Association for Information Systems
AIS Electronic Library (AISeL)

PACIS 2012 Proceedings

Pacific Asia Conference on Information Systems (PACIS)

7-15-2012

Native Mobile Applications For Personal Well-Being: A Persuasive Systems Design Evaluation

Sitwat Langrial
Oulu Advanced Research on Software and Information Systems, Department of Information Processing Science, University of Oulu, Finland, sitwat.langrial@oulu.fi

Tuomas Lehto
Oulu Advanced Research on Software and Information Systems, Department of Information Processing Science, University of Oulu, Finland, tuomas.lehto@oulu.fi

Harri Oinas-Kukkonen
Oulu Advanced Research on Software and Information Systems, Department of Information Processing Science, University of Oulu, Finland, harri.oinas-kukkonen@oulu.fi

Marja Harjumaa
VTT Technical Research Center of Finland, Kaitoväylä 1, 90570, Oulu, Finland, marja.harjumaa@vtt.fi

Pasi Karppinen
Oulu Advanced Research on Software and Information systems, Department of Information Processing Science, University of Oulu, Finland, pasi.karppinen@oulu.fi

NATIVE MOBILE APPLICATIONS FOR PERSONAL WELL-BEING: A PERSUASIVE SYSTEMS DESIGN EVALUATION

Sitwat Langrial, Oulu Advanced Research on Software and Information Systems, Department of Information Processing Science, University of Oulu, Finland, sitwat.langrial@oulu.fi

Tuomas Lehto, Oulu Advanced Research on Software and Information Systems, Department of Information Processing Science, University of Oulu, Finland, tuomas.lehto@oulu.fi

Harri Oinas-Kukkonen, Oulu Advanced Research on Software and Information Systems, Department of Information Processing Science, University of Oulu, Finland, harri.oinas-kukkonen@oulu.fi

Marja Harjumaa, VTT Technical Research Center of Finland, Kaitoväylä 1, 90570, Oulu, Finland, marja.harjumaa@vtt.fi

Pasi Karppinen, Oulu Advanced Research on Software and Information systems, Department of Information Processing Science, University of Oulu, Finland, pasi.karppinen@oulu.fi

Abstract

Smartphone applications have shown promise in supporting people to adopt healthy lifestyles. Hence, it is critical to understand persuasive design strategies incorporated in native mobile applications that facilitate behavior change. The aim of our study was to identify distinct persuasive software features assimilated in twelve selected applications using Persuasive Systems Design (PSD) model and provide a methodical framework for systems developers and IS researchers to extract and evaluate such features. Further, this study aimed to provide deeper comprehension of persuasive design and strategies by learning from practice. Exhaustive evaluations were performed by four researchers specializing in persuasive information systems simulating users walking through the applications step-by-step performing regular tasks. The results disclose the need for improvement in designing and incorporating persuasive techniques in personal well-being applications. While self-monitoring and personalization were moderately exploited, tailoring, a key persuasive feature, was not identified among the evaluated applications. In addition, evaluated applications lacked features that could augment human-computer dialogue as well as social support. The contribution of this paper is two-fold: while it exposes weakness in persuasive design of native mobile applications for personal well-being, it provides a methodical approach for enhancing general persuasiveness of such applications for instance, through enhanced dialogue support. We propose that designers and IS researchers perform rigorous evaluations of persuasive features incorporated in personal well-being applications.

Keywords: Native mobile applications, evaluation, persuasive systems design (PSD) model

1 INTRODUCTION

Smart mobile devices are shaping-up users' life styles by adding new dimensions to the concept of socializing, performing actions and forming new habits (Oulasvirta et al. 2011). As summarized by Fogg and Eckles (2007, p.5), "mobile phones will soon become the most important platform for changing human behavior". Oinas-Kukkonen (2012) argues that ubiquitous information systems are shaping up the creation and dissemination of information in new ways hence creating opportunities to foster healthier lifestyle. The diffusion of smartphones into our lives is an evidence of their popularity. The ever-growing liking and adoption of smartphones (e.g. Blackberry, iPhone, Google Android, Nokia Windows Phone) is reflective of their mammoth potential to promote health and general well-being of users. Portability, continuous data streaming, advanced computing power and easy dissemination of applications give them an edge over other forms of information and communication technologies. Smartphone applications have shown promise in helping people to change their behaviors (Abroms et al. 2011). According to Portnoy et al. (2010), digital interventions (via the Internet and mobile phones) are proving to be successful in the health and well-being field. They further add that such interventions have potential to produce new dimensions to health care. It is not unexpected that technological innovation and growing rate of technology acceptance are making smartphones an idyllic platform for promoting health care and general well-being (Tsai et al. 2007). They are more likely to support behavior change because of their pervasive nature and for their ability to provide right information at the right time and in the right context (Gefen & Straub 2011), thus empowering users to fulfil their tasks nearly anytime and anywhere. Such systems have been envisioned as behavior change support systems (Oinas-Kukkonen 2010a; 2012) for their potential to influence users' behaviors.

Native mobile applications are software, developed to run particularly on smartphones and tablet computing devices. iPhone alone had more than 350,000 applications and more than 10 billions downloads by January 2011[1]. Current research on mobile applications for well-being does not comprehensively discuss persuasive features and functionalities. However, there is indication that new research trends are titling towards a deeper evaluation of such features. A number of studies could be found that attempt to uncover reasons behind prodigious success of mobile applications, yet a few persuasive design features have been narrated. It appears that deeper understanding of design of smartphone applications is still required. Paradoxically, the ICT research community has shown tardiness in paying attention to this subject. Consolvo et al. (2009, p. 414) state: "It is important for technology designers to recognize that lifestyle behavior change is a long-term endeavour that pervades everyday life, including the social world. If done poorly, the technology is likely to be abandoned; therefore a principled approach for its design is needed." While research studies, such as Abroms et al. (2011), make a contribution to the persuasive nature of smartphone applications, conception of how to design specific persuasive features is relatively limited. We therefore propose that a thorough evaluation of native mobile applications is needed. It will help the research community identify specific persuasive techniques and create an opportunity to further enhance information systems that aim to support healthier lifestyles.

