Sitwat Langrial

EXPLORING THE INFLUENCE OF PERSUASIVE REMINDERS AND VIRTUAL REHEARSAL ON THE EFFICACY OF HEALTH BEHAVIOR CHANGE SUPPORT SYSTEM
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Abstract

Information technologies have opened new opportunities to develop persuasive systems that support people to adopt and sustain healthy behaviors. Both web-based and ubiquitous information systems have shown promising results in supporting people to adopt healthy routines. Persuasive systems have therefore received increasing attention from researchers over the past decade. Behavior Change Support Systems are an object of persuasive technology. These systems are designed to facilitate behavior change process over an extended period of time.

This dissertation comprises of six studies, including two investigative, two experimental, and two field studies. An effort has been made to consecutively build these studies to formulate a central research question: To what extent virtual rehearsal augmented with reminders influence overall efficacy of Behavior Change Support Systems?

The primary theoretical underpinning is the Persuasive Systems Design model, which highlights seven postulates and twenty-eight software features for developing Behavior Change Support Systems. However, in the presented work, reminders and virtual rehearsal are explicitly studied. The interplay between these software features is examined through using a mixed-method research approach, using qualitative methodology as a core research approach.

The results indicate that carefully selected and integrated persuasive software features have significant impact on the overall efficacy of Behavior Change Support Systems. Presented work addresses health behavioral change as a critical aspect of healthcare, and also extends contemporary research on critical issues in healthcare including task adherence, attrition and compliance.

Keywords: Behavior Change Support Systems, e-Health, health interventions, persuasive systems design model, persuasive technology, reminders, virtual rehearsal
Langrial, Sitwat, Suostuttelevien muistutusten ja virtuaisen harjoittelun vaikutus käyttöönsä muutosta tukevien järjestelmien tehokkuuteen.
Oulun yliopiston tutkijakoulu; Oulun yliopisto, Tieto- ja sähkötieteiden tiedekunta, Tietoteknian osasto

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**Tiivistelmä**


Tämä väitöskirja koostuu kuudesta tutkimuksesta, sisältäen kaksi eksploratiivista, kaksi kokeellista ja kaksi kentätutkimusta. Kyseiset tutkimukset on suunniteltu siten, että on voitu muodostaa yksi keskeinen tutkimuskeskysmys: Missä määrin virtuaalinen harjoittelut yhdistää muistutusten kanssa voi vaikuttaa käyttäytymisen muutoksen tehokkuuteen?


**Asiasanat:** käyttäytymisen muutoksen tukijärjestelmät, PSD-suunnittelumenetelmä, terveysinterventiot, vakuuttava teknologia, vakuuttavat järjestelmät, virtuaalinen harjoittelut, virtuaaliset muistutukset
This thesis is dedicated to my treasured parents, Mrs. & Mr. Shameem Riaz Ahmed Langrial. A special feeling of gratitude and appreciation for my parents who have supported me throughout my academic career. I also dedicate this thesis to my beloved wife for her support and unconditional love. This thesis is also dedicated to my dearest uncle Mr. Sadiq Ali for his unprecedented support over the years. Lastly, I dedicate this work to Mr. Abdullah Yusaf Ali Langrial for his love and care.
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I completed my first degree in Applied Finance from the University of Western Sydney, Australia. My then supervisor, Professor Tomas James Valentine hired me as a research assistant and it was then that I had the first taste of research. I enjoyed working under Professor Valentine’s supervision and realized that my professional path was going to be in academia. Later, Professor Brain Pinkstone hired me as a university tutor at the Department of Law and Economics, University of Western Sydney, Australia. While I was working as a part time university tutor, I undertook MBA at the University of Wollongong, Australia. Upon completion of my second degree, I worked in various capacities especially in Banking and Financial sector. However, I did not feel content and decided to change my career path and therefore moved to Scotland where I enrolled in MSc Computing Science. I would like to thank Dr. Sean Toohey, Mr. Bill Gwynne and Mrs. Jean Williamson for their kindness and extended support during my stay in Sydney, Australia.

I completed MSc IT with Distinction and Dr. Judith Masthoff advised me to undertake doctoral studies. Without any hesitation, I accepted the offer and started research studies under her supervision. Dr. Masthoff is a well-known and highly appreciated academic and researcher specializing in the area of Computing Science. I completed the first year of my doctoral studies under her supervision. Dr. Masthoff’s competence, experience and extensive support shall always be valued and if it were not for her, this work would not have been completed. Therefore, I wish to pay my deepest salutations and indebtedness for her thoughtfulness and support.

To be honest, it was a challenging task from day one for I had very little if any idea about scientific research. Dr. Masthoff guided me through the first year with great devotion and it was because of her commitment and outstanding supervision that I completed the first year of research. During my studies at the University of Aberdeen, I had an opportunity to work with distinguished scholars.
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I met Professor Oinas-Kukkonen from the University of Oulu, Finland and had brief discussion about my work. I immediately realized that my approach towards research was well in line with his research group else known as OASIS (Oulu Advanced Research on Software and Information Systems). It was the starting point of relatively lengthy communication between the two of us but all ended well as I was hired as a project researcher in the team. I thank Professor Oinas-Kukkonen for having faith in me.

My research journey was not as smooth as I had imagined. Perhaps I was a bit too optimistic not knowing how academics work and the snags a doctoral candidate faces in real life. Nevertheless, I was always highly motivated spending extra hours. While I spent countless hours reading scientific articles about psychology, persuasion, and human behavior, I still found myself in a state of confusion in terms of future research direction. I was never paranoid or afraid of the end result because I had the confidence that I might not solve all the problems in the world nevertheless I would able to contribute towards existing knowledge base.

I have had a long academic journey comprising of extensive work and now that I look back, it all seems like a dream. I had the honour of knowing and becoming friends with great people from across the globe. At the University of Oulu, Finland, I have met and known genuinely great people. I received exceptional support from reputable academics. I wish to extend my hearty gratitude to Professor Seppo Pahnila (My secondary supervisor), Professor Raija Halonen who is more like a family friend and has always stood by me in difficult times, Professor Anssi Öörni for his sincere advice and support over the past months, Professor Markku Oivo for listening to me and motivating me towards completion of this work, Professor Kari Kuutti for helping me in challenging times, Jouni Markkula for his guidance in performing statistical analyses, Professor Pasi Kuvaja for his encouragement, support and friendly attitude, Marja-Liisa Liedes and Eila Kankaala for helping me with all the administrative tasks for the past three years and Peter Hästö for his timely help in resolving a critical issue.

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For any errors that may appear in this work, of course, the responsibility is entirely my own.

Sitwat U. Langrial
Abbreviations

DI  Digital Interventions
IS  Information Systems
PSD Model  Persuasive Systems Design Model
PT  Persuasive Technology
BCSS  Behavior Change Support System
O/CDM  Outcome/Change Design Matrix
HCI  Human-computer Interaction
HI  Health Informatics
UCD  User Centered Design
UI  User Interface
CBT  Cognitive Behavioral Therapy
ACT  Acceptance and Commitment Therapy
List of original publications


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1 Introduction

The research field of persuasive technology (Fogg 2003) has received notable attention from researchers, academics and practitioners for over more than a decade. Persuasive information systems have shown promising outcomes in terms of promoting healthy behaviors and in parallel reducing costs associated with healthcare. Fogg (2003) introduced the new research area of *Persuasive Technology*. He defined persuasive technologies as information systems that are intentionally abstracted, designed and employed to bring desirable change in people’s attitudes or behaviors. Fogg’s inspiring work originates from human psychology. He puts emphasis on three key factors when it comes to changing human behaviors or attitudes. These factors include an individual’s motivation, ability to perform a desired behavior and need for reminders (Fogg 2009).

The research field of persuasive technology underlines the capacity of Information Systems (IS) as a tool for persuasion where technology acts as a medium and social actor (Fogg 2002). Although the description of persuasive technology is convincing however there is a seeming weakness as pointed out by Kelders (2012). Kelders (2012) outlines that persuasive technology as a research field is somehow limited to user-computer interaction and neglects the critical characteristic of computer-mediated communication between the user and technology (2012). It is important to understand the interplay between user-computer interaction and computer-mediated communication when research efforts are made to bring a positive change in people’s behaviors or attitudes. To further develop the research field of behavior change through persuasion, Oinas-Kukkonen (2013) introduced his point of view and labeled it as Behavior Change Support Systems (BCSSs).

A Behavior Change Support System is an object of study within the field of persuasive technology (Oinas-Kukkonen 2013). Typically, a BCSS is defined as,

> “a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes and behaviors or an act of compliance without using coercion, deception or inducements”.

According to Oinas-Kukkonen (2012), BCSSs are designed with intent to change people’s behaviors or attitudes by providing comprehensive and on-going support through a combination of vigilantly selected and integrated persuasive software features. Emerging technologies have opened sublime avenues for designing and implementing novel information systems with a potential to successfully change
people’s behaviors (see Oinas-Kukkonen & Oinas-Kukkonen 2013). Oinas-Kukkonen (2010) additionally highlights the importance of both human-computer as well as computer-mediated communication.

