incorporating persuasive strategies into software functionality may help achieve desired changes. However, as needs for behavior change become more specialized, in-depth knowledge of how the various strategies function is needed. This article describes findings from a three-month-long qualitative field trial, exploring how a training program in a new prototype heart rate monitor promotes proper exercising. A framework for evaluating and designing persuasive systems was used to identify distinct strategies and techniques that were embedded into the system. Users' responses to these strategies were explored. The study contributes to the body of knowledge on persuasive design by: 1) demonstrating how persuasive techniques can be identified in and embedded into system functionality, and 2) adding to the understanding of how persuasive techniques function.

## Categories and Subject Descriptors
H.1.2 [**Models and Principles**]: User/Machine Systems – *Human factors, Software psychology.*

## General Terms
Measurement, Performance, Design, Experimentation, Human Factors.

## Keywords
Persuasive design, persuasion techniques, case study, qualitative research, sports technology

## 1. INTRODUCTION
The need for technologies that influence people's attitudes and behaviors has been widely recognized [5,9]. One important application domain for persuasive systems is health and wellness.


*Persuasive'09*, April 26-29, Claremont, California, USA.


Regular exercise has been recognized as essential to maintaining good health [8]. The problems today lie not only in motivating people to exercise, but in motivating them to exercise in a proper way. The practical challenge is that even if people, in theory, know how to exercise properly, they all too often do it in a wrong way, i.e., by training too hard or by failing to include lower-intensity exercises in their regimen. These kinds of behaviors may increase the risk of injury, set back the improvement of physical fitness and motivation due to exhaustion, boredom or lack of progress. It should be noted that this study does not address the definition of 'proper' exercise but rather presents it as an important example of how the needs for persuasive interventions are becoming more and more specialized. [8,10]

A range of persuasive applications supporting healthier lifestyles have been developed over the past years. Examples include pedometers, web-based training diaries, and mobile applications as well as web-applications leveraging social influence (see, e.g., [12,14,15,19]). Despite the recognition of a variety of persuasive techniques in human-computer interaction, relatively little is known about how they function in real-world settings and the distinct ways in which they influence users. Thus, we have chosen to approach this issue in an exploratory manner as to gain in-depth knowledge for addressing some of the open questions regarding persuasive applications – questions such as: How do users react to different persuasive techniques? Why distinct techniques work in some cases better than in others? Which techniques are generally more powerful than others and why? This study focuses on *how different persuasive strategies function* with different people and in relation to each other in the context of exercising.

The next section discusses the motivation and background for the study. After this, we will describe the theoretical background, research approach and methods. Then, we will describe the functionality of the application under examination. The final sections will present the findings and discuss the research implications of the study.

## 2. MOTIVATION AND BACKGROUND
The scope of this study is in the domain of persuasive design. Persuasion is a social influence mechanism or a form of interaction that aims at changing the way people think or behave [23]. Persuasive systems may be defined as "computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or

deception" [17]. Studies on behavior change through human-computer interaction generally employ quantitative or experimental research designs, producing knowledge about the effects of different persuasive techniques (see, e.g., [5]). However, according to a recent meta-analysis of randomized controlled trials of computer-delivered interventions for health promotion [22], physical activity was not substantially improved by such interventions. One reason for this may be that despite the recognition of a variety of persuasive techniques in HCI, relatively little is known about the mechanisms by which they function in real-world settings. That is, what are the conditions that effect the efficiency of persuasive techniques and how do they actually function in practice.

There are a few qualitative studies that have discussed persuasive functionalities in practice. For example, Consolvo et al. [3] conducted a three-week field trial of a mobile prototype, the *UbiFit Garden*. They studied how users reacted to on-body sensing, activity inference, and a mobile display that were used in persuasive interventions. Maitland et al. [14] reported a one-week field trial of the *Shakra* prototype that supported sharing activity information and its influence on three groups of users. Both of the examples above focused on the outcome of persuasive interventions, whereas it is also important to understand how well the outcomes are achieved through different techniques used.

In spring 2008, we were given the opportunity to explore a prototype of a heart rate monitor, the Polar FT60, that includes a *persuasive training program*. This particular application proposed an interesting case as it employed a number of distinct persuasive techniques in promoting a proper way of exercise. What distinguishes our contribution from previous research is the use of a systematic framework, the Persuasive Systems Design (PSD) model [17,18] for identifying the distinct persuasive techniques and analyzing how they function together. The three-month-long trial conducted in this study also exceeds many others in its length.

## 3. THE POLAR FT60 PROTOTYPE

This study focuses on the persuasive training program incorporated into the prototype of the new Polar FT60 heart rate monitor prototype. In this section we will describe the functionality of the training program.

For the weekly training program the user can select whether s/he wants to improve fitness, maximize fitness or lose weight. After the user has set his/her long-term goal, the wrist unit sets him/her weekly goals that are tailored with respect to the user's personal information such as age, gender, height, weight, and activity level. The weekly goal includes time target, calorie target, and time targets for each of several different exercising intensities (see Figure 1, display 1). Exercise intensities defined by heart rate zones fall into three levels: low, moderate and high intensity. By mapping heart rate information to intensity zones, the system aims to help the user understand the quality of his/her workouts.

Each of the intensity zones has their benefits. As an example, training in the light intensity zone helps in weight management and improves endurance, whereas training in the hard intensity zone increases maximum performance capacity. The program is structured so as to promote an appropriate relative amount of exercise on each of the target zones on a weekly basis. This is believed to promote a proper way of exercise [8].


**Figure 1: Intensity targets and exercise summary**

During the exercise, the user can monitor a variety of data such as heart rate, calories, intensity zone, week target, speed, distance, and time of the day. After training, the program gives him/her summary feedback which includes, e.g., the time spent in different intensity zones in relation to the weekly target (see Figure 1, display 2), calories, average/maximum heart rate, average/ maximum speed, distance, and verbal feedback on the effect of the exercise such as "fat burn and fitness improving" or "maximal perform improving" (see Figure 1, display 3).

The weekly follow-up functionality presents displays comparing achievements with weekly targets in terms of training duration, expended calories, number of training sessions, and time spent in different intensity zones. It also provides training guidance for the next starting week, such as "train much less in zone 3" or "recovery week".


**Figure 2: Weekly system feedback and reward**

Every week an envelope appears on the wrist unit display, indicating the availability of weekly results and system feedback (see Figure 2, display 1). The training program tells how well the user has achieved his/her weekly targets. It also helps in interpretation of the results by giving verbal feedback such as "excellent!", and "well done!" (see Figure 2, display 2). If the match between user's behavior and the weekly targets is high enough, the training program rewards the user with stars or a trophy. These awards appear as an icon on the display (see Figure 2, display 3).

## 4. ANALYZING SYSTEM FEATURES WITH THE PSD FRAMEWORK

A relatively well-known conceptualization for the persuasiveness of information technology is Fogg's [5] functional triad. It suggests three persuasive roles for computer technology (tool, media and social actor), as well as several persuasion principles. However, it has been built to understand the different ways to

persuade through technology rather than as a theory for designing and/or evaluating persuasive systems [4].

Oinas-Kukkonen and Harjumaa [17,18] have presented a conceptual framework for designing and evaluating persuasive systems, known as the Persuasive Systems Design (PSD) model. It presents seven underlying postulates behind persuasive systems, and lists and categorizes persuasion techniques. The framework will be applied in this study in identifying the persuasive techniques that were incorporated into the training program. It will also be used to guide the analysis' of use and user contexts.

The PSD model encourages to analyze *the use and user contexts* of the application. Analyzing the use context focuses on what information is relevant for a user in a given situation, whereas the analysis of the user context stresses that also the larger contexts in a user's life may be considered (e.g. pre-existing attitudes, persistence of change, cultural factors, or social anchors). Moreover, the framework helps to identify those persuasive techniques that have been incorporated into the system under investigation. The Persuasive Systems Design framework [17,18] presents 28 persuasion techniques or principles which are grouped under four categories. Principles in the *primary task support* category focus on carrying out the primary task. The principles in the *dialogue support* category support the interaction between the user and the system in such a manner that it helps users keep moving towards their goal or target behavior. The principles in the category of *system credibility support* describe how to design a system that is more credible and thus more persuasive, and the principles in the *social support* category describe how to design the system so that it motivates users by leveraging social influence.

By using the PSD framework [17,18], we were able to identify the behavior modification strategies that were embedded into the functionality of the training program. The framework was used to guide our analysis and structure the findings. Three principles related to supporting the *primary task,* four principles related to supporting system-user *dialogue*, and three principles related to supporting the system *credibility* were recognized. We were not able to study techniques related to the category of *social support* because the system did not support communication between users through designated functionality at the time of the study.

## 4.1 Primary Task Support

The primary task is the user's real-world task or activity (target of behavior change) that the system under investigation is initially designed to support. In this case, the training program supports the user's primary task of proper exercising in several ways.

First, it applies the principle of *reduction* to lessen the effort that users need to invest in planning and carrying out the right kinds of exercises. The program provides easily executed weekly goals based on expert knowledge in physiology and sports medicine. This makes it easier for the user to carry out his/her exercising regimen and improves the cost-benefit ratio of the target behavior. Second, the personal training program is *tailored* with respect to the user's personal information such as age, gender, weight and heart rate information as well as the long-term goal that the user has set for the training program. Tailoring makes the program more appropriate and personalized for an individual user and thus more persuading. Finally, the system supports *self-monitoring* in that during the exercise the user can monitor his/her own exercise information and change current behavior according to it. After the exercise the program gives feedback which helps the user to change his/her plans for the following exercises that week. The weekly follow-up helps the user to evaluate his/her progress compared to past weeks and to plan future weeks.

## 4.2 Dialogue support

The training program also incorporates features which support the dialogue between the user and the system. The program *praises* in several ways, for example by giving positive verbal feedback after each exercise such as "Maximal performance improving," or through weekly feedback, e.g. "Excellent!", "Well done!" The program also *rewards* the users if they have reached their goals in an excellent manner. Rewards are in the form of one to three stars or a trophy that appear on the user's wrist unit display. An envelope on the wrist unit's display *reminds* to re-check the results of a past week's exercises, which helps the user follow his/her progress on a regular basis. The training program adopts the *social role* of a "personal trainer" by giving verbal, personalized feedback and guidance based on users' actions. By doing so, it attempts to imitate human communication. Thus, the user may regard the monitor as a social entity and therefore regard its advice as more persuasive.