This paper aims to identify distinct persuasive software features assimilated in selected iPhone applications using Persuasive Systems Design (PSD) model (Oinas-Kukkonen and Harjumaa 2009). The model a state-of-the-art tool for designing and evaluating persuasive systems and behavior change support systems (Oinas-Kukkonen 2012). The PSD model outlines the significance of persuasion context by addressing the intent (intended change), the event (use, users and the context) and the strategy (persuasive message and delivery route). It therefore provides a methodical framework for information systems developers and researchers to extract and evaluate such features. Further, this study aims to provide deeper comprehension of persuasive design and strategies by learning from

[1] Trujilo, R.: Apple reaches 10 Billion Apps Sold. Sacramento Business Journal. January 24, 2011

practise. The evaluated applications were selected from health and well-being category. The research question put forward is: *what varieties of persuasive systems features are employed in current native mobile applications for personal well-being?* In addition, it aims to demonstrate how the PSD model could be applied to extract and evaluate persuasive features and strategies from such applications.

2 RELATED RESEACH

2.1 Persuasive mobile applications for well-being

Consolvo et al. (2009) have highlighted the significance of behavioral theories as well as design mechanisms for persuasive systems. By applying a mix of behavior change theories to their work, they have come up with eight design strategies (Abstract and Reflective; Unobtrusive; Public; Aesthetic; Positive; Controllable; Trending; and Comprehensive). Consolvo et al. (2009) maintain that the persuasive systems designers need to design such technologies with appropriate methodologies. Froehlich et al. (2009) have studied personalized ambient displays that provide feedback on automatic as well as manually recorded driving activities. Their mobile tool (UBIGreen Transportation Display) aimed to encourage people to embrace environment friendly transport practices. The artefact provided feedback through iconic displays aiming to enhance mindfulness. It provided graphical rewards when users acted in an environmental friendly style. Based on their work, Froehlich et al. (2009) report that users appreciated the feedback they received and found it motivating to involve them in environmental friendly transport behavior. Soler et al. (2009) performed a preliminary evaluation of their persuasive mobile game, Molarcopolis. The game aimed to raise oral health awareness in young adults. It employed several persuasion strategies to help users reach target goals, for instance, simulation, suggestion and visual appeal. Soler et al. (2009) report that their mobile game was perceived as being informative and entertaining during the initial evaluations. It is worth noting that while designing the mobile games, they did not take into account exclusive persuasive systems features. Some researchers have highlighted opportunities for improvement in persuasive design to motivate users for a longer time. Holzinger et al. (2009) state that current wellness applications have several flaws including an extended amount of data entry by the users, lack of alarms (reminders), rewards, detailed analysis and results projection of the data. They further add that applications that feature higher level of interaction with the users could be more motivating. Referring to the features of Web 2.0, Holzinger et al. (2009) propose that features that enhance collaboration, better interaction and networking could improve the motivational features of current mobile applications.

Grimes et al. (2010) note that ubiquitous technologies have the potential to incite healthy living. They investigated the scope for mobile games to promote healthy lifestyle in adults. They designed OrderUP, a dietary game and applied the Transtheoratical Model as health behavior theory in the design process. While discussing the results of their preliminary study, Grimes et al. (2010) report that participants of the study were actively engaged in the change process. Their study gives an insight into the process of change paradigm and could help foster mobile technologies that are focused at sustainable behavior change. Oliveira et al. (2010) developed a mobile phone-based social game that engaged elderly people to be more compliant in taking their daily medication. Results from their study indicate that the game improved both remembering to take daily doses and accuracy in drug intake time. Moreover, Oliveira et al. (2010) promote application of personalized persuasive technologies matching to the user's profile and context. Buttussi and Chittaro (2010) developed a context-aware, user-adaptive fitness game for mobile phones. The game trained users to jog outdoors with precise intensity. Evaluations of the game confirmed its beneficial results on users' training and motivation. While discussing mobile phone applications, Pollak et al. (2010) summarize (p. 27): "We can use mobile phones and custom-designed mobile phone games to provide different types of support for individuals and peer groups. People tend to stick with and learn new healthy habits if they know they're being monitored; through good design, we can capitalize on mobile tools to encourage healthy behaviors". Verhoeven et al. (2011) argue that innovations such as mobile phones are making it easier for designers to implement persuasive technologies. However, the designers need to know precisely

what features might be persuasive. They have proposed an analysis grid that consists of three levels of the so-called behavioral determinants (Micro, Meso and Macro). They further propose that designers could use their analysis grid to systematically examine factors that may influence the target audience. However, their analysis grid completely ignores the persuasive content and functionalities of the software artefact.

2.2 Persuasive systems, persuasive systems design and evaluation

Technology that aims to change people's attitudes and behaviors is called persuasive technology (Fogg 2003). In information systems context, the following terms have been coined: persuasive systems (Oinas-Kukkonen and Harjumaa 2008; 2009) and behavior change support systems (Oinas-Kukkonen 2010a; 2012). When designing persuasive information systems, it is essential to comprehend "persuasion". Briñol and Petty (2009) have defined the persuasive process as: "A typical situation in which persuasion is possible, a person or a group of people (i.e., the recipient) receives an intervention (e.g., a persuasive message) from another individual or group (i.e., the source) in a particular setting (i.e., the context)" (p. 71). A given persuasive attempt is fruitful when the target (behavior, attitude) is altered in the desired way (Briñol and Petty 2009).