It could be suggested that BCSSs have a slight edge over more traditional persuasive information systems because the key objective of these systems is to achieve potential voluntary outcomes in the form of formation, alteration, or reinforcement (Formation of behaviors, Alteration of behaviors and, Reinforcement of behaviors) of attitude, behavior, or compliance (Attitude change, Behavioral change and, Compliance change). Further, they are transformatively and deliberately designed “information/communication systems” developed to bring realistic change in people’s behaviors or attitudes. As stated above, BCSSs are by essence persuasive in nature, assimilated with both computer-mediated and computer-human persuasion techniques.

Typically, a BCSS would facilitate positive user-system interaction and especially benefit those people who are self-motivated to some extent. Abstracting, designing and evaluating these systems are complex activities. According to Locke and Latham (2002) developing effective information systems would require technological services and functionalities, reliable quality of information, facilitation for setting goals, and capacity for social networking depending on the use context.

Development of a BCSS involves user-computer interaction, including user interface (UI) features, and computer-mediated communication through carefully employed socio-psychological theories. An effective BCSS is expected to be accessible 24/7 without being obtrusive, with simplified behavior change persuasion route and designed on incremental basis (Oinas-Kukkonen 2013). It is important to note that a BCSS would support its users through augmented user-computer interaction, facilitate social interaction and bring in the element of user empowerment. New software design elements come into play when abstracting and designing such systems, such as systematic analyses of persuasive software features. In addition, persuasive strategies, including direct or indirect routes for persuasion as highlighted by Oinas-Kukkonen and Harjumaa (2009) and lastly, special emphasis has to be laid on the persuasion context.

As cited by Kelders (2012), a BCSS as an object of persuasive information systems, complements the definition of web-based information systems. Barak et al. (2008) suggest that these interventions attempt to promote constructive change, improve knowledge, consciousness and understanding by providing health related information and the use of interactive web-based elements.

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There are several research studies in available literature that can be interrelated to BCSSs especially in healthcare purview. For example, Eysenbach (2000) worked on consumer health informatics, Gustafson et al. (2002) worked on consumer health information systems, Murray et al. (2005) worked on interactive health communication applications, Barak et al. (2009) worked on web-based interventions, Or and Karsh (2009) worked on consumer health information technology, and Langrial et al. (2013) worked on a web-based BCSS for mental wellness.

Oinas-Kukkonen (2010) has protracted the research discipline of persuasive information systems by maintaining that the next generation of web has ample potential for healthcare and general well-being. His work takes contemporary persuasive information systems research a step further because there is an emphasis on designing information systems that continuously support users during the behavioral change process. He proposes that emerging technologies have the potential for designers to develop information systems that could motivate and support people successfully over an extended period of time.

Healthier lifestyles and wellness of people are going to be prominent research domains for future research in behavioral change area (Oinas-Kukkonen 2010). It is important for researchers to understand that such systems despite being successors of persuasive information systems have something more to offer. Remarkably, the concept of these systems evolves from the persuasive information systems yet it shows promise to overcome its predecessors i.e. not all persuasive systems could be classified as BCSSs yet all the BCSSs would essentially have persuasive features in one form or the other.

The concept of BCSSs brings new elements into play for researchers, such as profound analysis and incorporation of persuasive software features (tunneling, reduction, personalization, reminders, praise, rewards, social influence etc.), what persuasive strategies ought to be implemented (direct or indirect routes) and a particular emphasis on the user context i.e. the problem domain and persuasion through profiling (see Oinas-Kukkonen & Harjumaa 2009).

A typical BCSS is not designed to detect change in a given behavior. Conversely it is a platform that has the prospective with key features to involve users in a long-term interaction with the system. In addition, it would effortlessly fit into users’ daily routines with components that provide continuing support during and after the behavior change process.

As stated above, BCSS is a relatively new area within the field of IS research. However, the idea is gaining increasing acknowledgment. It would be fair to
suggest that fully functional BCSSs would benefit research in preventive medicine; healthcare and behavioral sciences. In addition, they would positively impact the society as a whole. It is critical to understand that BCSSs are not ordinary and unsophisticated web interfaces. The fact is that it needs a creative fusion of various components of technology including specific software features, credible information, reliable content, robust software functionality and scalability to develop effective BCSSs.

Despite the fact that these systems are gaining growing attention from researchers from across the globe, oddly there is very limited number of thorough research studies about the effectiveness and approval of BCSSs. On the contrary, information systems for professionals such as managers, commonly labeled as Decision Support Systems (see Arnott & Pervan 2008), other information systems for consumers in various domains (e.g. Al-Natour et al. 2008) and specific persuasive information systems known as Recommender Systems (e.g. Kmaik & Benbasat 2006; Tintarev & Masthoff 2007; Masthoff 2011) have been broadly studied and narrated in the research area of information systems. Therefore, there is an evident need for further research in order to gain richer understanding of how people engage and interact with BCSSs and what software features either in combination or isolation could augment their overall efficacy.
2 Related work

2.1 Persuasive Systems

2.1.1 Persuasive System Design model

Enriching Fogg’s (2003) work, Oinas-Kukkonen and Harjumaa (2009) developed a systematic framework for designing and evaluating persuasive information systems. The model is known as the Persuasive System Design model (herein ‘PSD model’). Although the model is theoretical it nevertheless facilitates detailed assessment of the persuasion context (the Intent, the Event and the persuasion Strategy). The model comprises of four distinct software categories that are aimed to improve persuasiveness of information systems.

The PSD model provides a range of design features and software functionalities for developing effective BCSSs. The four distinct categories include primary task support, user-system dialogue support, credibility support and social support. Several researchers have used the PSD model in different contexts, for example, Derrick et al. (2011), Räisanen et al. (2010), Stibe et al. (2013), Tøring and Oinas-Kukkonen (2009) and Yetim (2011). Further the model has been applied in the area of ubiquitous applications for well-being (see Langrial et al. 2012), personal wearable devices for physical training (see Harjumaa et al. 2009), and design for persuasive information systems that promote healthy behavior (see Alahäivälä et al. 2013).
It is important to note that the PSD model does not promote implementation of all the software features in order to develop effective persuasive systems or BCSSs. In other words, the persuasiveness of a given BCSS is by no means guaranteed in terms of the quantity of incorporated software features. On the contrary, it is the quality of prudently selected software features and functionalities that could lead to development of successful BCSSs.

However, a meta-analysis performed by Webb et al. (2010) contradicts this argument where the authors report that behavior change interventions that were incorporated with higher number of behavioral change techniques resulted in greater effects. Yet there are studies that counter argue the findings of Webb et al. (2010). Nonetheless, the PSD model is now accepted as a practical framework for researchers, designers and practitioners for better understanding and estimating target audiences’ needs and expectations. Oinas-Kukkonen and Harjumaa (2009) provide a detailed description of the model, its postulates and the four distinct software categories.

Briefly, primary task support features are aimed to facilitate users’ interaction with BCSSs through features including reduction, tunneling, tailoring, self-monitoring, personalization and virtual rehearsal with the goal to reduce intellectual burden on users and to make user-system interaction simpler (Oinas-
Further, primary task support features help users in making decision as pointed out by Lehto (2013). Fogg and Nass (1997) outline that IT artefacts are social actors. Therefore, users consider their interactions with information systems as interpersonal or social. Also, users engage with IT artefacts as if they were interacting in social settings (see Lehto 2013).

In their study, Looije et al. (2010) report that users experienced virtual and physical characters as being more empathic and trustworthy when compared with text-based feedback. Such findings highlight the importance of augmenting user-system interaction. According to Oinas-Kukkonen and Harjumaa (2009), the dialogue support features enhance user-system interaction and support users to have an extended contact with the IT artefacts thereby leading them to achieve anticipated behaviors. Among others, the dialogue support features include praise, rewards, reminders and suggestions. Undeniably, system to user prompts in the form of subtle reminders and feedback play a significant role too.

As mentioned by Fogg and Nass (1997), adding praise while training users might as well lead to task completion and a state of improved self-confidence. While all the four categories delineated by the PSD model are significant, dialogue support features have fairly more to offer. It could be safely argued that dialogue support features are on par with human computer interaction. For instance, the software features are primarily focused on improved interaction between the users and a given persuasive system or a BCSS.

Improved dialogue between users and a given information system could help users reach their goals, improve self-efficacy, provide feeling of achievement when users are provided with features such as virtual rewards, immediate positive feedback and suggestion, liking and similarity (Oinas-Kukkonen & Harjumaa 2009). Researchers from the field of Human Computer Interaction also support the importance of enhanced dialogue between users and information systems. For example, Consolvo et al. (2009) propose that users should be rewarded for performing a desired behavior or reaching their goals however, negative reinforcement is not desirable, which is in line with the proposition made by Oinas-Kukkonen (2010, 2013).

Credibility support features bring in the element of reliability and dependability through features such as credibility, real world feel, expertise, 3rd party endorsements and authority. According to Everard and Galletta (2005:60), “trust is an attribute of an observer (to have trust), whereas credibility is an attribute of another person or an object of interest (to be credible).” When it comes to information systems’ credibility, it is essential that the users accept the
advice, trust accessible information, and believe the output as outlined by Everard and Galletta (2005).