## 4.3 Credibility Support

In addition to functional reliability, factors that contribute to the credibility of the training program are either emergent in the manufacturer's brand or embedded into the industrial design of the product. The "Polar" brand in this case is assumed to communicate *trustworthiness* and *expertise* through a history of high-quality products, and a position as a market leader as well as through grounding its product solutions in scientific research. The research is conducted in Finland, where the Polar brand is generally well-known. It is further assumed that users know that the information offered by the training program is based on expert knowledge in physiology and sports medicine. Therefore we suppose that the user will regard the information as showing *expertise*. The industrial design of the product may leverage *surface credibility* by establishing a distinct style. Surface credibility, as opposed to earned credibility, is related to the way the system appears or looks. Its impact is believed to be helpful in the early interactions with the system, when earned credibility has not yet been established. For example, if people simply like the way the product looks, they may associate its appearance with quality and credibility even if they have not used it yet.

The propositions above relate to the key functionalities of the training program. In theory, incorporating such functionalities into the design of an artifact should increase its persuasiveness. In this study we identified several factors that played a role in determining the effectiveness of these persuasive functionalities.

# 5. METHODOLOGY AND PARTICIPANTS

This research is exploratory and interpretative in nature as our aim is to understand how different persuasive techniques function together in real world settings. We employed a qualitative, longitudinal multiple-case study approach where the unit of analysis was an individual user. We studied a total of 12 users, and by taking all the cases together, we were able to establish a deeper understanding of the phenomenon of interest. We studied

the users over a period of three months. The methods used for data collection and analysis included group interviews, participant diaries and observation, as well as qualitative data analysis techniques, such as interpretative content analysis. [1,11]

In order to focus our data collection and the interpretive process, we used the PSD model [17,18]. The main purpose of the framework was to help in identifying the key issues for investigation and set the focus of the data collection. A formal recruitment procedure was carried out to select the participants. Volunteers could apply by submitting an application form that was used for screening participants. We received a total of 30 applications, based on which we selected 12 applicants to participate in the study. In the selection process, we applied the strategy of purposeful intensity sampling [20]. Using criteria provided in prior market studies as guidance, we formed a sample exemplifying the product's target users. The sample expressed diversity in terms of age, gender, professional background and training preferences. For example, if there were three applicants of the same age and gender, we selected the one that contributed additional diversity to the whole sample in terms of his/her professional background, motivation or training preferences. Applicants that expressed a risk regarding either the interpretation process (e.g. applicant being familiar to the researcher) or the ability to commit to the study (e.g. inability to fill out the application with care) were excluded in order to manage the risk of drop-outs or biased interpretations.

Data were drawn from four sets of questionnaires (total 48 questionnaires), four semi-structured group-interviews, 12 contextual inquiries and three sets of diaries (total 36). Group sessions were carried out monthly, i.e., one at the beginning, two during the study and one at the end. At the beginning of each group session the participants filled out questionnaires that were used for collecting phase-related data as well as data that would illustrate changes in user perceptions regarding their exercising and the system at various points of the study. Each group session was followed by a three-week-long self-documentation period when the participants used the technology in their daily lives and filled in diaries on a daily basis. The diary booklets contained both structured and open-ended questions. A set of questions on the left-hand pages were asked each day in order to capture data on how the participants carried out their exercise regimen and related daily experiences. The right-hand pages were reserved for open-ended questions that tackled users' attitudes and experiences. Some questions would be presented on specific days and some would be repeated periodically. For example on Mondays, when the heart rate monitor displayed the weekly summary report to the user, a question about the feelings and thoughts it evoked would be asked in the diaries. During the study each participant was also individually observed and interviewed using the technology in real-world settings. These sessions were approximately 1,5 hours each and they were conducted applying the principles of contextual inquiry [2]. The inquiries were carried out either at a gym when the participant was performing a workout or by participating his/her light run or jog

All interviews were recorded and professionally transcribed. Through the diaries we would also become aware of injuries, flues and special events that in some cases influenced users' regimen and their reactions to the product. The iterative interpretative analysis process was carried out by two researchers and supported by observations and notes from the contextual inquiries. Group interviews and contextual inquiries functioned as valuable data sources for understanding users' broader life contexts.

All participants were already active in sports. Participants' primary goals for exercising were to maintain and improve their fitness. For example weight loss was not reported or observed to be a significant issue among more than two of the participants. The main reasons for using a heart rate monitor were to sustain a regular exercising regimen, train more efficiently, curiosity, having a tool for self-monitoring and to find extra motivation. All participants were thus exemplary of the pre-defined target group of the product. This was further confirmed during the first group interview when the majority of them stated that they were about to purchase a similar product at the time when they found out about the study. Only four of the participants had no prior experience of heart rate monitoring technologies. Seven of the participants were female and five were male. The participants were between ages 23 and 40. All participants reported training approximately three to five times a week with a history of regular exercising. The users' most common exercising activities included jogging, cycling, and indoor exercise such as gym workouts or group exercise classes. Other activities included inline skating, dancing, and floor ball. Basic skills regarding everyday IT (e.g. PC/laptop, mobile phone, digital camera) were well established.

# 6. FINDINGS

We will now present our findings by following the structure of the framework. First, we will provide an account of the use and user contexts after which we will describe users' reactions to the different persuasion techniques.

## 6.1 Analysis of the Use Context

In this study, the user is both the *persuader* and the *persuadee*, because heart rate monitors would be considered as autogenous technology that people use in order to change their own attitudes or behaviors [5]. The wrist unit's, i.e. the *channel's*, training program presents a persuasive *message* – the user should change the way s/he performs exercises. The use *context* is challenging for persuasion, because during the exercise there may be external distractions, rapid display of information and messages, limited time for information processing, physiological arousal from exercising, persuadees' physical posture (for example during body workouts), among others, which all decrease substantive message processing [21]. This may have a negative effect on the endurance of the behavior change, because careless message processing would more likely create an indirect route to persuasion, which is less enduring than the direct route [17]. A direct route to persuasion usually requires that the user has time to carefully read and understand the message, which is unlikely in exercising situations. However, it was found that the exercise information was presented simply enough so that users could easily see their intensity zones, for instance, and they could slow down or speed up respectively. It was also discovered that the training program actually provided users with most of its feedback when they had time to read and reflect on it. The use context analysis suggests that the prevailing conditions during system use are favorable for behavior change.

## 6.2 Analysis of the User Context

The users were motivated to exercise and their reasons for exercising were often intrinsic. The group meetings revealed that three primary reasons for exercising were on average: 1) feeling of enjoyment, 2) staying healthy or improving health, and 3) staying fit or improving fitness. The aim for using the system was not to keep the weight under control, to lose weight, or to improve one's look. Neither have there been any significant changes in these during the course of the study. According to the users' own opinions, they knew how they should exercise. However, they admitted that they didn't always exercise according to their best knowledge. When users' lifestyles and their impact on exercise behavior was studied, it was found that although they may have known how they should exercise, they had to make compromises and conduct cost-benefit analysis due to their current life situations. For example, work, family, and hobbies quite understandably limit the time they have for exercising. This is one of the conditions that drove towards unhealthy choices in exercising. People are also tempted to carry out high-intensity exercises over lighter ones. A reason for this may be that as a result of a high-intensity exercise (even a short one) users may experience an instant gratifying sensation, for instance, shortness of breath, or sweating that they interpret as signs of effectiveness. The problem with lighter exercises, such as flexibility exercises, is that their benefits will show only after a longer period of time. These findings were derived mainly from user observations but they were also reinforced through the diaries and the surveys.

## 6.3 Reactions to Persuasion Techniques

In the beginning of the study, the users went through a short "running-in" phase when the following of a new kind of guidance obtained from the training program was regarded as challenging. As one of the users stated at the early phase of the study:

U12: "It [the heart rate monitor] tries to give you advice, but when you're a tough nut to crack you just don't get it. It is really good though that at least someone tries to give advice."

Some users also felt that it was difficult to train on lighter intensities as they had been used to training more intensely. However, after participants had been using the training program for two weeks, eight out of 12 carried out the suggested amounts of exercises and followed the three intensity zones. They changed their actual behavior during the exercises and also started to plan their exercises in a new way. The behavior changes are described in detail in following paragraphs and they are categorized by the ten identified persuasion techniques. Over the course of the study it was found that all users responded positively to eight out of the ten techniques. These techniques are, in the order of their relative strength, the following: *self-monitoring, reduction, reminders, trustworthiness, tailoring, social role, expertise, and surface credibility*. The impact from applying these principles was fairly consistent, whereas responses towards *praise* and *rewards* varied by user. In some cases praise and rewards outperformed some other techniques but their impact was not consistent across all of the cases. We will first describe users' reactions to the first eight techniques and then we will tackle the different ways in which users responded to praise and rewards.

*Self-monitoring:* The training program helped users to track their performance during and after exercising as well as tracking it on a weekly basis. It was motivating for the users to monitor their exercise information, because based on that information they were able to change their behavior during the exercise and thus improve the quality of their exercise.

U10: "I follow it more closely than before, like also during the exercise, to see that my heart rate doesn't always raise all the way up to the third level and even above…"

They also found the exercise information intrinsically rewarding. The functionalities that applied the principle of self-monitoring appeared to be the most meaningful for people – in fact, the principle of self monitoring was also underlying the praise, reward and reminder functionalities. All of these were in a way means of presenting information that users monitored about themselves. This is one example of the overlapping nature of persuasive techniques. It also emphasizes the interdependence of the principles.

*Reduction:* The training program reduced the cost-benefit ratio of the behavior by giving exact amounts how much users should exercise. Exercise amounts were seen as weekly challenges set by the system and users felt obligated to achieve them. Many of them said that they have to do the missing exercises on the last day of the week only because of the pressure they felt due to the program's suggestion. Users commented:

U1: "On Sunday I still had to go jogging to get that last half an hour! [to meet the weekly targets]"

U2: "Now I watch the heart rates and the amounts [of time in intensity zones] and try to plan my exercising so that the targets of the training program will be met."

*Reminders:* The system provided users with a weekly summary feedback that became available each Sunday at Midnight. This was indicated with an envelope symbol on the top right corner of the heart rate monitor display. All users checked their weekly feedback and suggestions regularly. As they learned that they would get the summary feedback at the same time every week, they begun to get excited and expect for it. Thus, over time the reminder in a way transformed into a reward. The weekly summary feedback was perceived more useful than the system feedback after each exercise. This is probably because there was more variation in users' weekly performance as opposed to among their individual exercises in short term. Users' would also be able to see the direction of their overall development from these weekly system feedbacks.