Several frameworks within the field of persuasive design have been introduced. Lockton et al. (2008) developed Design with Intent (DwI) that described the nature of design in terms of influencing user behaviors. The model attempts to explain various types of systems that are thoughtfully designed to influence users. DwI means design that is intended to influence or result in certain user behavior. It attempts to describe various types of systems that have been strategically designed with the intent to influence how people use them (Lockton et al. 2008). The Design with Intent toolkit consists of design patterns, which are grouped according to eight 'lenses' bringing divergent disciplinary perspectives on behavior change.

In his Behavior Model (FBM), Fogg (2009) states that three conditions are needed for an individual to perform a target behavior i.e. being motivated, having the ability to perform an action and receiving a timely trigger to perform the desired action. Fogg (2009) further adds that the three conditions must be met at the same time for a desired behavior to be performed. Fogg's behavior model provides an understanding of relationships between motivations, abilities and triggers. However, it does not explicitly discuss persuasive features implementation in designing a persuasive system. Wiafe et al.'s (2011) 3D-RAB model aims to evaluate and implement persuasive technology systems for behavior change. The model takes into account the relation between attitudes and behaviors, attitudes and behavior change and attitudes and sustaining behavior change. It identifies different levels of user cognition as argued by Wiafe et al. (2011). Yetim (2011) has proposed a set of critical heuristics for value sensitive designers and users of persuasive systems. He argues that the reflective methods with a set of concrete questions could be employed for a value sensitive participatory design of persuasive systems. According to Yetim (2011) value-based reasoning is necessitated in any persuasive design discourse to assess "the purposiveness, goodness or rightness of system actions to be designed".

Oinas-Kukkonen and Harjumaa (2008; 2009) conceptualized the PSD model. The model puts emphasis on detailed and rigorous analysis of the persuasion context (the intended change in behaviors and/or attitudes), the event (identifying context of use and users of technologies) and the strategy (carefully developing content of the message and delivery route in alignment with the identified target audience). In addition, it highlights seven postulates that are central to the design of persuasive information systems. These postulates address non-neutral nature of technology, motivational psychology, direct and indirect routes as persuasive strategies, incremental nature of persuasive techniques, identifying opportune moments and decreasing obtrusiveness, and developing systems that are easy to use and satisfy users' expectations. The PSD model provides profound understanding of interaction between users and technologies. Similar to user models that suggest that user experience is a consequence of users' internal state, the characteristics of the system and the use of context (e.g. Hassenzahl and Tactinsky 2006), the PSD model advocates a comprehensive analysis of use and user

context while designing persuasive software features. It provides design principles divided in four categories and presents concrete examples of how these principles could be implemented. These categories are: (i) primary task support; (ii) dialogue support; (iii) credibility support; and (iv) social support. Primary task support features facilitate users' interaction with a system and help track their performance through features such as self-monitoring. Dialogue support features improve dialogue between the user and the system, especially in terms of system's feedback to better guide the user through the intended behavior/attitude change process. Features such as authority, expertise, real-world feel, and verifiability promote the credibility of persuasive systems. Finally, social support features foster user motivation through components such as cooperation, normative influence, social comparison, and social learning. Many of the features have been adopted from Fogg (2003). The principles are described later in Section 4 in more detail.

3 RESEARCH SETTING

3.1 Evaluation method

The study aimed to identify and understand design of native mobile applications by categorizing their persuasive features. It was also seen as an opportunity to learn by practise and understand how different persuasive features could be enhanced. The methodology used was expert evaluation where one or more specialists evaluate the system against list of design principles. This is similar to heuristic evaluation, which is applied in usability engineering to identify usability problems (Nielsen 1993) and testing interactive technologies (Jaspers 2009). The PSD model was applied while evaluating the applications because it is equally applicable for designing and evaluating persuasive information systems. Previously, several researchers have used the PSD model in different contexts (e.g. Derrick et al. 2011; Loock et al. 2011; Yetim 2011). Four research scientists specializing in persuasive information systems carried out heuristic evaluations, simulating real users walking through the applications step-by-step performing regular tasks (i.e. cognitive walkthrough). Evaluations were made using the 28 persuasive software features outlined by the PSD model. The evaluators independently examined functionalities of the applications and compared them against recognised persuasion techniques. The selected applications were installed on iPhones and were actually used to perform representative tasks. An independent review of the selected applications was carried out where feature-by-feature evaluations were made. The evaluators made notes to Excel sheets and recorded their comments. Further, each evaluator examined the functionalities by reading descriptions of the applications and developers' web sites. When all the four evaluators concluded their individual evaluations, a synthesis of the findings was made and disparities, where applicable, were resolved through rigorous discussions and iterations. During the discussions, it was agreed that only those persuasive software features would be reported that were identified by at least three evaluators. Additionally, ideas were collected to further improve the PSD model based on the information gathered from evaluations.

3.2 Selected native mobile applications

We aimed to accumulate a concise yet illustrative pool of current health and well-being mobile applications. All the selected applications were in English and it was stated in their descriptions that they support some kind of health or wellness related behavior change. The applications were selected as a part of another research project and this study was limited only to evaluation of their persuasive features. Majority of the evaluated applications targeted general well-being of the users and different software features were utilized. The selected applications were: AngerCoach (ANG); Awareness Lite (AWA); Healthy Habits (HEA); Live Happy (LIV); MiMood (MIM); MoodKit (MOK); Mood Meter Lite (MOM); Mood Runner (MOR); MyBalance (MYB); MyCalmBeat (MYC); SeeMyCity (SEE); T2 Mood Tracker (T2M).