Sillence et al. (2006) propose that several factors enhance the extent to which an individual might feel that she could trust online advice. These factors include: (i) credible and aesthetic visual design, (ii) classing the web site, with familiar images or trusted logos; (iii) information quality; and (iv) personalization. According to Wathen and Burkell (2002), a given source of information, the receiver, and characteristics of messages (information) together add to a system’s credibility. Further, Pornpitakpan (2004) maintains that persuasiveness of an information system increases with a highly dependable source.

In modern-day life, social relationships are being developed progressively and sustained through technologically-mediated interaction instruments (cf: Oinas-Kukkonen & Oinas-Kukkonen 2013). Social support features are aimed at promoting users’ motivation through features including social learning, social comparison, cooperation, recognition and competition. Available literature does not provide a unanimously accepted definition of social support as indicated by Lehto (2013). Nevertheless, it is largely believed that social support comprises of several levels, for illustration, emotional, judgmental and informational.

According to Shumaker and Brownell (1984:11), social support relates to the exchange of resources between individuals. According to Barak et al. (2009), there is a variety of online social groups that could be identified in either synchronous or asynchronous arrangements, including web-based discussion forums, live chat rooms, and email lists. Barak (2009) outlines that online social support provides greater flexibility and liberty where people can join or leave a given social group at any point of time at their own will. Hwang et al. (2010) also acknowledge the advantages of online social groups by maintaining that users’ privacy and non-judgmental interactions make social networks exclusive from more traditional social groups. They also add that online social support promotes inspiration, distribution of knowledge and experiences. Lastly, Chiu et al. (2006) state that social connections, reliance, complementation, shared views and language govern users’ knowledge sharing in online communities.

The PSD model contributes to information systems research by providing a systematic approach to design and evaluate the context of persuasion and appropriate techniques. While carrying out an analysis of the persuasion context, it is essential to identify the Intent (of the persuader and anticipated change type), the Event (use context, user context and the technology context) and the Strategy (message and the route) employed (Oinas-Kukkonen & Harjumaa 2009).
This approach would provide system designers and researchers with a better understanding of target behaviors, audiences and appropriate persuasive strategies. The PSD model has been recognized as a framework for designing and evaluating persuasive information systems in recent times. More lately, it has been applied to evaluate persuasive software features in a number of studies, for instance, Drozd et al. (2012), Wiafe et al. (2012), Langrial et al. (2012), Langrial and Oinas-Kukkonen (2012) and Stibe and Oinas-Kukkonen (2012).

2.1.2 The Outcome/Change Design Matrix

Behavior Change Support Systems are described as an object of study within the research field of persuasive technology (see Oinas-Kukkonen 2013). It is important to note that a typical BCSS is different from more traditional persuasive system. It is essential for system designers and researchers to have a richer understanding of anticipated change in users, for an instance, what type of outcome and change the system is intended for (see Oinas-Kukkonen & Harjumaa 2009). The Outcome/Change Design matrix (see Oinas-Kukkonen 2013) can help researchers in identifying different types of design goals and strategies with a specific focus on how to facilitate a specific change type i.e. A-Change, B-Change or C-Change (attitude, behavior, compliance change respectively). A clear understanding of anticipated change type would be essential for designing effective persuasive information systems and BCSSs. The Outcome/Change Design matrix is a useful instrument for system designers and researchers to have a better understanding of intended outcomes from users of persuasive systems and BCSSs. The matrix helps researchers to focus on the anticipated change type: whether the users are expected to comply with a newly formed behavior (C-Change), whether the intended change is in users’ current behaviors, or if the expected change is more about users’ attitudes (A-Change). According to the Outcome/Change Design matrix, Formation (F-Outcome), Alteration (A-Outcome) or Reinforcement (F-Outcome) are the three possible outcomes. For illustration, consider formation of a behavior (F/B), e.g. user starts going to the gym, alteration of an existing behavior (A/B), user reduces or stops consuming alcohol, or reinforcement of an attitude (R/A), e.g. user continues to resist cravings for junk food.
2.1.3 Persuasive information systems

Persuasive information systems are essentially interactive and designed to influence users’ behaviors or attitudes. The web and ambient technologies (Verbeek 2009) have created opportunities for effective persuasive technologies. Persuasive technologies have shown particular potential in the area of health, well-being and socio-economic contexts (Oinas-Kukkonen & Harjumaa 2008; Chatterjee & Price 2009). Information systems research has a rich history in studying human behaviors and attitudes (see Jarvenpaa & Todd 1996). Recent studies have shown that information technologies could influence people’s behaviors or attitudes by motivating them to perform desired behaviors (Toscos et al. 2006; Zhu 2007; Pollock et al. 2010; Oinas-Kukkonen & Harjumaa 2008).

Persuasive information systems or persuasive systems (Oinas-Kukkonen & Harjumaa 2008) have a subtle difference when compared with digital interventions. Oinas-Kukkonen and Harjumaa (2008) define persuasive systems as “computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception”. A wide variety of narratives aiming to clarify the crux of persuasive systems could be found in existing literature. Fogg (2003) defines persuasive systems as technologies that are designed to bring a desirable change in people’s behaviors or attitudes.

Fogg’s definition adds a new dimension to the research of behavior change technologies by addressing attitudes as well as behaviors. At present, persuasive systems are being applied to a diverse range of domains such as promoting physical activity (see Toscos et al. 2006), encouraging smoking cessation (see Reiter et al. 2003), promoting healthier life styles (Chatterjee & Price 2009), encouraging people to save energy (Midden & Ham 2009) and promoting healthy aging (Intille 2004). Table 1 represents few examples of persuasive systems from the available literature.
Table 1. Examples of persuasive systems with brief descriptions (adapted from Langrial 2012).

<table>
<thead>
<tr>
<th>Paper title</th>
<th>Applied persuasive features/techniques</th>
<th>Problem domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>The persuasive power of virtual reality: Effects of simulated human distress</td>
<td>Negative feedback.</td>
<td>Personal safety issues.</td>
</tr>
<tr>
<td>towards fire safety (Chittaro &amp; Zangrando 2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designing for persuasion: Toward ambient eco-visualiza-</td>
<td>Unobtrusive feedback.</td>
<td>To create awareness</td>
</tr>
<tr>
<td>tion for awareness (Kim et al. 2010)</td>
<td></td>
<td>towards lifestyle and ecosystems.</td>
</tr>
<tr>
<td>Persuasive features in six weight loss websites: A qualitative evaluation</td>
<td>To identify persuasive features in evaluated</td>
<td>Weight loss.</td>
</tr>
<tr>
<td>(Lehto &amp; Oinas-Kukkonen 2010)</td>
<td>websites.</td>
<td></td>
</tr>
<tr>
<td>Turning the classic snake mobile game into exergame that encourages walk</td>
<td>Exergames</td>
<td>Physical activity.</td>
</tr>
<tr>
<td>ing (Chittaro &amp; Sioni 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Fizzy Drinks: A multi-method study of persuasive reminders (Langrial &amp;</td>
<td>Reminders</td>
<td>Reduced consumption of soda drinks.</td>
</tr>
<tr>
<td>Oinas-Kukkonen 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparative analysis of recognition and competition as features of social i</td>
<td>Social influence.</td>
<td>Twitter usage at public display s</td>
</tr>
<tr>
<td>nfluence using Twitter (Stibe &amp; Oinas-Kukkonen 2012)</td>
<td></td>
<td>creens.</td>
</tr>
</tbody>
</table>

2.2 Behavior change technologies

2.2.1 Behavior change interventions

It is important to understand and differentiate behavior change technologies. Generally speaking, there are three separate classes of these technologies with elusive differences. In simple words, these technologies could be classified as Digital Interventions (DIs), Persuasive Systems (PSs) and Behavior Change Support Systems (BCSSs). Digital interventions have been more or less focused on intervening behaviors in preventive health area primarily through reminders. Persuasive technologies have emerged as a sophisticated research field where IT artefacts are developed to promote behavior change in a much wider scope using software functionalities such as reminders, rewards, and social learning.

Despite its refinement, persuasive technology researchers have somewhat failed to demonstrate actual behavior change as pointed out by Oinas-Kukkonen
(2010). For successful behavior change technologies, Oinas-Kukkonen (2010) advocates richer understanding of social as well as technological features. Building upon existing research, he conceptualized BCSSs that would be built by incorporating carefully selected software features. Therefore, there is an evident hierarchical development illustrating the growth of behavior change technologies. This pattern is represented in Table 2.

<table>
<thead>
<tr>
<th>Intervention type</th>
<th>Brief description</th>
<th>Weakness/Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Interventions</td>
<td>Interventions via reminders primarily used in preventive medicine</td>
<td>Not necessarily persuasive in nature.</td>
</tr>
<tr>
<td>Persuasive Systems</td>
<td>Stand-alone systems aimed at detecting behaviour/attitude change</td>
<td>Generalizability.</td>
</tr>
<tr>
<td>Behavior Change Support Systems</td>
<td>Conceptual platform for developing behavior change technologies augmented with persuasive software features</td>
<td>Further empirical evidence required through rigorous research.</td>
</tr>
</tbody>
</table>

Information systems that are developed to change behaviors are often considered as digital (behavior) interventions (see Reeve & Dunbar 2001). It could be safely argued that labeling behavior change technologies as digital interventions is somewhat holistic. The research field of digital interventions dates back to the early 90s where interventions were primarily employed in the field of preventive medicine mainly through intermediations (paper-based and/or telephonic reminders). A considerable number of studies have been conducted that aimed to intervene health-related behaviors. For instance, Reiter et al.’s (2003) STOP system investigated smoking behaviors using digitally generated and letter-based interventions, Revere and Dunbar (2001) argue that tailored digital interventions are moderately effectual. Likewise, Brendryen and Kraft (2008) studied web-based digital intervention on smoke cessation. The intervention was completed using the Internet and by telephone.