U5: "The feedback influences my planning, I'm planning on exercising more this week than the last and in a higher intensity. It's easier to plan my training with the feedback and maybe that'll show later in my fitness level too!"

*Trustworthiness:* All participants regarded Polar as a quality company and a trustworthy source of information. When participants were asked whether the information that the product presents is truthful, fair and objective, ten out of the 12

participants agreed, agreed strongly or somewhat agreed. Trustworthiness was also apparent in user comments:

U9: "I have this sense of trust that Polar represents professionalism to me and I think that it's high-class and high-quality. I could utilize a running program given by [Polar]."

The main influencing factor for this result may be that the study was conducted in Finland, where Polar is generally well-known and considered as a high-quality brand. Many of the participants in the study had also used Polar products before, and none of the participants were unaware of the company behind the product. However, this may not be the case in all cultural contexts and thus, the influence of system features and characteristics that support the perception of trustworthiness or a trustworthy brand should be investigated.

*Tailoring:* Users did not respond to tailoring directly, but it was found that tailoring and credibility are closely related. Users were more motivated to follow the training program, because they knew that it had been tailored with respect to their personal data. Because of this, they perceived the system as more credible. Tailoring makes the instructions more relevant for the user and is at the same time a contributing factor to the functionality of techniques in the credibility support category.

*Social role:* Users were asked about the potential social role of the training program. It was perceived in three different ways: 1) as a personal trainer (instructor, coach) that guides and instructs, 2) as a friend (exercise buddy) that spurs to exercise, cheers, and records, or 3) as a caddie (sparring partner). Many users had a conception of the heart rate monitor as a social entity, which became quite clear from the way they spoke about it.

U3: "It's kind of both: in a way it's a teacher that guides and gives advice and in a way it's a companion that encourages me to exercise."

U8: "It's a training buddy that cheeres and encourages me to exercise and at the same time keeps track of my training."

Their positive beliefs about the system, their positive expectations towards the study, and the attractive appearance of the wrist unit for their part may have influenced their thinking. Based on the users' comments, it seemed that women were generally more prone to personification of the device compared to men. Personification was reinforced through the dialogue: the training program sets a challenge, the user exercises, and the program again gives feedback. For example:

U3: "So, it just said 'train less on zone three' and I'm like, okay, I'll try."

*Expertise:* When users were asked whether the product shows expertise, two of 12 agreed somewhat, and eight of 12 agreed, or agreed strongly. Users followed the training program although in the beginning they sometimes questioned the advice given by it. Some of them felt that it gave too little time for higher-intensity exercises and too much time for lighter exercises. However, they also mentioned that the system knows better how they should exercise than they do. It is difficult to determine, whether expertise was promoted by means of actual product functionality or if it was rather leveraged through Polar's marketing efforts.

U8: "I would trust the program [in the heart rate monitor] more, because I know that it's put into the system [by experts]. Experts know and I can make mistakes."

*Surface credibility:* Two versions of the product were utilized in the study, one designed for males and one for females. The female model was perceived as "stylish", and "futuristic" by most, but the male model also raised some negative opinions, e.g., by looking even "cheap" and "old-fashioned". It was found, however, that this did not significantly affect the perceived overall credibility of the product. It merely decreased the product's likeability in some cases. Supporting perceptions of *expertise* and *tailoring* content compensated this. It was found that users' familiarity with the brand and experience using the system (earned credibility) would dominate over appearance in leveraging credibility. Thus, surface credibility in this case was not as critical a factor even at the beginning due to the users' pre-existing conceptions about the brand associated with the system. This, however may not be the case when appearance as an explicit characteristic of the system is the only way of communicating credibility through the early interactions.

*Praise:* Some users found praises and other verbal feedback insignificant for their motivation, while others really liked them. Especially in the beginning of the study several users found the verbal feedback interesting and thought that it was fun to see a heart rate monitor "speak" to them. However, in most cases the effect wore out over time. Some of the users felt that they were mainly intrinsically motivated and they would not consider the verbal system feedback and praise as additionally motivating.

U9: "It doesn' really give me any extra motivation. I already have enough motivation in me, but it's more like a tool for observation and self-monitoring."

U12: "I haven't had any problems in terms of being motivated. I'm pretty much motivated intrinsically, so the feedback doesn't really add anything to it. That's why I'm more interested in the intensity zones, knowing how much I've trained in zone one, two and three, and how much time I've spent on each and when."

After some time, several users found that the comments repeated themselves and were too trivial. In some cases this aroused negative feelings and may even have decreased the perceived credibility of the system. We observed that many users would have liked to receive more constructive feedback over time rather than praise only.

U5: "It could be more critical, whereas now its like, what ever you do it always tells you that something is improving."

Many users were fairly critical about their own performance. When their own opinion was not in line with system feedback it made them wonder whether it was credible. That is, they questioned the system's ability to critically assess their performance even though they would at the same time still trust its measurement and reliability.

*Rewards:* There was variation in users' attitudes towards virtual rewards. In general, the users' intention in exercising was not to gain rewards, and, for this reason, most users did not perceive rewards as essential.

U1: "I don't necessarily train to get a trophy, but as long as the time target is met and how much I train on each target zone."

Although rewards were not essential to persuasion in general terms, they in some cases appeared to be powerful as an addition to other persuasive techniques in the process of directing users towards the desired behaviour.

U4: "Yes I have [tried lower intensity zones].. because it only gave me stars when I was not [training lightly enough]. I don't want the stars, I want the trophy…"

Two users thought getting the rewards was a fun game-like thing. They would also compare their achievements through the rewards at the group meetings. This shows that virtual rewards may act as communication tools for social interactions around training and for comparing otherwise subjective or relative goals and achievements.

Rewards were also a way to give feedback to users. They seemed to be quicker and easier to understand than numerical performance data. The type of reward was an indicator of the quality of the improvement. It included a message, such as: "You'll get only one star, because you shouldn't exceed your personal exercise limits on intensity zone three". In a way, rewards helped to analyze one's own exercising behavior. If rewards were treated as a way of presenting information, they could also be regarded as a form of reduction by making the data interpretation process easier for the users.

## 7. DISCUSSION

Exercise behavior change is a challenging goal for any persuasive system, because the persuasion situation is rather unstable during the exercise and interaction with the product is scattered over the course of the activity and occur at irregular intervals. However, our use context analysis demonstrated that the interaction techniques and information presentation that were used in this heart rate monitor were simple enough to influence user's behavior even during the exercises. The user context analysis showed that exercising in the right way is a common challenge for people who are otherwise active in sports. Two main reasons for exercising in the wrong way were found to be linked with one's life situation, which is more or less natural, and the instant positive sensation that one may get after even a short high-intensity exercise. Planning and carrying out new multitudinous exercises takes more time than repeating the old monotonic exercises, and people have to make compromises.

Some functionalities of the training program were effective in general terms and eventually influenced the behavior of almost all users (10 out of 12). These include: 1) the weekly goals set by the training program, 2) tracking performance during and after exercising as well as tracking it on a weekly basis, 3) the adoption of a social role, such as a caddy, and 4) overall perceived credibility, which was influenced mainly through the manufacturer brand and in some cases the industrial design of the product. However, for some people having the combination of different functionalities was important. As an example, short term verbal system feedback via praise and rewards influenced behavior change for some people but not for all. We also found that rewarding a user for performing the target behavior does not always require a virtual reward, such as a trophy, but instead tracking performance is rewarding in itself and virtual reward merely represents an image of the improvement.

It has been found previously that specific, difficult goals consistently lead to higher performance than simply urging people to do their best [13]. It is much easier for users to catch specific instructions, such as "exercise three hours", instead of non-specific instructions, such as "you should exercise more than before". People also need feedback from the system that reveals progress in relation to their goals in order to adjust their effort to match what the goal requires [13]. The importance of system credibility and trust has been well recognized in earlier studies. For example in online commerce, consumer trust has been found as important for success as perceived usefulness and perceived ease of use [6]. In our study, users perceived the system to be more knowledgeable than they themselves, which had a significant influence on their use behavior. At least to some extent, the mixed results concerning trophies and stars may be explained by the fact that some people find it hard to read technical or overly quantitative messages. For them it may be quicker and easier to see the reward as a sign of their improvement instead of spending time to interpret quantitative data [21]. Also while exercising there may not always be sufficient time for interpreting quantitative or "unprocessed" data. We also found a distinction between credibility and reliability in this study regarding exercise data and system feedback. Even though some users would not always feel that verbal feedback from the system was credible, they would still trust its ability to provide reliable data on their exercising.

For practitioners and designers, our results suggest that leveraging goal setting, tracking performance, adopting social roles, along with a high overall perceived credibility influences user behavior. Short-term verbal system feedback via praise and rewards may provide additional support in persuading some people. It was also emphasized in the results that even if the product is designed for a homogenous target group, small individual differences between users may weigh in persuasion. *It is safer to select a set of persuasion principles and use them together than rely on one principle only.* On the other hand, it should be noted, that the persuasion principles are inter-linked. The effect of persuasion principles may be "more than the sum of its parts". As an example, offering tailored information to a user may have a positive effect on system credibility whereas repeating rather trivial praises may have a negative effect on system credibility.

The studied persuasive principles were *limited* to the design of the particular product that was under investigation. As researchers we did not participate in the design process. With the selected approach we were not able to strictly isolate the influence of the distinct principles from each other. In qualitative research, results are always at least partially subjective in spite of the results being scrutinized under a thorough analysis. The results help recognize further research directions. It would be worth studying how users' pre-existing attitudes effect their "openness to persuasion", i.e., willingness to change their behavior and what this means for

persuasive design. Regarding sports and exercise, some people have deep-seated attitudes that they have learned over a long period of time [10]. Trying to influence these kinds of attitudes may cause resistance to persuasion. Another interesting question would be the meaning of social support for exercise behavior change. Within the sports domain, user motivation through persuasive systems would earn more research. It would also be interesting to study whether positive system feedback would be as important for intrinsically motivated people as it might be for extrinsically motivated people.