4 FINDINGS

4.1 Persuasion context

The first step was to evaluate the intent, the event and the persuasion strategy of the selected applications since they formulate the persuasion context (Oinas-Kukkonen and Harjumaa 2009). Dey (2001) explains context as information that can be used to depict the situation of an individual. Since the evaluation method was expert evaluation, the persuasion context was not studied in the field. Below are the findings from the selected applications with regard to the intent, the event and the strategy:

The intent. The intentions of the developers were not clearly specified in the application descriptions. It was noted that some of the applications were built to serve commercial purposes of another stakeholder (e.g. book publisher). Therefore, we cautiously suggest that applications such as ANG, LIV and MYC serve a commercial purpose since ANG and LIV were found to be promoting books while MYC aimed to promote a paid membership for the application. It seemed that other nine applications were built to support users in their everyday life and goals.

The event. The event is about understanding the user, technology and the use context. Based on the descriptions, MIM, MOR, MOK, MOM, T2M, LIV, and SEE are designed for people who wish track their moods, identify emotional patterns, or want to experience cities from different perspectives depending on their moods. HEA is intended for individuals who either wish to adopt new habits or break old ones and MYB is for individuals who wish to improve their well-being by monitoring their nutrition, fitness, and lifestyles. ANG is intended for individuals who need help with their anger and AWA is intended for individuals who wish to improve their well-being by being more peaceful. MYC is for individuals who wish to reduce stress by performing breathing exercises. Since all the selected applications operate on smartphones, they could be used at any time and place i.e. at home or office.

The strategy. The PSD model underlines two key elements as possible strategies for persuading users i.e. the message and the route. The message signifies the actual content in the form of rational arguments or logical representation of user's personal data for example, statistical data of a user's eating habits. The route is about how the persuasive arguments are conveyed. The route could be direct (using logical arguments), indirect (using cues) or a mix of both. The evaluation of selected applications indicated fairly compact presentation of messages. Based on our evaluations, we mapped the applications to the Outcome/Change (O/C) Matrix developed by Oinas-Kukkonen (2010a; 2010b; 2012). The O/C matrix highlights three categories in behavior change i.e. change in the act of complying (C-change: aiming to make the users comply with the system), change in behavior (B-change: aiming to bring sustainable change in behavior) and change in attitude (A-change: aiming to influence users' attitudes). Consequently, three potential outcomes are expected i.e. Formation (F-Outcome), Alteration (A-Outcome) and Reinforcement (R-Outcome). The results indicate that none of the applications were aimed at targeting compliance change while majority of the applications apparently targeted behavior change. See table 1.

O/C	C-Change	B-Change	A-Change
F-Outcome	Forming an act of complying (F/C)	Forming a behavior (F/B) HEA, MOR, MYC	Forming an attitude (F/A) LIV
A-Outcome	Altering an act of complying (A/C)	Altering a behavior (A/B) ANG, HEA, MOR, MYB	Altering an attitude (A/A) ANG, LIV, T2M
R-Outcome	Reinforcing an act of complying (R/C)	Reinforcing a behavior (R/B) HEA, MOK, MOR	Reinforcing an attitude (R/A) AWA, LIV, MOK, T2M

Table 1. The intended Outcome/Change as analyzed using the O/C matrix.

After the applications were actually used, it was detected that there were superficial narratives of use and user contexts in their descriptions. For instance, majority of the applications failed to address differences (e.g. age, gender, culture etc.) in a possible variety of potential users.

4.2 Identified persuasive features

The distinctive persuasive features assimilated in twelve selected mobile applications are presented in Table 2. It should be noted, however, that the quantity of identified features does not necessarily correlate with the overall persuasiveness of an application; instead user studies with adequate number of subjects are required to come to conclusive arguments.

PRIMARY TASK SUPPORT	ANG	AWA	HEA	LIV	MIM	MOM	MOK	MOR	MYB	MYC	SEE	T2M
Self-monitoring	■	■	■	■	■	■	■	■	■	■	■	■
Reduction	■	■	■	■	■		■	■	■	■	■	■
Personalization			■	■			■				■	
Rehearsal		■					■			■		
Tunnelling	■			■			■					
Simulation												
Tailoring												
DIALOGUE SUPPORT	ANG	AWA	HEA	LIV	MIM	MOM	MOK	MOR	MYB	MYC	SEE	T2M
Reminders		■	■				■	■				■
Praise			■			■						
Suggestion			■									■
Rewards			■									
Similarity								■				
Social role												
Liking	Not evaluated											
CREDIBILITY SUPPORT	ANG	AWA	HEA	LIV	MIM	MOM	MOK	MOR	MYB	MYC	SEE	T2M
Trustworthiness	■	■	■	■			■	■		■		■
Real-world feel	■	■	■	■			■			■		■
Expertise	■			■			■					■
Verifiability	■			■			■					
Authority	■											■
3rd party endorsements												
Surf. Credib	Not evaluated											
SOCIAL SUPPORT	ANG	AWA	HEA	LIV	MIM	MOM	MOK	MOR	MYB	MYC	SEE	T2M
Social Comp.			■	■	■	■	■				■	■
Cooperation											■	
Social Facil.											■	
Norm. Influen.											■	
Competition												
Social Learning												
Recognition												
Note. Shaded cell = feature was observed; clear cell = feature was not observed												

Table 2. Persuasive system features observed in evaluated mobile applications

4.3 Primary task support

The results from the evaluation indicate that all the applications employed primary task support components at a general level. Self-monitoring (found in all the applications), reduction (in eleven applications), and personalization (in four applications) appeared to be the most commonly utilized techniques. Surprisingly, tailoring was not incorporated in any of the evaluated applications. Most of the applications reduced required effort to perform an action, however in this study, reduction was identified as persuasive software feature that helped users to find the most important information or action. For instance, ANG utilized "Help I'm Mad Now" button on the main page hence reducing the number of steps to reach the core functionality. Other features such as simulation and rehearsal were also underutilized in most of the evaluated applications. Primary task support features, their descriptions and example implementations are described in table 3.