Brendryen and Kraft (2008) argue that digital interventions showed promise in supporting people’s behavioral change process. Noar et al. (2009) report that a substantial amount of work has been done in personalizing interventions in the health domain. They base their illustration on a review of 37 health behavior intervention studies. Noar et al. (2009) also performed a meta-analytic review of
57 studies evaluating health behavior interventions and report that tailoring can bring effectiveness to interventions for the health domain.

2.2.2 Development of behavior change interventions

To this point designers of behavior change technologies have somewhat failed to produce a common platform that could bring a permanent change in a users’ behaviors. However, the area of designing web-based technologies that support users to improve general well-being is gaining momentum (see Oinas-Kukkonen 2010). These technologies predominantly aim to help users in better managing their lifestyles. Presently, different platforms are available for developing behavior change technologies i.e. web-based systems, portable devices and smart phones (Langrial et al. 2012). Still, the task of designing behavior change technologies evidently maintains its coherent challenges, for example, how would users interact with a given information system and how would they process and cognize the information (Eysenbach 2000). Moreover, it is necessary that designers methodically understand how the users perceive to benefit from such technologies. The list of challenges in designing interactive technologies aimed at supporting behavior change goes on like an endless loop.

To be able to design technologies that are by essence interactive is problematic for several reasons therefore designers need to be mindful of the actual needs and expectations of the users. Generally, there is a lack of understanding of theoretical paradigms that are aimed at changing or influencing human behavior (Or et al. 2011) and lack of emphasis on HCI methodologies being employed in the design process. According to Benbasat (2010), systems developed in the HCI discipline are neutral in nature however, this argument is subjective. On the contrary, bringing in HCI into designing persuasive or BCSSs can enrich the aesthetics of the systems.

Aesthetics could play a critical part in designing and developing behavior change technologies and is promoted by Oinas-Kukkonen and Harjumaa (2009). One reason is that generally users’ initial impression and evaluation of a given system is dependent on its visual layout. Maitland and Sick (2009) argue that design of an interface plays a central role in engaging users and making the user experience (UX) enjoyable. A good example is that of UbiFit Garden (Consolvo et al. 2008). It is an interactive persuasive system that aims to promote physical activity through different tools and techniques. One of the key features of the UbiFit Garden is the visual display that presents aesthetic images representing
user information about their physical activity. While reporting the results from their study, Consolvo et al. (2008) add that the users were generally very much amazed with the interface design and visual layout leading them to a higher motivation to perform physical activity.

Another area that needs further research and deliberation is that of the commonly incorporated persuasive techniques. It is evident from existing literature that most frequently incorporated techniques to improve the interaction between the users and systems are prompts or reminders (see Walji & Zhang 2008), praise or feedback (see Arroyo et al. 2005), rewards (see Harjumaa et al. 2009) and social facilitation (see Gasser et al. 2006). Table 3 presents a few selected examples of the most commonly applied persuasive software features for promoting behavior change.

Table 3. A few examples of most commonly used persuasive software features.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Publication title</th>
<th>Identified persuasive features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walji &amp; Zhang 2008</td>
<td>Human-centered design of persuasive appointment reminders</td>
<td>Reminders.</td>
</tr>
<tr>
<td>Lawson et al. 2007</td>
<td>Design of interactive technology for ageing-in-place Waterbot: exploring feedback and persuasive techniques at the sink</td>
<td>Reminders.</td>
</tr>
<tr>
<td>Purpura et al. 2011</td>
<td>Fit4life: the design of a persuasive technology promoting healthy behavior and ideal weight</td>
<td>Virtual rewards.</td>
</tr>
</tbody>
</table>

The aforesaid methods and features could play an important role in developing behavior change technologies however there is a need to craft and enhance persuasive features that could improve user-system interaction (Oinas-Kukkonen & Harjumaa 2009). For example, virtual rewards as a software feature could prove to be meaningless for some users, for some it might be motivating still there could be users who would have an altogether different opinion. Correspondingly, social facilitation is a sensitive and delicate issue. On a general level, users could be categorized as introverts and extroverts. Additionally, not many users would like to share personal information with others especially when
it comes to issues relating to, for instance, alcohol consumption, sleep disorders or even more importantly about health problems. Therefore, if social sharing is incorporated in a BCSS there should always be an option for people to “opt-out” from social sharing or comparison. These are relatively simplistic issues but could have a significant effect on the overall persuasiveness of a BCSS.

It has become a common practice in the field of persuasive information systems that designers and researchers aim at changing behaviors that are somewhat inflexible and therefore require higher motivation and long-drawn-out support. For example, targeting smoking behaviors (Reiter et al. 2003; Brendryen & Kraft 2008) have been studied at different levels. As outlined by Fogg (2009), “stopping smoking especially for those who have a long-time habit is the mount Everest of human behavior change”. However, he supports development of information technologies that could bring progressive and incremental change in people’s behaviors. Such arguments strengthen the idea that researchers and system designers should aim at behavior change that are realistic to induce in the target audience.

Additionally, an incremental persuasive strategy (supported by the PSD model) to modify an existing behavior is highly desirable. Available literature indicates that an overwhelming majority of publications highlight success or positive outcomes; for example, Kim et al. (2010) worked on ambient displays for encouraging users improve their behaviors towards ecological environment, Salam et al. (2010) worked on dental anxiety in children and reported promising results from their study, Mazzotta et al. (2007) worked on promoting healthy eating and Intille (2004) worked on the use of persuasive technology to promote healthy aging.

To the best of our knowledge none of the publications from persuasive technology platforms have reported failures. They either reflect success or at least some evidence towards a potential successful technological development. As hinted by Fogg (2009), failures are not bad at all. The fact of the matter is that we can learn more from failures than success. Reiter et al. (2003) have promoted work that elaborates failures in Natural Language Generation research community. Reporting failures is equally applicable to research outcomes in persuasive information systems and BCSSs. It would add to the current research knowledge and help researchers in accepting unpredicted research outcomes, learn from them and turn those lessons into new intuitions.

This research approach is also advisable because it could help researchers think outside of the box and be more resourceful similar to what successful
businesses do (cf: Oinas-Kukkonen & Oinas-Kukkonen 2013). The main idea is to bring in the critical elements of innovation and creativity within the information research community. The need for innovation and creativity has been identified as a key to success for businesses as well as academics as highlighted by Oinas-Kukkonen and Oinas-Kukkonen (2013).

In addition to accepting and reporting research failures, there is a growing need to combine multiple disciplines. One possible step towards this direction would include using socio-psychological and cognitive behavioral theories in abstraction and implementation of BCSSs. Theory driven design approaches have been advocated by Briggs (2006) and Consolvo et al. (2009). The importance of combining multiple disciplines is also outlined by Oinas-Kukkonen and Oinas-Kukkonen (2013).

2.2.3 Socio-psychological theories for behavior change

One of the decisive objectives of designing behavior change technologies is to successfully inspire and persuade users to bring a desired and enduring change in their behaviors. Successful persuasive strategies influence target audience and their perceptions when behavior change techniques are supported by socio-psychological theories. As stated by Bostrom (1983), persuasion and persuasive techniques is all about effective and carefully crafted communication. In addition, Consolvo et al. (2009) have also endorsed the importance of theory driven design strategies for developing behavior change technologies. Several researchers from health informatics and behavior change technologies have highlighted the importance of theory driven design for behavior change technologies (see Perkins et al. 2007; Brug et al. 2005).

Therefore, it would be reasonable to claim that helping people to maintain their motivation is one of the key features of a given BCSS. An individual might feel motivated to perform a certain action but her ability to perform that action is a different matter. Even when someone is motivated and willing to perform an action, time constraints or lack of resources could cause significant hindrances. The later is about an individual’s ability to perform an action (see Fogg 2003). An example could be of a person who is highly motivated to perform physical exercise but lack of time restricts her from doing so. Early theories of motivation have presented broad rationalizations of human behavior. For example, Hull’s Drive theory (Graham & Weiner 1996), the Incentive theory (Hogg et al. 1995), and the Goal-setting theory (Locke & Lathman 2002) provide an understanding of
reasons behind human motivation. By and large, motivation could be categorized into three main types: Intrinsic, Extrinsic and Image motivation (see Ariely et al. 2008; Goffman 1959). A considerable amount of work has been accomplished in the area of persuasive information systems and other behavior change interventions using motivational techniques such as goal-setting (Locke & Latham 2002), conditioning though positive and negative reinforcement (Dey & Abowd 2000), Social Identity theory (Turner & Reynolds 2010) and Cognitive Dissonance theory (Festinger 1957).