## 8. CONCLUSIONS

Practical means to promote behavior change in exercise domain were presented in this paper. The training program under study incorporated ten distinct persuasive techniques and each implementation into system functionality was described. A field trial was conducted in order to understand how these techniques functioned in practice. The findings show that some functionalities of the training program were generally effective and had influence on behavior change of most users whereas some of them had effect only on some people. The most motivating features of the training program were the weekly goals set by the training program, tracking performance during and after exercising as well as tracking it on a weekly basis, and the adoption of a social role of, e.g., a caddy. The overall perceived credibility was mainly influenced through the manufacturer brand communicating expertise and trustworthiness. Short-term verbal system feedback via praise and rewards also appeared to be very powerful in some cases. We want to emphasize that persuasive strategies should be used systematically and in appropriate combinations. Further research should be directed into how various persuasive techniques function in different circumstances, for different user groups and most importantly, in various combinations.

## 9. ACKNOWLEDGMENTS

We wish to thank the RichWeb project, National Technology Agency of Finland (TEKES), Graduate School of Software Systems and Engineering (SoSE), Oulun Yliopiston Tukisäätiö, and Polar Electro Oy for funding parts of this research. We also wish to thank Esa Juusola, Tanja Kalliojärvi, Sirpa Hope, and Petteri Siekkinen for their assistance and support and Svante Kärkkäinen and SATS Oulu fitness centers for co-operation.

## 10. REFERENCES

[1] Benbasat, I., Goldstein, D.K. and Mead, M. 1987. The Case Research Strategy in Studies of Information Systems. MIS Quarterly, 11(3), 369-386.

[2] Beyer, H. and Holzblatt, K. 1998. Contextual Design: Defining Customer-Centered Systems. Morgan Kaufmann Publishers, San Francisco. Academic Press.

[3] Consolvo, S., McDonald, D., Toscos, T., Chen, M., Froelich, J., Harrison, B., Klasnja, P., La Marca, A., LeGrand, L, Libby, R., Smith, I. and Landay, J. 2008. Activity Sensing in the Wild: A Field Trial of UbiFit Garden. Proceedings of the Conference on Human Factors and Computing Systems: CHI '08.

[4] Fogg, B.J. 1998. "Persuasive computers: perspectives and research directions" in Proceedings of the SIGCHI conference on Human factors in computing systems ACM Press/Addison-Wesley Publishing Co, Los Angeles, California, United States, pp. 225-232.

[5] Fogg, B.J. 2003. Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann Publishers.

[6] Gefen, D., Karahanna, E., and Straub, D.W. 2003. Trust and TAM in Online Shopping: An Integrated Model. MIS Quarterly, 27(1) 51-90.

[7] Hartnett, J., Lin, P., Ortiz, L. and Tabas, L. 2006. A responsive and persuasive audio device to stimulate exercise and fitness in children. Ext. abstracts CHI 2006, ACM Press. 1837-1842.

[8] Haskell, W., L., Lee, I., Pate, R., R., Powell, K., E., Blair, S., N., Franklin, B., A., Macera, C., A., Heath, G., W., Thompson, P., D., and Bauman, A. 2007. Physical Activity and Public Health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association, Medical Science Sports Exercise, 39(8) 1423-1434.

[9] Intille, S. 2004 A new research challenge: Persuasive technology to motivate healthy aging. IEEE Transactions on Information Technology in Biomedicine, 8. 235-237.

[10] Kärkkäinen S., representative of the SATS Oulu fitness centers, professional personal trainer and exercise specialist, personal communication (March 19, 2008).

[11] Klein, H.K. & Myers, M.D. A set of principles for conducting and evaluating interpretive field studies in information systems. MIS Quarterly 23, 1, 1999, 67-88.

[12] Lin, J.J., et al. “Fish’n’Steps: Encouraging Physical Activity with an Interactive Computer Game” Proceedings of UbiComp í06, Sep 2006, 261-78.

[13] Locke, E.A. & Latham, G.P. Building a Practically Useful Theory of Goal Setting and Task Motivation. American Psychologist 57, 9, 2002, 705-717.

[14] Maitland, J., et al. “Increasing the Awareness of Daily Activity Levels with Pervasive Computing” Proceedings of Pervasive Health í06, (Nov/Dec 2006).

[15] Nuschke, P., Holmes, T. and Qadah, Y. "My health, my life: a web-based health monitoring application". Ext. abstracts CHI2006, ACM Press, 2006, 1861-1864.

[16] Oinas-Kukkonen, H. and Harjumaa, M. 2008. “Towards Deeper Understanding of Persuasion in Software and Information Systems” in Proceedings of The First International Conference on Advances in Human-Computer Interaction (ACHI 2008), pp. 10-15.

[17] Oinas-Kukkonen, H. and Harjumaa, M. 2008. A Systematic Framework for Designing and Evaluating Persuasive Systems. In: Oinas-Kukkonen et al. (Eds.), Lecture notes in Computer Science 5033, Proc. Persuasive 2008, Springer-Verlag.

[18] Oinas-Kukkonen H. and Harjumaa M. 2009. Persuasive Systems Design Key Issues, Process Model, and System

Features, Communications of the Association for Information Systems (forthcoming).

[19] Oliveira, R.d. & Oliver, N. 2008. TripleBeat: enhancing exercise performance with persuasion, Proc. MobileCHI'08, ACM Press, 255-264.

[20] Patton, M.Q. 1990. Qualitative evaluation and research methods, 2nd edition, Sage Publications, Newbury Park.

[21] Petty, R.E. & Wegener, D.T. 1985. Attitude change: multiple roles for persuasion variables. In Gilbert D., Fiske, S. & Lindzey, G. The Handbook of Social Psychology. 4th edition, vol II, The McGraw-Hill Companies, Inc.

[22] Portnoy, D., Scott-Sheldon, L.A.J., Johnson, B.T. and Carey, M.P. 2008. Computer-delivered interventions for health promotion and behavioral risk reduction: A meta-analysis of 75 randomized controlled trials, 1988-2007. Preventive Medicine 47, Elsevier, 3-16.

[23] Xia, W. & Lee, G. 2000. The influence of persuasion, training, and experience on user perceptions and acceptance of IT innovation. Proc. ICIS 2000. 371-384.

PUBLICATION VI

# Expectations and user experience of a multimodal medicine management system for older users

In: Journal of Assistive Technologies 8(2),
pp. 51–63.

# Expectations and user experience of a multimodal medicine management system for older users

Marja Harjumaa, Igone Idigoras, Minna Isomursu and Ainara Garzo

Marja Harjumaa is a Research Scientist, based at Digital Health, VTT Technical Research Centre of Finland, Oulu, Finland.
Igone Idigoras is the Director, based at Assistive Technologies, Tecnalia, Zamudio, Spain.
Minna Isomursu is a Research Professor, based at Digital Services in Context, VTT Technical Research Centre of Finland, Oulu, Finland.
Ainara Garzo is a Researcher, based at Assistive Technologies, Tecnalia, San Sebastian, Spain.

The authors thank the Finnish Funding Agency for Technology and Innovation (TEKES), Ministerio de Industria, Turismo y Comercio in Spain, AAL JP, and DIGILE Digital Services Programme for financially supporting this research. The authors are also grateful to the home care professionals and the ageing users for their valuable contribution in the study.

**Abstract**

**Purpose** – *The purpose of this paper is to analyse the adoption of a multimodal medication management system (MMS) targeted on older people and home care professionals. The paper aims to describe the expectations of the system and the user experience findings from an empirical qualitative field trial. The field trial results are used to discuss how MMSs should be designed in order to improve adherence to medications.*

**Design/methodology/approach** – *The paper suggests that building a multimodal medicine management system targeted on both older users and home care professionals brings many benefits over electronic medicine dispenser systems or general reminder systems. The research process uses an iterative prototyping approach including phases of requirements analysis and concept design, prototype building and evaluation in a field trial.*

**Findings** – *The study demonstrates how a system that merely satisfied users during the prototype building phase does not necessarily succeed as well as expected in the field trials. It would be important to consider reasons for medication non-adherence and non-technology factors influencing willingness to adopt new assistive devices in order to promote diffusion of new MMSs at home. The paper also discusses how the different persuasive functionalities of the system addressed patient-centred factors influencing non-adherence and how they could be addressed.*

**Research limitations/implications** – *This study has some limitations. The actual adherence to medications was not measured. However, in the future, it will be important to study how the MMSs influence medication adherence. Also, the user experiences of the home care professionals were not studied in the field trials. Home care professionals who were involved in the user studies and trials merely estimated the value for their patients and not for themselves.*

**Originality/value** – *This paper analyses design issues relevant when designing systems to help older people manage their medications.*

**Keywords** *Assistive technologies, AAL, Health behaviour change, Home technology, Medication management, Reminders*

**Paper type** *Research paper*

## 1. Introduction

Over the last century average life expectancy in western countries has increased enormously, while birth rates have declined. For these two main reasons the population is ageing rapidly. This demographic change has both economic and social implications, which force us to re-consider traditional models of delivering care. It is expected that more and more services will be delivered to homes, where people can live independently, supported by their relatives and social- and health-care services. Home care is more cost-effective than institutional care (Tang and Venables, 2000) and it also reflects the wish of many older people (Hammar *et al.*, 2008). Ambient assisted living (AAL) environment aims to provide personalised services and

health care for older people. It integrates various assistive devices with elements of smart homes, and tele-health services (Robert Savage, 2009). However, diffusion of assistive home technologies has proceeded slowly and the majority of the solutions have not been able to achieve notable social or business benefits (Eberhardt *et al.*, 2010).

Difficulties in medication management are one factor to add to care needs in the home environment. Compliance with a drug regimen is a major problem, particularly for those older people who live alone, are confused, have poor vision, impaired manual dexterity or a failing memory (Ryan, 1999). Studies have shown that older people manage their established medication routines quite well, but introducing a new drug into the regimen or changing a schedule can be problematical, because it is demanding cognitively (Beckman *et al.*, 2005). Other reasons for not following instructions are the extent to which drug regimens interfere with daily life, a lack of understanding or misinterpretation of the instructions, complex drug regimens and forgetfulness (Ryan, 1999). Even though regimens for preventing and treating chronic conditions have been repeatedly shown to slow the progression or even reverse the course of a disease and prevent morbidity and mortality, many patients repeatedly fail to adhere to regimens (Vlasnik *et al.*, 2005). Review of medication compliance has shown that the overall rate of compliance with prescribed regimens is $71 \pm 17$ per cent (range, 34-97 per cent), and compliance is the lower the more dose regimens there are. Dose-timing measures assessing whether the doses have been taken within an appropriate time showed that the average overall dose-timing compliance rate has been $59 \pm 24$ per cent (Claxton *et al.*, 2001). It has been estimated that poor adherence to medical therapy may account for as much as $300 billion in unnecessary health care expenses a year (Vlasnik *et al.*, 2005).