Feature	Description	Example Implementation
Self-monitoring (n=12)	Providing means for users to track their behavior, performance or status.	Past behaviors / activities / measurements presented on graphs (MOM); pie charts, timelines (MYC)
Reduction (n=11)	Reducing effort that users expend with regard to performing their target behavior.	Predefined habit library (HEA); mood improvement tools (MOK); effortless goal-setting (MOK)
Personalization (n=4)	Offering personalized content and services for the users.	The service and its content is personalized based on user-inputs and other known variables e.g. name, gender, age, location, language (HEA, MOK)
Rehearsal (n=3)	Providing means for rehearsing target behavior.	Breathing exercise supported by the application. (MYC)
Tunnelling (n=3)	Guiding users in the attitude change process by providing means for action that brings them closer to the target behavior.	After filling a questionnaire / survey the user is presented with appropriate set of tools and means for action. (ANG)
Simulation (n=0)	Providing means for observing the cause and effect with regard to users' behavior.	Simulated overall health score based on users' aggregated personal health data.
Tailoring (n=0)	Providing tailored content for distinct user groups.	Different content for women and men; beginners and advanced users

Table 3. Primary task support

4.4 Dialogue support

The components of dialogue support were largely underutilized in the evaluated applications with only two applications (HEA, MOM) using praise while rewards were used in only one application, i.e. HEA. The use of reminders was found to be the most common feature to enhance the user-system dialogue. Essential persuasive features such as suggestion and similarity were found to be absent from the evaluated applications except for HEA. We believe that this is an alarming outcome since mobile applications are expected to enhance greater level of dialogue with the users. The findings related to dialogue support are described in table 4.

Feature	Description	Example Implementation
Reminders (n=5)	Reminding users of their target behavior during the use of the application.	Automatized / event-triggered reminders; customizable reminders via e.g. email/SMS/screen prompt (HEA)
Praise (n=2)	The application praises via words, images, symbols, or sounds as a way to provide positive feedback.	Automated prompt praises the user for reaching a certain goal. (HEA; MOM)

Suggestion (n=2)	The application suggests that users carry out behaviors during the system use process.	Application for healthier eating habits provides an option for coaching messages. (HEA)
Rewards (n=1)	The application gives credit for performing the target behavior.	Trophies, badges, icons, pictures and other content provided to the user for successfully finishing a certain task / challenge or reaching a goal. (HEA)
Similarity (n=0)	The application imitates its users in some specific way.	Slang names are used in an application, which aims at motivating teenagers to exercise.
Social role (n=0)	The application should adopt a social role.	Embodied conversational agent offering advice and suggestions.
Liking (not evaluated)	The application should have a look and feel that appeals to its users.	Likeable characters, such as a colourful droid.

Table 4. Dialogue support

4.5 Credibility support

Based on the evaluations, we carefully suggest that majority of the applications indicated very little credibility, if any. For instance, in some of the evaluated applications, excessive advertisements and/or marketing and promotional information reduced the overall credibility (e.g. HEA). Although trustworthiness was found in eight applications, other important features such as expertise, authority, third party endorsements and verifiability were hardly employed. For example, none of the applications displayed the use of third party endorsements while only three (ANG, LIV and MOK) demonstrated verifiability. The findings related to credibility support are described in table 5.

Feature	Description	Example Implementation
Trustworthiness (n=8)	The application provides information that is truthful, fair and unbiased. The application must not exploit private user data.	The system/application explicitly states the privacy policy. The user has control over security settings (e.g. setting pin/lock code; disabling/enabling location tracking; disabling/enabling data sharing).
Real-world feel (n=7)	The application provides information of the organization and/or actual people behind its content and services.	The application provides means to contact the developer. E-mail address; web address; physical address; photos; map etc. (HEA, T2M, AWA)
Expertise (n=4)	The application provides information demonstrating knowledge, experience, and competence.	Expert videos (ANG). Users can ask questions from the expert(T2M).
Verifiability (n=3)	The application provides means to verify the accuracy of site content via outside sources.	Providing links to external resources and references to scientific publications. (ANG, LIV, MOK)
Authority (n=2)	The application refers to people in the role of authority.	Quoting an authority, such as a statement by government health authority/office (ANG, T2M)
Third party endorsements (n=0)	The application provides endorsements from respected sources.	A certificate / trust seal indicating the use of secure connections. A recommendation / an approval from an authoritative organization.
Surface credibility (not evaluated)	The application has a competent look and feel. The visual design should reflect the context.	Clear layout; consistent graphics, images and typography; avoiding old-fashioned graphics; avoiding excessive marketing; avoiding typos and grammatical errors.

Table 5. Credibility support

4.6 Social support

The degree of social support features in the evaluated applications was found to be minimal. In most cases, users were given an option to share their progress via email or Facebook. In this study, social support was identified only when the applications displayed features such as blogs, forums and discussion boards. As delineated in the PSD model, social learning has the potential to enrich users' individual motivation to perform a desired behavior since the users are able to view performance of others. Similarly, social comparison allows users to relate their individual performance with other users. The findings related to social support are described in table 6.

Feature	Description	Example Implementation
Social comparison / sharing (n=7)	The application provides means for comparing performance with the performance of other users.	Users can share and compare information related to their health behavior via social networking application. (HEA, MOK)
Cooperation (n=1)	The application provides means for co-operation.	Users can tag and share locations with other users. (SEE)
Normative influence (n=1)	The application provides means for gathering together people who have the same goal and make them feel norms.	Users can share their information with similar users, and view information from similar users. (SEE)
Social facilitation (n=1)	The application provides means for discerning other users who are performing the behavior.	Users can recognize how many others are at the same location. (SEE)
Competition (n=0)	The application provides means for competing with other users.	Stop smoking for a month and win a prize.
Recognition (n=0)	The application provides public recognition for users who perform their target behavior.	Personal stories of the people who have succeeded in their target behavior / goal are presented to other users.
Social learning (n=0)	The application provides means to observe other users who are performing their target behaviors and to see the outcomes of their behavior.	A shared fitness journal.