Indeed it is a promising sign to observe that designers of behavior change technologies have recognized the significance of theoretical constructs in the design process and it is therefore that we witness studies that are more often theory driven. For instance, Consolvo et al. (2009) have proposed theory driven strategies for designing BCSSs and have incorporated the Transtheoretical Model and Presentation of Self in Everyday Life. Likewise, the notion of BCSSs (Oinas-Kukkonen 2013) promotes the use of theory of Self-efficacy (Bandura 1977) by incorporating primary task and dialogue support components with an aim to support users in bringing an enduring change in their behaviors.

A detailed conception of socio-psychological theories is essential in the design process yet there is the technical side for developing and implementing BCSSs. As discussed by Consolvo et al. (2009), technical support ought to be incorporated in such a manner that the system integrates impeccably in users’ everyday lifestyle. This claim is furthermore supported by Oinas-Kukkonen (2010). To sum it up, theories of motivation and behavior change that have been studied provide a rich foundation for understanding and predicting human behavior and could therefore prove to be a handful when it comes to development of effective BCSSs.

There is a need for incorporating socio-psychological theories in the design process while keeping in mind the problem domain (Use Context) and the target audience (Oinas-Kukkonen & Harjumaa 2009). Clearly the prominence is upon targeting audience in a systematic manner by incorporating appropriate socio-psychological theories. For example, if the target behavior were to encourage people to walk more, a pre-study survey would be a good starting point to identify the right kind of audience that is enthusiastic and determined to take the initiative.

Further, involving the users to gather deeper information is a suitable step because it could provide information about users’ expectations, what stops them from a desired action and what could inspire them. Involving users in the design process and evaluation of the system is also highly required. Previously, users
have been involved in various studies that are aimed to promote health (see Crawford et al. 2003) and assistive technologies (see Robinson et al. 2009).

**2.2.4 Cognitive psychology and behavior change**

Effectiveness of e-Health interventions that are incorporated with Cognitive Behavioral Therapy-based techniques is highlighted in available literature (see Andersson and Cuijpers 2009). Usefulness of CBT-based treatments for mental well-being is also supported by Seligman et al. (2011). It is often proposed that these treatments are superior to other forms of available treatments. Incorporation of psychological components in behavior change interventions has resulted in successful outcomes. While there are several studies that highlight the practicality of traditional behavioral therapies, Acceptance and Commitment Therapy-based interventions are fairly understudied (see Gaudiano & Herbert 2006; Forman et al. 2007). Acceptance and Commitment Therapy (ACT) is recognized for its positive influence on psychological flexibility (Hayes et al. 2005). Several research studies have highlighted the effectiveness of Acceptance and Commitment Therapy for wider population in terms of wellness and behavior change (see Hayes et al. 1999).

As mentioned earlier, virtual rehearsal as a software feature has not received much attention. However, there is some evidence that supports practicality of rehearsal aimed at learning new skills and behaviors (see Jaafar & Nur 2009; Davis & Yi 2004; Fetterman 2001). Richardson and Richardson (2012) have also supported the amalgamation of cognitive psychological content for behavior change interventions. However, the use of Acceptance and Commitment Therapy is relatively understudied in terms of behavior change, acquiring new skills and general well-being. Identifying this evident gap, we developed BCSSs especially for mental health with a specific focus on sleep deprivation and depressive symptoms (Studies V and VI respectively).

As outlined by Oinas-Kukkonen and Harjumaa (2009), interactive information systems are expected to provide instant feedback and facilitate completion of target behaviors. Studied BCSSs were incorporated with reminders and virtual rehearsal as central software features. Real patients of sleep deprivation and depressive symptoms were recruited through local newspapers. Studies V and VI evaluate the effectiveness of both the BCSSs. It is cautiously stated that we are among the few in information systems research who have
developed and evaluated health BCSSs augmented with Acceptance and Commitment Therapy.

2.2.5 Evaluating Behavior Change Support Systems

The design and implementation of Behavior Change Support Systems is a multifaceted process. It involves technological expertise, carefully designed application of socio-psychological characteristics, vigilant software functionalities, and information credibility as outlined by Locke and Latham (2002). In addition, a typical BCSS is expected to be adaptable and scalable for multiple problem domains. In the context of health-related BCSSs, Kaselman et al. (2008) state that for an information system to reach health care professionals, the research field should employ a broad range of traditional as well as novel health information resources.

Computing technologies and novelties that aim at supporting behavior change are evolving at a swift pace however weaknesses in prevalent research practices are also evident, for instance, lack of rigorous evaluation (see Oinas-Kukkonen 2010). Rigorous assessment methodologies would enhance the discipline of persuasive technologies and BCSSs. According to Consolvo and Walker (2003), for successful implementation of such technologies, thorough evaluation process is highly desirable. They maintain that if evaluations are carried out on incessant basis, there is a greater chance of refining computing technologies by identifying and isolating users’ needs and expectations. Technologies that promote healthier lifestyles are also gaining popularity in HCI discipline according to Klasnja et al. (2011).

Surprisingly, the evaluation of such technologies remains somewhat vague. Essentially there is a need for a framework that could be employed in the process of evaluating BCSSs. It would be fairly challenging to have a comprehensive framework that could evaluate all the relevant persuasive software features incorporated in behavior change technologies. However, there are already a number of schemas available. Perhaps a good strategy would be to combined key techniques from each and make an effort to come up with a more effective evaluation apparatus.

Researchers from HCI and IS fields have contributed towards developing frameworks, for example, Consolvo et al. (2009) signify the importance of behavior change theories as well as design components. They have outlined eight (8) strategies for design i.e. Abstract and Reflective; Unobtrusive; Public;
Aesthetic; Positive; Controllable; Trending and Comprehensive. A key element of Consolvo et al.s’ (2009) work is that it involves users in the evaluation process while designing and studying the system. Likewise, Consolvo and Walker (2003) have advocated Experience Sampling Method (ESM). Again, this method is user-centered and researchers have previously employed the technique to study areas such as social interactions.

Scholtz and Consolvo (2004) argue that there is a lack of a widely accepted framework for users to evaluate the efficacy of ubiquitous computing applications. They have conceptualized a framework that is aimed at evaluating ubiquitous computing technologies. They call their framework as UEAs or framework for Ubiquitous Computing Evaluation Areas. The key constructs of UEAs are (i) Attention; (ii) Adoption; (iii) Trust; (iv) Conceptual Models; (v) Interactions; (vi) Invisibility, Impact and Side Effects and (vii) Appeal and Application Robustness (see Scholtz & Consolvo 2004).

More recently, Fogg (2009) proposed a framework also known as Fogg Behavior Model (FMB). The model states that for a desired action to be performed, it is important that the individual has the motivation, ability and timely reminders. Fogg’s (2009) model explains the relationship between motivations; abilities and reminders however it fails to provide an evaluation methodology for measuring persuasiveness of BCSSs. Waife et al. (2011) have come up with their own framework known as the 3D-RAB model. It is aimed at evaluating persuasive information systems and considers the connection between (i) attitudes and behaviors, (ii) attitudes and behavioral changes and (iii) attitudes and sustaining behavior change. It would be hard to vindicate whether the 3D-RAB model could be utilized to evaluate the success of a persuasive information system. Nevertheless it could help identify various levels of users’ cognitions.

Oinas-Kukkonen and Harjumaa (2009) put forward a conceptual framework for designing and evaluating persuasive systems. They labeled their framework as the Persuasive Systems Design model or the PSD model. Although the PSD model is conceptual yet it facilitates thorough evaluation of the persuasion context (the Intent, the Event and the Strategy). The model comprises of four distinct categories aimed at enhancing persuasiveness and evaluation of persuasive information systems. These categories include: (i) primary task support; (ii) dialogue support; (iii) credibility support and (iv) social support (Oinas-Kukkonen & Harjumaa 2009).

Primary task support aims to facilitate users’ interaction with the system through features such as reduction, tunneling, tailoring and personalization with

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the goal to reduce the cognitive encumbrance on the user and make the interaction simpler. Further features such as personalization help users identify and set their goals and monitor their progress through self-monitoring. It could be safely argued that primary task software features help users in decision-making. As fittingly stated by Eysenbach (2000), features that help users make decisions also enable them to have a clear view of their values and the level of importance.

Dialogue support features aim at reassuring, motivating and supporting users to have a continuous interaction with the system through features such as praise, virtual rewards, reminders and suggestions. In other words, software features form the dialogue support category support users to actively engage and sustain their interactions with the technologies. This in turn helps them achieve desired behaviors or attitudes. Software features including praise, reminders and rewards being essential positive user experience. This is in line with the proposition made by Consolvo et al. (2009), who argue that positive reinforcement is essential for successful user-system interaction.

Credibility support features bring in the element of integrity and trustworthiness through features such as expertise, third party endorsements and authority. According to Everard and Galletta (2005: 60), the apparent difference between trust and credibility is that “trust is an attribute of an observer (to have trust), whereas credibility is an attribute of another person or an object of interest (to be credible)”. Sillence et al. (2006) outline that several factors add to the trustworthiness of presented information.