Interventions to help older people adhere to medication regimens basically fall into two categories: external cognitive supports involving the mechanics of medication delivery, and educational strategies. They may also combine elements from both (Higgins and Regan, 2004). Compliance to medication and medication management can be technologically assisted by means of electronic medicine dispenser systems or generic reminder systems (Costa and Doughty, 2009). The medicine dispenser systems include a number of compartments for each day of the week, and the person is reminded by the alarm to take their medication at the right time. Some of these include a radio transmitter to enable connection to a remote monitoring centre if the medication has not been removed from the container. Generic reminder systems are used to set, manage and deliver electronic reminders and notifications (McGee-Lennon *et al.*, 2011) and are suitable also for general purposes, such as reminding people about daily tasks, weekly activities and more occasional events (Costa and Doughty, 2009). In addition, the reminder functionality of alarm watches, pagers and alarm clocks can be used as memory support. However, their basic functionality is limited to reminding people and not providing support in the medication management process. Also, they rarely provide support for the care process of a professional carer and other issues relevant in medication management, such as expiry dates, information about side effects and monitoring of medicine taking. This kind of solutions, including support for professional carers, could be adopted more quickly, as their use can also lead to easily calculable financial benefits in the form of more efficient care, and not only to easier medication management on the individual level.

Behaviour change support systems (BCSS) provide content and functionalities which engage users with new behaviours, make them easy to perform and support users in their everyday lives. A BCSS can be defined as "a socio-technical information system with psychological and behavioural outcomes designed to form, alter or reinforce attitudes, behaviours or an act of complying without using coercion or deception" (Oinas-kukkonen, 2010). BCSS are often designed to promote health and wellness. As an example, technology could play a role in convincing, stimulating or motivating users to engage in healthy behaviours (De Kort *et al.*, 2005). BCSSs have been proposed to offer benefits also for ageing users, such as motivating healthy behaviour as people age (Intille, 2004). Persuasive gerontechnology has been introduced by stating that persuasive technologies should not be designed only for younger people, but they could offer great value for the ageing population as well (De Kort *et al.*, 2005). However, persuasive design has not yet aroused much interest in the field of assistive home technologies.

This study describes a new assistive medication management solution for older people and home care professionals. The aim of this study is to develop and validate a multimodal medicine

management system for older users and to explore users' expectations of the system as well as user experiences, and also to understand how its persuasive functionalities address non-adherence. Understanding user experience is important, because although health applications designed without understanding a person's underlying expectations, attitudes and experiences may lead to a usable product, it is one that is not necessarily acceptable or integrated easily into a person's daily living behaviours (McGee-Lennon *et al.*, 2012). The discussion on persuasive functionalities leads to implications for how systems might be designed to better help older people to manage their medications.

## 2. Research setting

### *2.1 The research process and methods*

The development process of the Personal Medicine Assistant (PMA) consisted of the following iterative phases:

- requirements analysis and concept design;
- prototype building; and
- evaluation of prototypes.

In the requirement analysis and concept design phase, user requirements were collected through exploratory work which aimed at constructing scenarios on how Near-Field Communication (NFC) technology and mobile applications could support visually impaired older people in their daily medication processes. NFC makes it possible to write and read data in tags, which can be attached to medication packages. As a result, two alternative scenarios were created: a "talking" medicine package providing medicine information, and a computer-based medication management system (MMS). These two scenarios were based on discussions, workshops and concept evaluations with technology providers, professional caregivers, representatives of associations of the blind, pharmacy professionals and older visually impaired people. The concept development process and the medicine package concept are described in earlier publications (Isomursu *et al.*, 2009; Harjumaa *et al.*, 2011).

In the prototype building phase, the first initial version of the PMA was built, and it was evaluated in co-design sessions regarding its expected ease of adoption, ease of use and performance. The objective of the co-design sessions was to understand users, tasks and the environment in which the system will be used. In both evaluations, semi-structured interviews with open and closed questions were used as a data collection method. The first co-design session was held in August 2010 when five home care professionals participated in the evaluation of the prototype. Their average age was 51 years and their technological experience was limited to using mobile phones. They control the medication taking of independently living older people, and thus their expertise was needed to evaluate how well the system would fit into their existing medication management practices. The second co-design session took place in September 2010, when six older people, whose functional capacity was good and who mainly managed their activities of daily living by themselves, participated in the evaluation of the prototype. Their average age was 70 years and they were highly educated. Their technological experience was quite good since they used mobile phones, digital cameras and computers.

In the evaluation phase, the PMA was evaluated in short field trials. The objective of the field trials was to explore the ease of adoption, ease of use and performance of the system in real-life settings. In both trials, semi-structured interviews with open and closed questions were used as a data collection method, and people's real medication plans were entered into the system. The first field trial was held from October to December 2010, when the system was evaluated in a two-week field trial with four older people who live at a care centre and have assistance available, because the participants did not have much previous experience from technology, although they were familiar with tele-assistance services. Their average age was 80 and they were not highly educated. All of them had problems with their eyesight and they took medicine at least twice a day. Three of them managed their medications independently; only one needed help from his son. Nobody felt that they had problems with medications, such as forgetfulness or drugs confusion.

After these first trials some technical issues were detected and resolved, with the aim of building a much more stable second version of the prototype which was used in the next field trials. The second field trial was held from March to July 2011, when the system was evaluated in trials which lasted three weeks per person. Participants were four older people who lived independently in their own homes except for one who lived with his nephew; they were not as frail as the participants in the first trials, so they did not need assistance in using the system. Their average age was 80 and they were not highly educated. They did not have much earlier experience from technology, but they were familiar with tele-assistance services. Only one used a pill dispenser because they managed their medications with the usual medicine packages. All said that they did not have problems with drug recognition or remembering. In this second phase of the trials the aim was to test the usefulness and ease of use by final users in their homes, with a short training session but no support.

The qualitative data from the evaluations was reported and analysed. Since the system leveraged new and innovative interaction paradigms, users' responses to the multimodal interface and its combination of graphical, touch and audio components were at the focus of the analysis. Also, the user experience findings were analysed from the persuasiveness point of view in order to understand how its persuasive functionalities address non-adherence. Ideas for future development were identified, presenting how persuasive functionalities could be used to tackle different patient-centred factors in non-adherence.

### *2.2 The Personal Medicine Assistant*

The PMA is a multimodal reminder system which reminds its primary end-users to take their medicines, supports them in the medicine taking process, and provides medicine information and personalised feedback. For home care professionals, the PMA provides an opportunity to monitor medicine taking. The persuasive features of the PMA are described as follows (the persuasion principles are in Italics).

*2.2.1 System description*. The system is based on basic off-the-shelf equipment. The main components are an Asus Eee tablet PC T91MT with an 8.9-inch touch screen, a Verbio TTS 8.0 text to speech synthesiser application, an external NFC reader/writer device by Feig Electronics (model ID CPR40.30), and regular medicine packages tagged with NFC labels. Three kinds of tags were used, but they differed only in their external shape. All the tags are Mifare Classic 1K and operate under the ISO 14443-A standard. The selected NFC reader/writer device supports multiple types of tags which use ISO 14443 A & B standard. It is connected to the PC through a USB.

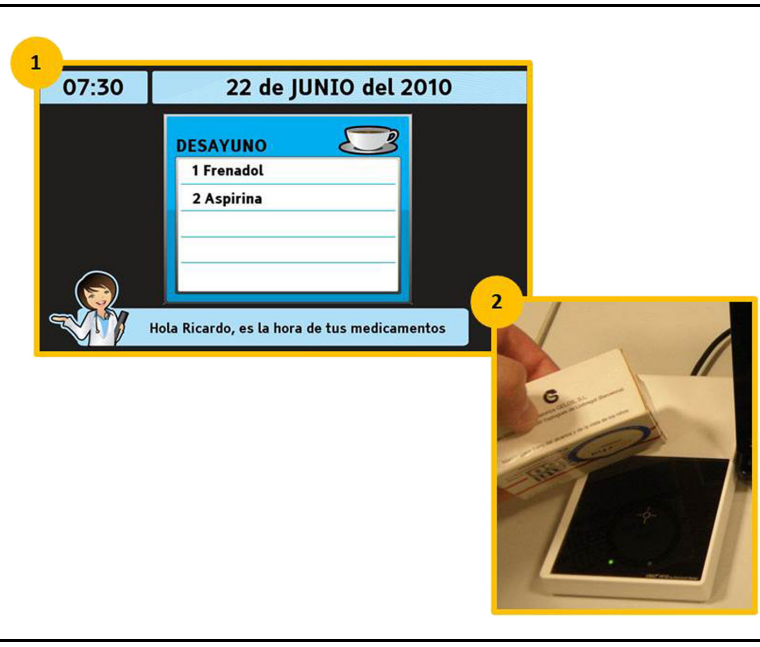
The main purpose of the PC is to display the calendar, alert the user with reminders and provide a view for care professionals for medication planning and adherence, whereas the NFC reader/writer device and tagged medicine packages are used for storing and reading medicine information from NFC tags. The role of the speech synthesiser is to transform the text displayed on the screen into speech.

*2.2.2 Functionalities for the primary end-users*. The main view of the interface shows a medication plan for a day, and thus the system aims to reduce the effort required to remember to take the correct medicines at the correct time (*principle of reduction*). The plan shows the medicine and dosage information of the medicines that the user has to take during the day. Information provided can be tailored according to the user's needs (*tailoring*). The default medicine plan is divided into four sections. By default these are breakfast, lunch, dinner and bedtime, but they can be personalised based on the needs of the particular user (*personalisation*). The main screen of the graphical user interface for older users is presented in Figure 1.