Table 6. Social support

4.7 Findings related to PSD model

The user context was analysed using expert evaluation in this study. However, field studies involving real users are also recommended for understanding persuasion context. All the four evaluators had to rely on the information and descriptions that were provided on the applications' web sites. It was particularly hard to identify exact motivations of the designers of the applications. Likewise, it was difficult to conclude whether any of the evaluated applications was aimed at influencing behaviors or attitudes (change type) of the users. None of the applications disclosed an explicit purpose. The findings from heuristic evaluation are an outcome of synthesis of observations and remarks made by the four research scientists. While the synthesis of the evaluations was being made, it was found out that some of the persuasive features were ambiguous and the findings of individual evaluators differed from the overall synthesis. To overcome ambiguous situations, it was agreed that three out of the four evaluators had to agree in identifying a feature for it to be included in the synthesis. For instance, all the evaluators highly agreed that features such as liking and surface credibility were hard to identify because of their subjective nature. Therefore, it was decided that both liking and surface credibility would be excluded from the evaluation process.

The findings of our study indicate that functionalities that employ primary task support features were incorporated fairly broadly in the evaluated applications. Self-monitoring, reduction, and personalization appeared to be the most commonly used techniques to support users in fulfilling their tasks. However, tailoring was not employed in any of the evaluated applications. While reminders

were commonly utilized, software features from dialogue support were largely under-utilized in the evaluated applications. For instance, vital persuasive features such as praise and virtual rewards were found to be absent from the evaluated applications. Based on the evaluations, it was noted that majority of the applications demonstrated trustworthiness and/or expertise. However, all the evaluators pinpointed excessive advertisements and marketing promotions in some of the applications as a factor that could reduce the overall credibility perceived by users. The degree of social support in the evaluated applications was remarkably shallow. In the applications that utilized social comparison (e.g. HEA, LIV, MOK, T2M), users were provided with an option to share their progress via email/Facebook etc. Evaluated applications failed to provide deeper social connectivity such as instant messaging, forums and discussion boards.

5 DISCUSSION

The findings suggest that majority of the applications lacked tailored information. The implementation and design of primary task support features was found to be poor. For instance, where self-monitoring was incorporated, it required considerable effort from the users in terms of data input. Tailoring was not incorporated in any of the evaluated applications however some evaluators indicated use of tailoring. This was followed by rigorous re-evaluations and exhaustive discussions. It was agreed that none of the applications presented information content based on the user group or use context. This could be due to the nature of the applications, the target behavior and lack of knowledge of persuasive software features on the developers' behalf. An interactive system typically provides feedback. Al-Natour and Benbasat (2009) maintain that IT artefacts are social actors. Accordingly, people consider their interactions with IT artefacts as interpersonal in nature. Likewise, people tend to engage with IT artefacts as if they were interacting in social situations (Al-Natour and Benbasat 2009; Lee 2009). Effective dialogue support features should be incorporated to keep users involved and motivated in continuing to interact with the system and helping them reach their goals. It has been stated that features supporting users' primary task are desirable for persuasion (Oinas-Kukkonen and Harjumaa 2009). Further, primary task support features aim to improve users' self-efficacy while decreasing cognitive efforts and disorientation (cf. Nadkarni and Gupta 2007; Webster and Ahuja 2006). The degree of social support in the evaluated applications was largely shallow. Despite the prevalence of social support components in the form of blogs, forums, groups, messaging boards and chat rooms in web-based health applications, mobile applications seem to be lagging far behind. We find this contrast to be very interesting. Other researchers have reported similar findings. For instance, Chomutare et al. (2011) found very little social connectivity in current mobile applications that address diabetes. They point out that majority of applications include minimal social features mainly by providing a link to social networking sites. They further state that: "Some applications also provide the user with an account to a forum. However, there are no functional links or integration between information in the mobile application and the social media application. For instance, it is not easy to share graphs and data in the mobile applications with friends or relatives in social network." The use of social networking sites has become a routine at work and/or free time for millions of users. For their captivating nature, online communities have been rigorously examined. Preece and Shneiderman (2009) have reviewed users' roles and their impact on online communities. They suggest that a high majority of users who participate in social networking platforms generally take part in discussion forums, read blogs, or watch multimedia (photos, videos). As proposed by Connelly et al. (2006), mobile applications have the potential to improve self-monitoring along with real-time feedback hence effectively utilizing persuasive technologies.

This study also demonstrates how the PSD model could be applied to evaluate persuasive features. The initial evaluations had some disparities especially the difference between credibility and trust. Everard and Galletta (2005) explain the difference between credibility and trust by stating that trust relates to an observer while credibility is the characteristic of the person or an object being observed. Sillence et al. (2006) propose that different features could enhance users' trust in online health advice: (i) reliable and pleasant visual designs; (ii) use of well-known brands and logos; (iii) reliable

information, and (iv) personalized content. This research did not aim to evaluate trust features in detail. Therefore all trust related issues are integrated into one category, perceived credibility support. A notable limitation in this study is that the amount of the selected and evaluated applications represents only a mere drop in the ocean in the context of health and well-being applications. Nevertheless, we argue that our work is valuable for both designers and researchers of native mobile applications. This study provides better understanding of evaluating persuasion principles and persuasive software features. It illustrates the analysis and evaluation of persuasive information systems using the PSD model using expert evaluations. The findings provide a critique of native mobile applications with regard to persuasive design. Our work opens further opportunities for designers to identify and incorporate software features that could significantly enhance the overall efficacy of the information systems. However, we would like to emphasize that the mere presence of persuasive features might not be enough to make an application or a system more persuasive. Whether a given application is persuasive or perceived to be persuasive in a certain context, user studies with sufficient number of participants is recommended. Further research is also warranted to improve practices that could help designers understand how and under what circumstances explicit persuasive system features (either in isolation or collectively) could lead to desired outcomes in behavior change support systems (Oinas-Kukkonen 2010a; 2012) in diverse contexts and across larger populations.