Finally, Social support features aim to foster users’ motivation through features such as social learning, social comparison, cooperation, recognition and competition. According to Oinas-Kukkonen and Oinas-Kukkonen (2013), there is a growing trend to maintain social interaction between individuals through technology driven platforms. Technology-mediated communications help form online relationships leading to social support as highlighted by Lehto (2013). Social support could be in the form of social networking sites (SNSs) bringing in the element of informational as well as emotional support (see Uchino 2006). Another important aspect of social support is that it entails encouragement, motivation, sharing of information and ideas (see Hwang et al. 2010). According to Shumaker and Brownwell (1984), social support involves exchange of resources (information, experiences) between individuals.

The PSD model contributes to persuasive systems’ research by providing a logical approach to analyse and evaluate the context of persuasion and pertinent techniques. While carrying out an analysis of the persuasion context, it is
essential to identify the Intent \textit{(of the persuader and the change type)}, the Event \textit{(use context, user context and the technology context)} of persuasion and the Strategy \textit{(message and the route)} employed. Such an approach will provide system designers and researchers with a better understanding of the target behavior, audience and appropriate persuasive strategies. As mentioned above, the model has been recognized as a methodical framework for designing and evaluating persuasive information systems in recent times. More recently, it has been applied to evaluate persuasive software features in score of studies, for instance, Drozd \textit{et al.} (2012), Wiafe \textit{et al.} (2012), Langrial \textit{et al.} (2012), Langrial and Oinas-Kukkonen (2012) and Stibe and Oinas-Kukkonen (2012).

\subsection*{2.2.6 Evaluating Behavior Change Support Systems' persuasiveness}

The process of evaluating perceived persuasiveness of Behavior Change Support Systems poses an on-going challenge. Designing systems that aim to modify users’ behaviors is a multi-layered task that requires an across-the-board understanding of multiple disciplines. Researchers and designers need to be realistic while targeting anticipated behavior change. Computing technologies cannot perform miracles therefore it is prudent that the target behavior is simple as argued by Fogg (2009). Further, user involvement (see McGee-Lennon \textit{et al.} 2011) offers an opening for designers to segregate target audience that is responsive to persuasion.

User involvement in the process of designing behavior change technologies could provide valuable understandings and intelligence that otherwise would be hard to obtain (McGee-Lennon \textit{et al.} 2011). For example, users could provide information of what stops them from performing a desired behavior (factors acting as potential barriers), what are their expectations from a given system (perceived benefit etc.), how do they anticipate to use the system (intention to use the system), what is the best channel to reach them (persuasion route), whether they are goal-oriented or competitors (individualized information). Such insights could provide key information for using pertinent theoretical constructs for the design process. Naturally for goal-oriented individuals, the Goal-setting theory (Locke & Latham 1994) would be suitable, for those who do not have enough self-assurance about their ability to perform desired actions, the theory of Self-efficacy (Bandura 1977) would make perfect sense and for users who are at different cognitive levels of changing their behaviors, Transtheoretical Model can provide a suitable platform.
In addition, there is a need for involving users (healthcare experts, social psychologists and end-users) in the design and evaluation process. Health professionals and social scientists could augment effectiveness of the content of the persuasive messages for instance, and users could provide valuable feedback for continuous improvements in the systems. It is also time that the IS research community makes an effort to recruit and study a larger sample sizes. Traditionally, in the persuasive information systems research discipline, relatively small population samples are studied yet major claims are made. Smaller sample sizes might offer an indication of success or failure but having a larger population sample would bring in further assuring estimations leading to better generalizability.

Similarly researchers and experts could play a vital role in better designing and evaluating persuasive information systems. For example, Klasnja et al. (2011) have raised two critical issues regarding evaluation of BCSSs in the general HCI context: identifying and employing adequate evaluative methods and the reporting the results of the evaluations. They argue that initial findings that might indicate a potential of behavior change are have a limited scope. Thus, multi-method approaches should be adopted including both quantitative and qualitative methodologies. Such strategies could provide deeper insights into users’ experiences with technologies leading to a better evaluation of success or failure of BCSSs.

According to Vredenburg et al. (2002), User Centered Design (UCD) has the tendency to improve a product’s (technology) usefulness and usability. They further add that for an optimal use of UCD process, key areas such as user experience (UX), end user involvement and overall user satisfaction need to be given prime attention. Brandt (2006) discusses the process of participatory design involving users to develop technological artefacts. She advocates involving users in the design and development of technologies thereby creating an environment of collaboration between designers and end-users. Among other benefits of participatory design, several authors have reported enhanced communication, negotiation and compromises. Brandt (2006) argues that participatory design offers an ideal framework for designing and developing useful technologies. Langrial and Oinas-Kukkonen (2012) carried out a multi-method study on reminders and suggested that user involvement in the design, implementation and evaluation of persuasive information systems could highlight insights (see McGee-Lennon et al. 2011) that are rather hard to obtain from statistical data alone.
2.2.7 Task completion and compliance

Low adherence and failure to complete expected tasks in behavior change interventions undermine the perceived benefits as stated by McDonald et al. (2002). There is no unified definition and description of adherence and task completion in the area of eHealth interventions as stated by Christensen et al. (2002). Adherence is generally referred to the extent to which users experience the content of a given intervention or BCSS. Additionally, the term drop out is often used to describe a situation where a user does not fulfill the research or intervention protocol (see Christensen et al. 2002). Adherence, attrition and drop out could be reasonably related to Eysenbach’s (2000) work. Task adherence has been a major problem for researchers in health informatics and has gained significant attention ever since Eysenbach (2005) put forward the “Law of Attrition”. Task adherence could be inferred and accordingly studied in multiple contexts. For example, it could be examined as to why participants of research studies or eHealth interventions do not adhere to the expected tasks. As stated earlier, significant numbers of studies have attempted to investigate the explanations for non-adherence (e.g. Christensen et al. 2009; Wangberg et al. 2008).

Based on the findings relating to non-adherence, it is essential to have deeper insights as to what factors could improve adherence. We propose that it is important for researchers not to confuse adherence with “low-attrition” and “high drop-out rates”. For example, dropout generally pertains to participants in a given study who do not fulfill the research protocol (Kelders 2013). According to Eysenbach (2005), adherence refers to the extent to which participants of a given study or intervention experience the content. Adherence has also been reported as the extent to which participants’ behaviors balance with the advice and recommendations as stimulated by the interventions (e.g. Aronson 2007). Such explanations provide much better understanding of adherence and high dropout rates based on the goals of the participants for a given intervention.

This also includes what benefits participants anticipate from using an intervention according to Eysenbach (2000). He argues that one of the major challenges for developing effective interventions is how participants interact with technologies and act upon the commended information. Perceived benefit has also been studied and reported by Jimison et al. (2008) who highlight that one of the most critical obstacle for participants is perceived lack of benefits. In addition,
information systems that are hard to use and interact with (e.g. burdensome data entry) and have credibility issues also affect adherence and drop out rates.

Evidently, significant research efforts have been made to understand the phenomenon of adherence. Studies such as (Brouwer et al. 2011) provide richer insights into the occurrence of adherence. Despite the importance of adherence and high dropout rates, a central aspect of this thesis is on task completion and learning new behaviors through practicing skills and a potential improvement in self-efficacy. As outlined by (Mohr et al. 2011) eHealth interventions are plagued by high attrition rate. Interestingly, much less attention has been paid to how adherence could be improved, for example, through computer-user dialogue or computer-mediated interaction.

For years, research has been carried out to examine the influence of computer-mediated communication (see Carlson et al. 2004) especially in terms of bandwidth (see Walther & D’Addario 2001) that refers to the number of cues (see Walther & Tidwell 1995), presented information and visual aesthetics (see Riva 2002). The assumption is that computer-mediated communication would lead to a high level of task completion or compliance. It is essential to note that task completion is not precisely the same as adherence. We propose that task completion or an act of compliance has an elusive yet noteworthy difference from adherence. While adherence is more about users’ interaction with interventions in a desirable manner (Kelders et al. 2012), task completion is more about an act of compliance and compliance could be further described as an act of forming, altering or reinforcing a routine (Oinas-Kukkonen 2013).

Therefore, our argument is that forming compliance is about completing tasks and reminders could provide much needed prompts to initiate this important process. Task completion could be interpreted as a first step towards solving the problematic issue of adherence and high drop out rates in web-based interventions and other information systems such as BCSSs. This argument is supported by a study carried out by (van Deursen & van Dijk 2011). According to Donkin and Glozier (2012), participants of a qualitative study reported time constraints, busy life styles, undecided priorities and anxiety related to computer usage as being the reasons for not completing tasks. Participants who were able to complete tasks reported intrinsic motivation as the main driver and acknowledged external motivators that helped them in fulfilling the required tasks.

Several studies have supported the role of reminders especially in terms of task completion where participants achieved desired outcomes (e.g. Langrial et al. 2012, Walji & Zang 2008, Lawson & Nutter 2005, Oinas-Kukkonen & Harjumaa
Numerous factors have been reported for poor adherence and participants not completing required tasks. For example, forgetfulness, complexity of the intervention, low motivation, and busy daily routines and interestingly in some cases “intentional experimentation” (Kaushik et al. 2008). In their concluding remarks, Kaushik et al. (2008) propose that reminders have the potential of improving not only adherence levels but, when employed prudently, could lead to trigger desired action helping participants in task completion.