The system aims to guide users through the medication taking process (*tunnelling*). When it is time to take medicines, the PMA reminds users visually by showing a reminder and providing an audio description (*reminders*) (see Figure 2 step 1) and informs the user one by one which medication to take and the respective dosage. Then it asks the user to find the medicine package and to place it on the NFC reader to verify its content (see Figure 2 step 2). Once the medicine is identified and the reminder system confirms that it is the right one (*reduction*), the user receives a positive response and a prompt to take the medicine. Then the user confirms

**Figure 1** The main screen


**Figure 2** Reminder window and confirmation




their medicine consumption by touching the "OK" button on the PC screen, and the system registers that the user has taken their medicines. When the user gives confirmation, the system notifies the user by displaying the reminder window in a green colour. The previous verification and confirmation steps will be repeated, one by one, until all the medicines are taken. When the confirmation process is finished, the calendar will be shown again with information about the next

medicine and dosage of the day. The PMA uses *praise* via words to give motivating feedback about successful medication taking.

The designers have also aimed at using terminology which would be familiar to older users (*similarity*) and selecting attractive colours and figures (*liking*). Using an avatar "virtual nurse", the system adopts a *social role*. The system provides information that is perceived as trusted by the users, because it is managed by home care professionals (*trustworthiness*). The system is also viewed as incorporating expertise, because it is provided by home care professionals (*expertise*). The system has been designed to have a competent look and feel (*surface credibility*). In addition to the scheduled medication process, PMA can be used to provide information about the medicines at any time. The user can read the information stored in the NFC tag attached to the medicine package by placing the NFC-labelled medicine package on top of the NFC reader.

*2.2.3 Multimodality.* Basically, all the information which is displayed on the screen is also provided in audio. When it is time to take medicines, the PMA aims to get the user's attention with a warning sound that comes about ten seconds before the actual reminder message. Then it provides the information of the reminder message by audio. The user can listen to the reminder message at any time by touching the screen. When the user gives a confirmation that he or she has taken the medicines, the medicine assistant notifies the user with a sound effect. The audio channel is used also for error messages.

In addition to audio information, touch-based user interfaces were used. The user can use a touch gesture to confirm medicine taking and interact with the application through a touch interface. NFC-based touch interaction is used to identify the correct medicine package, to verify if it is the right time to take medicines, to provide medicine information at any time, and to make sure that the medicine has not expired.

*2.2.4 Functionalities for the home care professionals*. The PMA provides support functions related to medication management for home care professionals. These authorised people are able to add new prescriptions, update the information and status of the medication plan, study the active medication plan, configure and adapt the system parameters to the user's needs and preferences and monitor medication consumption.

Authorised users use an NFC-based ID card to log in to the system. When a home care professional places his or her ID card on the NFC reader device, the management functions will be activated.

The NFC tags for the medicine packages are created by a gerontologist or a home care professional. Because the NFC tag contains all the medicine information required, the home care professional can easily update the medication plan by placing the new medicine package on the NFC reader/writer device and the information is written on the tag automatically. Then the system presents the information to the home care professional for confirmation.

When the home care professional studies the active medication plan, all the active prescriptions are shown in a list, and the home care professional can access the details of each prescription, change some parameters of a prescription and also create a new prescription and an NFC tag to be attached to the medication package.

In order to monitor medication adherence, a monthly calendar was designed. It is displayed on the screen, and the home care professional can easily access the details of each day by selecting it from the calendar. Green colour was used for days when all medicines were registered as "taken" and red colour for days where some medicines were registered as "not taken". Detailed information shows which medicines have been taken and which have not. The calendar is presented in Figure 3.

## 3. Results

The findings of co-design sessions and field trials are summarised here. First the expectations of the PMA are analysed, and then the subjective experiences collected during user studies are summarised.

**Figure 3** Calendar for monitoring purposes


*3.1 Expectations*

In the first co-design session, home care professionals stated that the confirmation procedure and how the user is guided through the medication intake seems easy to use, but they expected that the older users would face problems in locating the NFC tag attached to the medication package. They expected that the new procedure would help users to remember to take their medicine, because they need to pick up the medicine package and place it on the NFC reader. This would be an advantage over traditional reminders, which can be switched off without actually touching the medication package. They also considered that audio information would be useful, because it might be easier to remember than written information. Also, they estimated that many users in the target group have trouble reading and thus would benefit especially from audio information. Home care professionals suggested that, when the user places the wrong medicine package on the NFC reader, audio information should be provided, because it would help users notice that it is the wrong medicine package. They also asked whether warnings about expired prescriptions and medicines could be added. They estimated that the reminders would support effective task fulfilment and would be suitable for people who suffer from mild cognitive impairment, but they doubted that people with severe cognitive impairment would be able to learn to use the system.

Home care professionals expected that the system would be especially useful, because they would be able to check at the beginning of the day whether some medicine remains to be taken. Interviewees suggested that this monitoring functionality could be available to the family and relatives also. They expected that the monitoring functionality would help them to diagnose, for example, cognitive problems earlier than they currently do, which would be a clear improvement. Home care professionals commented that the graphical design is good and registering new medicines is really easy due to the touch screen and NFC functionality.

Older people who were interviewed in the second co-design session stated that the confirmation procedure and how the user is guided through the medication intake would be easy to use, but additional instructions were considered necessary. It was discovered that the touch-screen interface is not self-explanatory and that there should be instructions explicitly stating that it is a touch-screen. Participants suggested that making the confirmation through the touch screen would activate users more than using their speech, which might encourage them to take their medicines. All feedback and warnings, such as finished process, wrong medicine and expired medicine, were found to be helpful in bringing peace of mind. The reminders would support effective task fulfilment and they would be especially useful for people who live alone. The blinking screen was seen as a reinforcement of the reminder, and the audio

information was considered to be really useful. One person mentioned that the praising feedback is a bit silly. Most of them stated that the audio- and graphical designs are clear and good, but one stated that the screen and font size are too small. Some people suggested that there could be more information about the medicines, but some were satisfied with the amount of information. Also haptic features, such as vibration of the PC, could be useful, as well as Braille text in the NFC labels of the medicine packages.

The users' responses were encouraging, because both the home care professionals and the older people expected that the system would bring value for them. The instant feedback in the prototyping phase also helped to fix usability issues.

### *3.2 User experience findings*

During the first days of the first field trial it was discovered that not all of the instructions are clear or detailed enough. Observations during the field trial at the nursing home showed that all the participants require several days to learn how to use the device. Two of them needed help from the gerontologist during the first three days and after they were able to use the device without any support; for the other two participants it was difficult to learn. Participants from the nursing home were in a somewhat fragile situation; they came from the hospital and needed special care and support. They were not able to return to their homes and live independently. One of the participants in particular was not able to learn and remember how to use the system at the end of the trials, she had a severe hearing limitation and she also had some cognitive problems. She was able to explain the process and what the system asked her to do, but she often got confused and did not remember how to proceed. She constantly asked for help and support from the gerontologist who supervised the trials.

The users considered that the daily medication plan and medicine reminders are useful. They especially appreciated details such as the fact that the names of the medicine were personalised (such as "heart medication") and time of the day was included in the plan. Participants mentioned that the reminders are especially useful when the medication plan is modified or updated. Participants felt that through the confirmation procedure (i.e. the possibility to test that the medicine package is correct and confirming medicine consumption) they are able to avoid mistakes; as they put it: "you learn from the machine when you are wrong". One participant who had a medicine dispenser felt that the confirmation procedure did not bring any additional value for him/her, but that the reminders were useful. The warnings, such as not to take the same medication again, were found especially useful and "fantastic" as stated by some participants. All participants stated that the audio and graphical design were clear and good. One participant suggested that the device should be small enough to take along when travelling, for example.

Three participants considered the audio feedback as the "voice of a friend", which implies that the technology adopted some kind of a social role. One participant also said "goodbye" to the machine every day. The credibility of the system was seen as being high; one participant said "if it says that you have already taken it, it must be true".

In the second field trial, participants' experiences of the confirmation procedure varied. Taking into account the results from the first field trials, some modifications were made in the design. The participants in this second field trial were shown how to use the system by a technician. The system was installed at their homes and they only had support in case of an error. No special problems were reported by the participants during the period of the test. After three weeks of use by four users, the participants were interviewed about their user experience issues and the problems they identified during testing. It was found out that the older participants living on their own had very heterogeneous needs regarding the medication management support. One participant who used a medicine dispenser would have preferred to have the information on all of her medicines that she needs to take at that time of day at the same time. She also said that only one confirmation in the end would be enough. One participant stated that he/she would need only reminder functionality and not medicine verification and confirmation procedure. She was also interested in getting warnings about expired medicines. Two participants stated that medicine verification is very useful; especially for the verification of new medicines and providing

a feeling of safety. Later, the application was modified for the user who had a medicine dispenser, and she found it really useful, since the modified version used only the reminder functionality.

Participants stated that the medicine reminders are useful. However, of the four participants only one considered that he/she would need the reminder functionality. Still, all participants reported that they have had some occasional lapses with their medication. One participant mentioned that the feedback gets repetitive and thus annoying, and it should be changed every now and then. All participants were happy with the audio and graphical design. They also said that it was easy to learn how to use the NFC tags and the NFC reader function.

It was found out that some users' perceived need for this kind of service was low. There were several reasons for this: they were using medicine dispensers and thus they did not have a need for a medication confirmation procedure; they thought they knew their medicines by heart, or they felt that they did not have any problems in remembering or managing their medicines. Still, the observations of home care professionals showed that actually these users had medication management-related problems but they overlooked the errors they made. It was discovered that there is a need to understand the reasons for non-adherence, to easily tailor system functionality (and not only information provided) to meet the needs of the different users and to understand the other possible factors influencing technology adoption (e.g. fear of losing human contact after adopting assistive technologies).

## 4. Discussion

The study showed that the PMA system was expected to provide concrete assistance with medication management by reminding people to take their medicines and guiding users through the medication taking process, providing a monitoring functionality for the home care professionals and even helping home care professionals to identify patients' cognitive problems at an early stage. In addition, multimodality was expected to bring benefits through providing information in audio format, reinforcing reminders using visual feedback (e.g. blinking screen) and requiring users to pick up the medication package during the medication taking process.

The user experience analysis showed that the older participants considered many of the system qualities as useful for themselves or somebody else in a certain situation, such as a person living alone or a person whose medication plan has been changed. Users experienced that the system offers concrete assistance with medication management through reminding them to take their medicines and guiding them through the medication taking process. Users' attitudes towards the multimodality with audio feedback and touch-based user interfaces were positive. However, older users' perceived need for this kind of system was low, even if a need for the system was identified both in the early stages of the development as well as later by the home care professionals. The reason might be that, although the system performed as expected and met the requirements, reasons for non-adherence and other possible factors influencing technology adoption were not understood thoroughly enough. Thus, the system partly failed to bring value for the users. It can be discussed whether the older users had a perceived need to manage their medication better and improve their medication adherence in the first place. Research has shown that non-adherence among older people is not always unintentional, but it can also be intentional. Perceptions of illness and poor comprehension of the role of the medicines in the management of long-term conditions can lead to intentional non-adherence with medication (Banning, 2008). Thus, it is important to discuss the patient-centred factors that influence non-adherence and solutions how the different persuasive functionalities of the system addressed these reasons.