6 CONCLUSION

This paper presents findings from evaluation of persuasive features in twelve native mobile applications for general well-being. It categorizes different persuasive features from the evaluated applications. In addition, it demonstrates application of the PSD model in expert evaluation. Expert evaluations have some limitations, for instance potential bias. However, we have attempted to overcome such limitations by having four evaluators. The results indicate that there is a scope for improvement in designing and implementing persuasive mobile applications for health and well-being. In the primary task support category, reduction, self-monitoring and personalization are generally employed however; key persuasive features such as tailoring were found to be absent from the evaluated applications. Whilst most of the applications exhibited acceptable level of credibility, the degree of social support components utilized was found to be poor. This study revealed several action points for system developers and IS researchers. For instance, it is recommended that persuasive systems should be developed in a way that they provide tailored information to address different user groups, human-computer interaction could be fostered by incorporating software features such as social cues, feedback and virtual rewards, and users could be motivated through enhanced social support i.e. by allowing/facilitating users to share and monitor their progress with others.

Regarding PSD model it was found out that some of the principles e.g. liking, surface credibility, authority and expertise are somewhat ambiguous. Various improvement ideas were presented in this paper. Although the use of persuasive technologies in native mobile applications is expanding yet it is apparent that there is leeway for further research that will help designers to develop efficacious persuasive mobile applications. Furthermore, it can help designers to build behavior change support systems rather than stand-alone persuasive applications. Current research on persuasive mobile applications does not meticulously unearth the core techniques employed. There is an indication of application of behavior change theories while developing mobile applications, which is not adequate. While a theoretical background is highly desirable, we advocate incorporation of explicit persuasive software features in the design process of persuasive mobile applications.

Acknowledgments

The study was supported by SalWe Research Program for Mind and Body (Tekes – the Finnish Funding Agency for Technology and Innovation grant 1104/10).

References

Abroms, L. C., Padmanabhan, N., Thaweethi, L., and Philips, T. (2011). iPhone apps for smoking cessation: A content analysis. *Am. J. Prev. Med.* 40, 3 (March 2011), 279-285.

Al-Natour, S. and Benbasat, I. (2009). The adoption and use of IT Artefacts: A new interaction-centric model for the study of user-artefact relationships. *JAIS* 10, 9, 661–685.

Briñol, P., and Petty, R. E. (2009). Persuasion: Insights from the self-validation hypothesis. *Adv. Exp. Soc. Psychol.* 41, 69–118.

Buttussi, F. and Chittaro, L. (2010). Smarter phones for healthier lifestyles: An adaptive fitness game. *Pervasive Comput.* 9, 4, 51–57.

Chomutare, T., Fernandez-Luque, L., Årsand, E., Hartvigsen, G. (2011). Features of mobile diabetes applications: review of the literature and analysis of current applications compared against evidence-based guidelines. *J Med Internet Res* 13, 3, e65.

Connelly, K. H., Faber, A. M., Rogers, Y., Siek, K. A. and Toscos, T. (2006). Mobile applications that empower people to monitor their personal health. *e & i Elektrotechnik und Informationstechnik* 123, 4, 124–128.

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 Conference on Human Factors & Computing Systems* (Boston, MA, USA, April 04 - 09, 2009). CHI '09.

Derrick, D., Jenkins, J. and Nunamaker, J. (2011). Design principles for Special Purpose, Embodied, Conversational Intelligence with Environmental Sensors (SPECIES). *AIS THCI* 3, 2, 62–81.

Dey, A. K. (2001). Understanding and using Context. *Pers. Ubiquit. Comput.* 5, 1, 4–7.

Everard, A. and Galletta, D. F. (2005). How presentation flaws affect perceived site quality, trust, and intention to purchase from an online store. *J. Manage. Inform. Syst.* 22, 3, 55–95.

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

Fogg, B. J. (2009). A behavior model for persuasive design. In *Proceedings of the 4th International Conference on Persuasive Technology* (Claremont, CA, USA, April 26 - 29, 2009). Persuasive '09. ACM, New York, NY.

Fogg, B. J. and Eckles, D. (2007). *Mobile Persuasion: 20 Perspectives on the Future of Behavior Change*. Stanford Captology Media, Stanford.

Froehlich, J., Dillahunt, T., Klasnja, P., Mankoff, J., Consolvo, S., Harrison, B., and Landay, J. (2009). UbiGreen: Investigating a mobile tool for tracking and supporting green transportation habits. In *Proceedings of the Conference on Human Factors & Computing Systems* (Boston, MA, USA, April 04 - 09, 2009). CHI '09. ACM, New York, NY, 1043-1052.

Gasser, R., Brodbeck. D., Degen, M., Luthiger. J., Wyss, R. and Reichlin, S. (2006). Persuasiveness of a mobile lifestyle coaching application using social facilitation. In *Proceedings of First International Conference on Persuasive Technology* (Eindhoven, The Netherlands, May 2006). Persuasive '06. Springer, Lecture Notes in Computer Science, Vol. 3962, 27-38.

Gefen, D. and Straub, D., (2000). The relative importance of perceived ease of use in IS adoption: A study of e-commerce adoption. *JAIS* 1, 1, Article 8. Available at: http://aisel.aisnet.org/jais/vol1/iss1/8 (Last accessed: Oct 29, 2011)

Grimes, A., Kantroo, V., and Grinter, R. E. (2010). Let's play! Mobile health games for adults. In *Proceedings of The 2010 ACM Conference on Ubiquitous Computing* (Copenhagen, Denmark, September 26 - 29, 2010). Ubicomp '10. ACM, New York, NY, 241-250.