In order to improve task completion and compliance, researchers would need to pay detailed attention to psychological theories to better understand underlying reasons for high dropouts and attrition. According to Davis and Addis (1999: 347), “What is needed are the theories which link specific client characteristics and treatment processes onto attrition”. Yet another important research direction would be to understand those methods and strategies that are employed to engage users. For one instance, Eysenbach (2005) emphasizes on usability issues and technological features that could lead to improved task completion. Last but not the least, eHealth interventions sometimes also known as health BCSSs comprise of unique software features including tunneling, reduction, self-monitoring, praise, rewards, reminders, rehearsal, liking, credibility and suggestions. Further, the ease of use, extent of interaction between users and the intervention (user-system dialogue) and users’ expectations play a vital role. We propose that detailed attention should be paid to the above said software features and techniques to improve task completion and compliance in eHealth interventions and health BCSSs.

2.2.8 Learning through virtual rehearsal as a software feature

According to Silver and Mercer (2002: 90):

“One of the key aspects of human learning is that individuals face a sequence of learning problems over a lifetime. Humans take advantage of this by transferring knowledge from previously learned tasks to facilitate the learning of new tasks.”

Billett (2001) highlights that guided learning practices when frequently exercised, can help formation of newly learned behaviors. Although Billett’s work is focused on workplace learning, however, it can be inferred that appropriate development and implementation of learning techniques, individuals’ willingness to learn and
learning guidelines could lead to newly learned skills and behaviors. The PSD model (Oinas-Kukkonen & Harjumaa 2009) provides a conceptual yet wide-ranging framework for designing and evaluating persuasive information systems and BCSSs. The model depicts an array of persuasive software features for designing effective eHealth interventions that are summarized into four distinct categories.

While existing literature provides plentiful examples of the use of these software features either in isolation or combination, it is surprising to note that virtual rehearsal (Oinas-Kukkonen & Harjumaa 2009) has received little if any attention (see Tørning & Oinas-Kukkonen 2009). The principal aim of software features from the primary task support include goal-setting, self-monitoring (tracking one’s progress) and reducing cognitive burden. Virtual rehearsal stands out from other features as it has the potential to help users learn new skills and behaviors through practicing.

The basic idea of virtual rehearsal could perhaps be connected to “learning through practice”. According to Billett (2010), practice pertains to regular exercise of a given skill, trade or occupation. It is further proposed that learning through practice is not only limited to developing an individual’s capabilities but equally to enable her to tackle existing or new problems. Exercising could also be related to virtual rehearsal as a technique to learn new skills and behaviors.

According to Callaghan (2004), ancient and modern societies have used exercising as a technique to prevent diseases as well as promoting general well-being. Callaghan (2004) adds that there is evidence in favour of the effectiveness of exercising and that exercising (herein termed as “virtual rehearsal”) improves mental health by reducing anxiety, depression and by improving self-esteem and better cognitive functioning. Callaghan (2004) has acknowledged the potential of virtual rehearsal as a software feature although in his paper he has used the term “exercise”. Importantly, he has concluded that there is significant evidence that exercise as a mean for learning new behaviors and skills is neglected especially in e-Health interventions for mental well-being.

Identifying this research gap, we have investigated the impact of virtual rehearsal (i.e. exercising and learning through practice) on the efficacy of BCSSs for mental health. It is encouraging to note that researchers and scholars are starting to pay due attention to rehearsal as a software feature. There are a few examples about the use of virtual rehearsal in existing literature however in different problem domains. For example, Yusoff et al. (2011) implemented a persuasive information system that enabled users to learn “Hajj” pilgrimage tasks
through virtual learning. Yusoff et al. (2011) report that the uses of information technologies such as multimedia have the potential to improve learning process. In addition, such techniques enhance the persuasiveness of a given system. According to Oinas-Kukkonen and Harjuma (2009), virtual rehearsal pertains to a system that provides means for users to exercise or rehearse behaviors i.e. system should provide means for rehearsing a target behavior.
3 Research question and evaluation methodologies

3.1 Research question

The focal research question of this doctoral dissertation is:

To what extent virtual rehearsal augmented with reminders influence efficacy of health Behavior Change Support Systems?

Low task completion and high drop out rates have been reported as major challenges for e-Health interventions (see Eysenbach 2005). Study I investigates the presence and utilization of persuasive software features in pre-selected native mobile applications for mental and general well-being. As outlined by Kelders et al. (2012), persuasive software features have the potential to motivate users in active interaction with eHealth interventions. Therefore, it was a rational step to determine the level and extent of persuasive software features in the evaluated applications. Study II takes a step further where we used the Outcome/Change Design matrix (Oinas-Kukkonen 2010) and provided practical examples of well-being as well as social mobile applications for deeper understanding of the evaluation process of BCSSs. Study III and IV were performed as trial and experimental studies with an aim to identify the potential influence of selected persuasive software features i.e. reminders on task completion and virtual rehearsal on learning new skills and behaviors. Finally, Studies V and VI were performed in a field setting involving real people. The identified software features were implemented in two distinct BCSSs and analyses were performed to determine their potential influence on their overall efficacy.

In this dissertation, we opted to shift away from relatively well-studied issues such as attrition rates and placed greater emphasis on task completion and compliance. We propose that task completion is a distinctive phase that could potentially lead to the solution for issues including attrition and extended engagement. However, it would be relatively hard to present and promote task completion and compliance directly under the umbrella of adherence as outlined by Mohr et al. (2011). A large body of literature provides valuable information relating to task completion. Generally speaking, tangible rewards, praise, positive feedback have been proposed to enhance task completion (Volpp et al. 2008).
Task completion and compliance could also be enhanced by giving careful consideration to intrinsic motivation, developing engaging interventions, avoiding obtrusive techniques (uncalled-for reminders, for one instance) and providing augmented user-system interaction (praise, rewards, reminders and suggestions etc.) as proposed by several researchers, for example Deci et al. (1999). While all the aforesaid stand valid, we wanted to investigate the influence of persuasive and non-obtrusive reminders on task completion and compliance. Table 4 presents an overview of the studied information systems and problem domains.

<table>
<thead>
<tr>
<th>Study</th>
<th>Studied information systems</th>
<th>Problem domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>12 native mobile applications</td>
<td>General well-being</td>
</tr>
<tr>
<td>II</td>
<td>9 native mobile applications</td>
<td>General well-being</td>
</tr>
<tr>
<td>III</td>
<td>A web-based persuasive system</td>
<td>Reducing consumption of fizzy drinks</td>
</tr>
<tr>
<td>IV</td>
<td>A web-based persuasive system</td>
<td>Sleep disorders</td>
</tr>
<tr>
<td>V</td>
<td>A web-based BCSS</td>
<td>Sleep deprivation</td>
</tr>
<tr>
<td>VI</td>
<td>A web-based BCSS</td>
<td>Mild to moderate Depression</td>
</tr>
</tbody>
</table>

### 3.2 Research methodology

For study I, we used expert evaluation and heuristic methodology (Jaspers 2009). Using the PSD model (Oinas-Kukkonen & Harjumaa 2009), four research experts in persuasive systems carried out the heuristic evaluation by installing the applications (on iPhones) and carrying out everyday tasks. Generally, such an approach is used in usability engineering and evaluating user interfaces (Neilson & Molich 1990). However, the use of heuristic evaluation is also becoming popular in the research field of information systems (see Kientz et al. 2010; Doherty et al. 2010; Oinas-Kukkonen & Harjumaa 2008). Scholars have described heuristic evaluations as a technique to find key issues such as identifying usability related problems in a cost-effective manner (see Jeffries & Desurvire 1992). It is further reported that heuristic evaluations provide reliable outcomes. According to Jeffries et al. (1991), heuristic evaluations have reported to identify far more problems when compared with other evaluation methodologies.

For Study II, we used expert evaluation and cognitive walkthrough by mapping a number of selected mobile applications against the Outcome/Change Design matrix (Oinas-Kukkonen 2010). These evaluation techniques can be
swiftly applied leading to identification of usability and related problems (Sears 1997). Nielsen and Molich (1990) developed the heuristic evaluation process. They outline:

“Evaluators begin with a description of the interface and a list of usability heuristics. Evaluators are free to inspect any part of the interface but are instructed to use the usability heuristics to guide their evaluations. Each problem is documented, including the heuristics that are violated and enough contexts to help understand the problem. The simplicity of the technique and its ability to help evaluators quickly find numerous usability problems made it a staple for many development teams”.

Further, Sears (1997) points out that expert evaluations such as cognitive walkthrough is an inspection oriented methodology that has gained extensive recognition. It provides a structured process for evaluation purposes. The aim of the study was to identify whether and to what extent information systems’ designers have an idea of what they expect from end users in terms of behavior change. Both studies II and I helped us identify commonly employed persuasive software features. Further, findings from the two studies paved the way for designing research goals for Studies IV and III.