There are many opportunities for further development of the PMA. In order to increase medication adherence, it would be important to design new persuasive functionalities into the system. Table I presents examples of ideas for future development – how persuasion principles (Oinas-Kukkonen and Harjumaa, 2009) could be used to tackle different patient-centred factors to contribute to non-adherence (Vlasnik *et al.*, 2005).

Also, the role of the family members in the medication management process and their requirements and value expectations of new technology should be studied. Regarding the

**Table I** Future development ideas

| *Reason for non-adherence* | *Persuasion principle* | *How to use* |
|---|---|---|
| Misunderstanding of prescribing instructions | Reduction | MMS can reduce users' efforts to manage medicines by providing a daily medication plan[a] |
| | Tunnelling | MMS can provide the means to guide the user through the medication taking process and thus users are able to avoid mistakes and learn to take the right medicines at the right time[a] |
| | Personalisation | MMS can help to understand prescribing instructions by using personalised medicine names which are familiar for the user[a] |
| | Rehearsal | MMS can provide the means to rehearse the medication-taking process |
| | Reminders | MMS can remind users to take their medicines[a] |
| | Similarity | MMS can help to understand prescribing instructions by using language that is familiar to users[a] |
| | Tailoring | MMS can provide tailored information showing only information that is relevant to the current user |
| Frequent changes to drug regimens | Reduction | MMS can reduce users' effort to manage medicines by providing a daily medication plan[a] |
| | Reminders | MMS can remind users to take their medicines[a] |
| Limited faith in the medication or the provider | Trustworthiness | MMS can increase trustworthiness if the system is provided by a trusted party, such as home care professionals[a] |
| | Expertise | MMS can increase the feeling of expertise if the system content, such as a medication plan, is managed by home care professionals[a] |
| | Surface credibility | MMS can increase surface credibility if the look and feel of the system is competent[a] |
| | Real-world feel | MMS can increase the real-world feel by providing information on the organisation behind its content |
| | Authority | MMS can refer to real people in the role of authority |
| | Third-party endorsements | MMS can provide endorsements from respected sources |
| | Verifiability | MMS can provide the means to verify the accuracy of the content |
| Inability to read written instructions | Reduction | MMS can reduce users' efforts to manage medicines by providing the possibility to verify new medicines through the NFC interface[a] |
| Forgetfulness or confusion | Reduction | MMS can reduce users' efforts to manage medicines by providing a daily medication plan[a] |
| | Reminders | MMS can remind users to take their medicines[a] |
| Denial of the illness or its significance | Self-monitoring | MMS can provide the means to track symptoms, such as diary functionality |
| Anger about the illness | Rehearsal | MMS can provide mental wellness training, which consists of experiential exercises to reduce anger |
| Apathy | Rehearsal | MMS can provide mental wellness training, which consists of experiential exercises to encourage positive thinking |
| Depression | Rehearsal | MMS can provide mental wellness training, which consists of experiential exercises to reduce depression |
| High stress | Rehearsal | MMS can provide mental wellness training, which consists of experiential exercises to reduce stress |
| Reduction, disappearance or fluctuation of symptoms | Self-monitoring | MMS can provide the means to track medication use by providing a calendar functionality presenting taken and not taken medicines |
| Concern about taking drugs, including fear of addiction | Simulation | MMS can provide the means to observe the link between the cause and effect – what follows if the user does or does not comply with medication |
| | Suggestion | MMS can provide information about the effects and purpose of the medication |
| Inability to distinguish colours or identifying markings on medications | Reduction | MMS can reduce users' effort to manage medicines by providing the possibility to verify new medicines through the NFC interface[a] |
| Problems with assistance required in the home | Reduction | MMS can reduce users' efforts to manage medicines by providing the possibility to verify new medicines through the NFC interface[a] |
| Limited education about the illness or the need for medication | Suggestion | MMS can provide information about the effects and purpose of the medication |
| Limited social or family support | Social role | MMS can provide social support by using an avatar, such as a "virtual nurse"[a] |
| | Praise | MMS can provide social support by giving motivating feedback about successful medication taking[a] |

*(continued)*

**Table I**

| *Reason for non-adherence* | *Persuasion principle* | *How to use* |
|---|---|---|
| Complex and complicated drug regimens | Reduction | MMS can reduce users' efforts to manage medicines by providing a daily medication plan[a] |
| | Tunnelling | MMS can provide the means to guide the user through the medication taking process and thus users are able to avoid mistakes and learn to take the right medicines at the right time[a] |

Note: [a]Suggestion is supported by the user experience findings

system content, educational strategies should be involved and the assistance should not only focus on the external cognitive support.

This study has some limitations. The actual adherence to medications was not measured. However, in the future, it will be important to study how the MMSs influence medication adherence. Also, the user experiences of the home care professionals were not studied in the field trials. Home care professionals who were involved in the user studies and trials merely estimated the value for their patients and not for themselves.

Further research challenges in assistive home technologies include user profiling needed in personalisation, customisation and adaptation of services (Clark and McGee-Lennon, 2011). As an example, in order to contribute to non-adherence to medications caused by forgetfulness requires that all possible underlying causes, such as confused mental state, lack of environmental cues considering the time of the day or complex medication regimen would be used as a basis to tailor the programme to an individual (Ryan, 1999). In our study it was identified that, when the functionality of the PMA was modified for one participant who had a medicine dispenser, she started to consider the system to be very useful. This kind of user profiling and personalised services is needed, but in order to achieve social or business benefits, services need to scale up for large populations of users. Thus, it is important to pay attention to the easy and low-cost end-user configuration of home care technologies.

## 5. Conclusions

AAL environment has considerable potential in promoting the independent living of older people. In this study a design and evaluation process of a multimodal MMS was presented. The process was iterative and included involvement of both end user groups – older people and home care professionals. The findings show that, especially during the prototype-building phase, the PMA was expected to bring value for both user groups, but during the actual field trial many practical challenges were faced and people's interest in adopting the system varied among users. This can be due to many reasons, ranging from wrongly defined value proposition to fear of losing social connections with the home care professionals. This paper also brings out the paradigm of persuasive design in assistive technologies. It shows how persuasive functionalities of MMS can address non-adherence and discusses how systems might be designed in the future to better help older people to manage their medications.

## References


Banning, M. (2008), "Older people and adherence with medication: a review of the literature", *International Journal of Nursing Studies*, Vol. 45 No. 10, pp. 1550-61.

Beckman, A.G.K., Parker, M.G. and Thorslund, M. (2005), "Can elderly people take their medicine?", *Patient Education and Counseling*, Vol. 59 No. 2, pp. 186-91.

Clark, J. and McGee-Lennon, M. (2011), "A stakeholder-centred exploration of the current barriers to the uptake of home care technology in the UK", *Journal of Assistive Technologies*, Vol. 5 No. 1, pp. 12-25.

Claxton, A.J., Cramer, J. and Pierce, C. (2001), "A systematic review of the associations between dose regimens and medication compliance", *Clinical Therapeutics*, Vol. 23 No. 8, pp. 1296-310.

Costa, J. and Doughty, K. (2009), "The role of reminder aids and systems to support independence in people with memory problems", *Journal of Assistive Technologies*, Vol. 3 No. 2, pp. 60-4.

Eberhardt, B., Fachinger, U. and Henke, K. (2010), "Better health and ambient assisted living (AAL) from a global, regional and local economic perspective", *International Journal of Behavioural and Healthcare Research*, Vol. 2 No. 2, pp. 172-91.

Hammar, T., Rissanen, P. and Perälä, M.-L. (2008), "Home-care clients' need for help, and use and costs of services", *European Journal of Ageing*, Vol. 5 No. 2, pp. 147-60.

Harjumaa, M., Isomursu, M., Muuraiskangas, S. and Konttila, A. (2011), "HearMe: a touch-to-speech UI for medicine identification", *5th International Conference on Pervasive Computing Technologies for Healthcare (Pervasive Health)*, *IEEE*, pp. 85-92.

Higgins, N. and Regan, C. (2004), "A systematic review of the effectiveness of interventions to help older people adhere to medication regimes", *Age and ageing*, Vol. 33 No. 3, pp. 224-9.

Intille, S.S. (2004), "A new research challenge: persuasive technology to motivate healthy aging", *IEEE Transactions on Information Technology in Biomedicine*, Vol. 8 No. 3, pp. 235-7.

Isomursu, M., Ervasti, M. and Tormanen, V. (2009), "Medication management support for vision impaired elderly: scenarios and technological possibilities", *2nd International Symposium on Applied Sciences in Biomedical and Communication Technologies, IEEE*, pp. 1-6.

De Kort, Y.A.W., IJsselsteijn, W.A., Eggen, J.H. and van den Hoven, E.A.W.H. (2005), "Persuasive gerontechnology", *Gerontechnology*, Vol. 4 No. 3, pp. 123-7.

McGee-Lennon, M., Smeaton, A. and Brewster, S. (2012), "Designing home care reminder systems: lessons learned through co-design with older users", *Pervasive Computing Technologies for Healthcare (Pervasive Health), 2012 6th International Conference on IEEE*, pp. 49-56.

McGee-Lennon, M.R., Wolters, M.K. and Brewster, S. (2011), "User-centred multimodal reminders for assistive living", *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI 11, ACM Press, New York, NY*, pp. 2105-14.

Oinas-kukkonen, H. (2010), "Behavior change support systems: a research model and agenda", in Ploug, T., Hasle, P. and Oinas-Kukkonen, H. (Eds), *Change*, Springer-Verlag, Berlin and Heidelberg, pp. 4-14.

Oinas-Kukkonen, H. and Harjumaa, M. (2009), "Persuasive systems design: key issues , process model , and system features", *Communications of the Association for Information Systems*, Vol. 24 No. 1, pp. 485-500.

Robert Savage, Y.Y. (2009), "Ambient assistive health and wellness management in the heart of the City", in Mokhtari, M. *et al*. (Eds), Springer, Berlin and Heidelberg.