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

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, 340-353.

Holzinger, A., Dorner, S., Födinger, M., Valdez, A, C., and Ziefle, M. (2010). Chances of increasing youth health awareness through mobile wellness applications. *Lecture Notes in Computer Science* 6389, 71-81.

Lee, E.-J. (2009). I like you, but I won't listen to you: Effects of rationality on affective and behavioral responses to computers that flatter. *Int. J. Hum.-Comput. St.* 67, 8, 628-63.

Lockton, D., Harrison, D., Stanton, N. (2008). Design with intent: Persuasive technology in a wider context. In *Proceedings of the 3rd International Conference on Persuasive Technology* (Oulu, Finland, June 4-6, 2008). Persuasive '08. Springer-Verlag, Berlin, Heidelberg. Lecture Notes in Computer Science, vol. 5033, 274-278.

Loock, C. M., Staake, T. and Landwehr, J. (2011). Green IS design and energy conservation: an empirical investigation of social normative feedback. In *Proceedings of the International Conference on Information Systems* (Shanghai, China, December 4-7, 2011). Paper 10. Available at: http://aisel.aisnet.org/icis2011/proceedings/humanbehavior/10

Nadkarni, S. and Gupta, R. (2007). Task-based model of perceived website complexity. *MIS Quarterly* 31, 3, 501-524.

Nielsen, J. (1993). Usability Engineering. Morgan Kaufmann, San Francisco. ISBN 0-12-518406-9

Oinas-Kukkonen, H. (2010a). Behavior change support systems: A research model and agenda. In *Proceedings of the 5th International Conference on Persuasive Technology* (Copenhagen, Denmark, June 7-10, 2010). Springer-Verlag, Berlin, Heidelberg, Lecture Notes in Computer Science, Vol. 6137, 4-14.

Oinas-Kukkonen, H. (2010b). Requirements for measuring the success of persuasive technology applications. In: MB'10 August 24-27, Eindhoven, the Netherlands

Oinas-Kukkonen, H. (2012): A foundation for the study of Behavior Change Support Systems. Forthcoming in: Personal and Ubiquitous Computing.

Oinas-Kukkonen, H. and Harjumaa, M. (2008). A systematic framework for designing and evaluating persuasive systems. In *Proceedings of the 3rd International Conference on Persuasive Technology* (Oulu, Finland, June 4-6, 2008). Persuasive '08. Springer-Verlag, Berlin, Heidelberg. Lecture Notes in Computer Science, vol. 5033, pp. 164-176.

Oinas-Kukkonen, H. and Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Comm. Assoc. Inform. Sys.* 24, 1, Article 28. Available at: http://aisel.aisnet.org/cais/vol24/iss1/28

Oliveira, R., Cherubini, M, and Oliver, N. (2010). MoviPill: Improving medication compliance for elders using a mobile persuasive social game. In *Proceedings of The 2010 ACM Conference on Ubiquitous Computing* (Copenhagen, Denmark, September 26 - 29, 2010). Ubicomp '10. ACM, New York, NY, 251-260.

Oulasvirta, A., Rattenbudy, T., Ma, L., and Raita, E. (2011). Habits make smartphones more persuasive. Pers. Ubiquit. Comput. DOI 10.1007/s00779-011-0412-2

Pollak, J., Gay, G., Byrne, S., Wagner, E., Retelny, D., Humphreys, L. (2010). It's time to eat! Using mobile games to promote healthy eating. *Pervasive Comput.* 9, 3, 21-27.

Portnoy, D. B., Scott-Sheldon, L. A. J., Johnson, B. T., and Carey M. P. (2010). Computer delivered interventions for health promotion and behavioral risk reduction: A meta-analysis of 75 randomized controlled trials. *Prev. Med.* 47, 3-16.

Preece, J. and Shneiderman, B. (2009). The reader-to-leader framework: Motivating technology-mediated social participation. *AIS THCI* 1, 1, 13–32.

Shumaker, S. A., and Brownell, A. (1984). Toward a theory of social support: Closing conceptual gaps. *JSI* 40, 4, 11–36.

Sillence, E., Briggs, P., Harris, P., Fishwick, L. (2006). A framework for understanding trust factors in web-based health advice. *Int. J. Hum.-Comput. St.* 64, 8, 697-713.

Soler, C., Zacarías, A., Lucero, A. (2009). Molarcopolis: a mobile persuasive game to raise oral health and dental hygiene awareness. In: Proceedings of the International Conference on Advances in Computer Entertainment Technology, pp. 388–391. ACM, New York (2009)

Tsai, C. C., Lee, G., Raab, F., Norman, G. J., Sohn, T., Griswold, W. G., and Patrick, K. (2007). Usability and feasibility of PmEB: A mobile phone application for monitoring real time caloric balance. *Mobile Netw. Appl.* 12, 2-3, 173-184.

Verhoeven, F., Haring, A., Lugt, R., Van Der., Vreekamp, L. and Zielhuis, M. (2011) Multifaceted design for persuasion: A case study about the design of a mobile safety watch. CHI SPARKS 2011.

Webster, J. and Ahuja, J.S. (2006). Enhancing the design of web navigation systems: The influence of user disorientation on engagement and performance. *MIS Quarterly* 30, 3, 661-678.

Wiafe, I., Nakata, K., Moran, S., Gulliver, S., (2011). Considering user attitude and behavior in persuasive systems design: The 3D-RAB MODEL. ECIS 2011 Proceedings. Paper 186. Available at: http://aisel.aisnet.org/ecis2011/186 (Last accessed: Oct 29, 2011)

Yetim, F., (2011). A set of critical heuristics for value sensitive designers and users of persuasive systems. ECIS 2011 proceedings. Paper 185. Available at: http://aisel.aisnet.org/ecis2011/185 (Last accessed: Oct 29, 2011)