Ryan, A.A. (1999), "Medication compliance and older people: a review of the literature", *International Journal of Nursing Studies*, Vol. 36 No. 2, pp. 153-62.

Tang, P. and Venables, T. (2000), "'Smart' homes and telecare for independent living", *Journal of Telemedicine and Telecare*, Vol. 6 No. 1, pp. 8-14.

Vlasnik, J.J., Aliotta, S.L. and DeLor, B. (2005), "Medication adherence: factors influencing compliance with prescribed medication plans", *The Case Manager*, Vol. 16 No. 2, pp. 47-51.

## Appendix

**Table AI** Summary of the expectations

| *Parameter* | *Home care professionals* | *Older users* |
|---|---|---|
| Ease of adoption | Medication verification through NFC is easy to use, especially for people under 70 years old | The system will not be needed in a nursing house, because there is supervision available, but the system would be useful at home |
| Ease of use | Graphical design and colours are good<br>Adding new medicines and medication plan is easy. Also relatives could do it Also video demonstrations about the use would be helpful | Graphical design, colours and screen size are good<br>Reminder messages are clear and there is enough information<br>Medication verification through NFC is easy to use, but some training was needed<br>Some features (such as medication verification with NFC) require better feedback and instructions |
| Performance | Useful for home care professionals and older users who suffer from mild cognitive impairment, but reminders are not suitable for people with severe cognitive impairments<br>Audio reminders are especially useful for this target group<br>It is good that medication verification through NFC warns about wrong medications and expired receipts/ medications. Warnings should also be provided as audio information<br>Adding medication plans and monitoring medicine intake are helpful<br>Monitoring functionality can even help to identify patients' cognitive problems at early phase | Medicine reminders are useful<br>Audio reminders with text are very good<br>It is good that medication verification through NFC warns about wrong medications and expired receipts/ medications |


### About the authors

Marja Harjumaa works as a Research Scientist at the VTT Technical Research Centre of Finland. She is experienced in conducting user-oriented research with different kind of user groups. Her main interest is digital health, focusing especially on technologies for personal health and behaviour change. Marja Harjumaa is the corresponding author and can be contacted at: marja.harjumaa@vtt.fi

Igone Idigoras works as the Director of the Assistive Technologies area at Tecnalia Research and Innovation in Spain. She is experienced in managing research and development projects on new accessible solutions based on a user-centred approach. Her main interests are ICT-based accessible solutions and devices supporting daily living activities of elderly and disabled people, focusing especially on accessible interaction and cognitive assisting solutions.

Minna Isomursu, PhD, is a Research Professor of Networked Services and Media at the VTT Technical Research Centre of Finland. Her research explores digital services and social media. Her current research projects study digital services and health, use of social media as a source for innovation indicators and social media for older adults.

Ainara Garzo works as a Researcher at Tecnalia Research and Innovation in Spain. She is experienced in user involvement and consideration of ethical issues. Her main interests are user-centred design, human-computer interaction, user involvement, usability, accessibility, ethical issues and procedures.

Series title and number

VTT Science 68

| | |
|---|---|
| Title | **On the development of persuasive systems**<br>A framework for designing and evaluating behaviour change support systems and its applicability for e-Health |
| Author(s) | Marja Harjumaa |
| Abstract | A growing number of information and communication technologies are being developed to support a change in users' attitudes and behaviour or both i.e. to persuade people. In the development of these kinds of systems, persuasion strategies and principles play an important role. They are classical principles that are found to have an influence on attitudes and behaviours. There already exist several approaches to the design and evaluation of behaviour change support systems. However, there is a need for a more comprehensive framework which describes how the persuasion principles can be implemented; that is, how to transform them into software requirements and functionalities. It would also be important to address the question of how to integrate persuasive design approaches into systems development.<br><br>The objective of this doctoral thesis is to provide a framework for designing and evaluating behaviour change support systems and evaluating the utility of the developed model by using it for its purpose in an e-Health context, in particular in the early stages of systems development and in the evaluation of existing systems. This doctoral thesis applies a design science research approach which aims at designing new and novel artefacts, constructs, intended to solve identified organizational problems. The construct is a conceptual model based on literature analysis, and the evaluations are conducted using a case study approach.<br><br>This doctoral thesis describes the key theories behind the development of persuasive systems and proposes an innovative construction, the Persuasive Systems Design model. It also evaluates the practical applicability of the model in three case studies. The findings show that the model can be successfully applied during the user requirements analysis and concept design phases in order to identify new potential persuasive functionalities and analysing persuasive functionalities of an existing product. The main contribution of this doctoral thesis is participation in the development of a conceptual model for designing and evaluating behaviour change support systems. |
| ISBN, ISSN | ISBN 978-951-38-8169-6 (Soft back ed.)<br>ISBN 978-951-38-8170-2 (URL: http://www.vtt.fi/publications/index.jsp)<br>ISSN-L 2242-119X<br>ISSN 2242-119X (Print)<br>ISSN 2242-1203 (Online) |
| Date | October 2014 |
| Language | English, Finnish abstract |
| Pages | 103 p. + app. 76 p. |
| Name of the project | |
| Commissioned by | |
| Keywords | Persuasive systems design, behavior change support systems, e-Health, PSD, BCSS |
| Publisher | VTT Technical Research Centre of Finland<br>P.O. Box 1000, FI-02044 VTT, Finland, Tel. 020 722 111 |

Julkaisun sarja ja numero

VTT Science 68

| | |
|---|---|
| Nimeke | **Vakuuttavien tietojärjestelmien kehittäminen**<br>Viitekehys käyttäytymisen muutosta tukevien tietojärjestelmien suunnitteluun ja arviointiin ja sen soveltuvuus e-Health-kontekstissa |
| Tekijä(t) | Marja Harjumaa |
| Tiivistelmä | Yhä useammin informaatio- ja kommunikaatioteknologiaa kehitetään siinä tarkoituksessa, että se pyrkii muuttamaan käyttäjien asenteita, käyttäytymistä tai molempia eli suostuttelemaan tai vakuuttamaan ihmisiä. Tällaisten järjestelmien kehittämisessä suostuttelustrategiat ja -periaatteet ovat tärkeässä asemassa. Ne ovat yleisesti tunnustettuja periaatteita, joilla on todettu olevan vaikutusta ihmisten asenteisiin ja käyttäytymiseen. Vakuuttavien tietojärjestelmien suunnitteluun on olemassa useita lähestymistapoja. Kattavampaa viitekehystä kuitenkin tarvitaan. Olisi tarpeellista kuvata, kuinka suostutteluperiaatteet voidaan toteuttaa eli kuinka ne voidaan muuttaa ohjelmistovaatimuksiksi ja toiminnallisuuksiksi. Olisi myös tärkeää ymmärtää, kuinka vakuuttavien tietojärjestelmien suunnittelumenetelmät voidaan yhdistää osaksi tietojärjestelmien kehittämistä.<br><br>Tämän väitöskirjan tavoitteena on tarjota viitekehys vakuuttavien tietojärjestelmien suunnitteluun ja arviointiin ja arvioida kehyksen hyödyllisyyttä käyttämällä sitä e-Health-kontekstissa; erityisesti järjestelmäkehityksen varhaisissa vaiheissa ja olemassa olevien järjestelmien arvioinnissa. Väitöskirja soveltaa ns. design science -lähestymistapaa, jonka avulla voidaan kehittää uusia ja aivan toisenlaisia artefaktoja, konstruktioita, ratkaisemaan organisatorisia haasteita. Konstruktio on käsitteellinen malli, joka perustuu kirjallisuusanalyysiin, ja arviointi on tehty tapaustutkimuksen keinoin.<br><br>Väitöskirja kuvaa vakuuttavien tietojärjestelmien suunnitteluun liittyvät avainteoriat ja esittelee uudenlaisen konstruktion, PSD-mallin. Sen lisäksi työ arvioi mallin soveltuvuutta kolmen tapaustutkimuksen kautta. Löydökset osoittavat, että mallia voidaan käyttää tuloksekkaasti vaatimusmäärittely- ja konseptin suunnitteluvaiheissa uusien suostuttelevien toiminnallisuuksien tunnistamiseen ja olemassa olevan tuotteen suostuttelevien toiminnallisuuksien analysointiin. Väitöskirjatyön pääkontribuutio on osallistuminen vakuuttavien tietojärjestelmien suunnitteluun ja arviointiin tarkoitetun käsitteellisen viitekehyksen kehittämiseen. |
| ISBN, ISSN | ISBN 978-951-38-8169-6 (nid.)<br>ISBN 978-951-38-8170-2 (URL: http://www.vtt.fi/publications/index.jsp)<br>ISSN-L 2242-119X<br>ISSN 2242-119X (Painettu)<br>ISSN 2242-1203 (Verkkojulkaisu) |
| Julkaisuaika | Lokakuu 2014 |
| Kieli | Englanti, suomenkielinen tiivistelmä |
| Sivumäärä | 103 s. + liitt. 76 s. |
| Projektin nimi | |
| Rahoittajat | |
| Avainsanat | Vakuuttavat tietojärjestelmät, käyttäytymisen muutos, e-Health, PSD, BCSS |
| Julkaisija | VTT<br>PL 1000, 02044 VTT, puh. 020 722 111 |

# On the development of persuasive systems

## A framework for designing and evaluating behavior change support systems and its applicability for e-Health

A growing number of information and communication technologies are being developed to support a change in users' attitudes and behaviour or both i.e. to persuade people. In the development of these kinds of systems, persuasion strategies and principles play an important role. They are classical principles that are found to have an influence on attitudes and behaviours. There already exist several approaches to the design and evaluation of behaviour change support systems. However, there is a need for a more comprehensive framework which describes how the persuasion principles can be implemented; that is, how to transform them into software requirements and functionalities. It would also be important to address the question of how to integrate persuasive design approaches into systems development.

This doctoral thesis describes the key theories behind the development of persuasive systems and proposes an innovative construction, the Persuasive Systems Design model. It also evaluates the practical applicability of the model in three case studies. The findings show that the model can be successfully applied during the user requirements analysis and concept design phases in order to identify new potential persuasive functionalities and analysing persuasive functionalities of an existing product.

ISBN 978-951-38-8169-6 (Soft back ed.)
ISBN 978-951-38-8170-2 (URL: http://www.vtt.fi/publications/index.jsp)
ISSN-L 2242-119X
ISSN 2242-119X (Print)
ISSN 2242-1203 (Online)