Study III was carried out as a 14-day field experiment to investigate the potential impact of reminders on task completion. We used a mixed-method research approach by performing statistical analysis as well as conducting focus groups to gather qualitative data. Focus groups are similar to group interviews that capitalize on verbal and face-to-face communication between researchers (moderators) and the participants. Focus groups provide an opportunity for the participants to communicate with each other, discuss various issues, and give remarks about their experiences and viewpoints (see Kitzinger 1995). Further, it is proposed by Kitzinger (1995) that focus groups could be the most appropriate method for researching particular type of questions. Additionally, focus groups are highlighted as a strong qualitative research methodology to develop ideas, gain richer insights and detect emerging themes from the discussions (see Smithson 2000).

A mixed-method approach, sometimes also known as triangulation is commonly used in multiple disciplines (Brewer & Hunter 1989). In addition, Wood et al. (1999) state that a mixed-method approach helps researchers investigate a given research problem by employing a combination of empirical each other. The different research methods indeed compliment each other in the
form of findings detailed research outcomes. According to Kaplan and Duchon (1988), combinations of both qualitative and quantitative approaches provide a deeper understanding for interpreting and validating research outcomes.

Study IV was performed to examine the potential impact of reminders and virtual rehearsal on the effectiveness of a web-based persuasive system. The system was developed to help people improve their sleep behaviors. A mixed-method strategy was adopted to collect and perform data analysis. This research effort was carried out as an investigative experimental study involving real user interaction as well as expert evaluation. According to Wood et al. (1999) a multi-method research approach is grounded on the pattern of corresponding research techniques. It is also proposed that this particular approach helps researchers gain robust information for verifying or examining research hypotheses. A multi-method research approach is generally used in software engineering research (Wood et al. 1999) and in IS research (Gable 1994). According to Bewer and Hunter (1989), a multi-method approach is a combination of different research methods and helps in overcoming weaknesses in contemporary stand-alone research methods (see Wood et al. 1999).

Study V was conducted as a six-week field study primarily with a qualitative research methodology. This study examined the potential impact of reminders and virtual rehearsal on the effectiveness of a health BCSS. The web-based system was built to help people overcome sleep deprivation. According to Forman et al. (2008), qualitative research methods can highlight issues that are sometimes ignored. Further, qualitative data analysis could be helpful in developing interventions and understanding their mechanisms. In addition, Fossey et al. (2002) state that:

“Psychiatrists, and other mental health practitioners, need to be knowledgeable across multiple paradigms and perspectives that inform an understanding of the biological, psychological, social, cultural, ethical, and political dimensions of human lives. In practice, they also recognize the interactive nature of practitioners/patient relationships, attend closely to patients’ subjective experiences of illness, and draw their own personal understanding of human suffering, behavior and interpersonal interactions”.

Applying qualitative research methodology is known to be highly beneficial because it helps minimize ambiguity about critical underlying concepts and questions. In other words, it is a developmental approach that increases the overall understanding of research questions and helps gain meaningful answers.
A comparison of qualitative and quantitative research methodologies is presented in Table 5.

<table>
<thead>
<tr>
<th>Qualitative research</th>
<th>Quantitative research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovery oriented and holistic to understand questions</td>
<td>To determine relationships among variables.</td>
</tr>
<tr>
<td>and assumptions.</td>
<td></td>
</tr>
<tr>
<td>Data collection through open-ended questionnaires.</td>
<td>Data collection is closed-ended.</td>
</tr>
<tr>
<td>Iterative research process.</td>
<td>Sequential and fixed research process.</td>
</tr>
<tr>
<td>Inductive and interpretive data analysis.</td>
<td>Deductive data analysis.</td>
</tr>
<tr>
<td>Validity through methodical rigor.</td>
<td>Validity through correlation, prediction.</td>
</tr>
<tr>
<td>Findings could be generalised in similar settings.</td>
<td>Findings could be generalized from study sample to population.</td>
</tr>
<tr>
<td>Outcomes reported as themes.</td>
<td>Outcomes reported as frequencies and statistical tests.</td>
</tr>
</tbody>
</table>

Qualitative research is a broad approach for performing research analyses and it describes and explains people’s experiences, behaviors, interactions and their social contexts (Strauss 1990). He further adds that qualitative research does not depend on the use of quantifying statistical results. Paraho (2006) highlights the advantages of qualitative research approach by stating that it allows flexibility while carrying out rigorous research. This flexibility helps in selection of participants, data sampling strategies and finally leading to the principle of data saturation, which is also endorsed by Rodwell (1998).

Study VI was also a six-week field study. In this study we evaluated a web-based health BCSS that was developed to support people overcome depressive symptoms. For evaluation purposes, we employed qualitative research methodology. For data collection, semi-structured interviews and Likert-scale questionnaires were employed. In addition, we used SPSS version 20 to perform statistical analysis on pre and post-study psychological measures. The main focus was however on the analysis of qualitative data. Three critical steps in conducting qualitative research include design of sampling techniques, data collection and analysis of collected data sets (see Clissett 2008). In the context of healthcare related research, qualitative methodologies have been described as a constructive approach. According to Forman et al. (2008), these methods provide detailed account of individuals that in return adds to the richness of research efforts.
According to Sofaer (1999), qualitative methods have been employed to explain different types of complex situations and interactions especially in the field of health research field. Further, qualitative research helps clarify the values, language, and meanings that are attributed to people who play central roles in different organizations. In simple word, Sofaer (1999) outlines that qualitative research allows research participants to “speak in their own language, rather than conforming to categories and terms imposed on them by others”. Importantly, it is a special approach to conduct research in health area where the dependent variables are generally normative (formal). Sofaer (1999) further highlights that there are instances when the outcomes of an intervention are known well in advance, yet there are cases where outcomes from a given health intervention are yet to be fully discovered. And this is precisely where qualitative research approach proves to be so effective.

Qualitative research approach has its origins in multiple fields including anthropology, sociology and psychology. As outlined by Forman et al. (2008), these methodologies are based on actual understanding as compared to measuring a given phenomenon. They further add that:

“To do this, qualitative researchers start with an open-ended research question (e.g. “What are the processes through which hospitals adopt and implement programs for early catheter removal?”) and gather information using open-ended data collection techniques, such as individual interviews, focus groups, direct observation, document and artifacts, and even audio and video data, to address that question. Because data collection is open-ended (with research participants free to express themselves in their own words rather than answering, say, a fixed-response survey), qualitative studies involve a discovery process”.

Typically qualitative methodology starts where a researcher does not know what she will end up finding out and uses whatever outcomes she discovers from the data to shape up the research quest. Forman et al. (2008: 765) add that:

“Qualitative methods are holistic, because investigators seek to understand an entire complex picture that cannot be meaningfully reduced to a few discrete variables and linear cause-and-effect relationships”.

The research focus and methodologies used in study I, II, III and IV provided an opportunity to carry out studies V and VI that were based on qualitative research methodologies. These studies were carefully designed and carried out where real
people were recruited. According to Boudreau et al. (2001:4), field studies are “non-experimental inquiries occurring in natural systems.” Following description by Boudreau et al. (2001: 4) provides richer explanation:

“Researchers using field studies cannot manipulate independent variables or control the influence of confounding variables. For data-gathering techniques, field studies can employ either questionnaires, administrated in person, by mail or email, or over the web, or they can use interview transcripts.”

The key research question is investigated and reported in the two qualitative field studies involving real patients of mental disorders. Qualitative research methodology has a long drawn usage in different research areas including anthropology, sociology and clinical psychology. It has received significant attention as a rigorous research methodology over the past decades (Merriam 2002). According to Merriam (2002: 3),

“The key to understanding qualitative research lies with the idea that meaning is socially constructed by individuals in interaction with their world. The world, or reality, is not fixed, single, agreed upon, or measurable phenomenon that it is assumed to be positivist, qualitative research. Instead, there are multiple constructions of reality that are in flux and that change over time. Qualitative researchers are interested in understanding what those interpretations are at a particular point of time and in a particular context”.

Patton (1985) explains qualitative research as an attempt to better understand situations and contexts with their uniqueness in a given context. He (Patton 1985: 1) further adds,

“This understanding is an end in itself, so that it is not attempting to predict what may happen in the future necessarily, but to understand the nature of the setting – what it means for participants to be in that setting, what their lives are like, what's going on for them, what their meanings are, what the world looks like in that particular setting. The analysis strives for depth of understanding”.

Another reason to adopt qualitative research approach is that it helps researchers better understand complex situations and find out issues that are somewhat ignored (Sofaer 1999) or when there is a lack of theory or an existing theory does not explain a given phenomenon (see Corbin & Strauss 2008). Therefore,
qualitative research methodology being an inductive process provides the solution according to Merriam (2002). In addition, qualitative research is richly descriptive (Merriam 2002: 5). The data in the form of quotes, field notes, participants interviews, excerpts from videotapes, electronic communication, or a combination always support the findings as outlined by Merriam (2002). Table 6 demonstrates the studies included in this dissertation with respective research methodologies. Lastly, a combination of qualitative and quantitative research methods has been reported to be a successful approach for finding better understanding of unknown phenomenon (see Sofaer 1999).

Table 6. An overview of research methods used for studies included in this dissertation.

<table>
<thead>
<tr>
<th>Study No</th>
<th>Research objective</th>
<th>Research methodology used</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>To identify incorporated persuasive software features</td>
<td>Exploratory study based on expert evaluation.</td>
</tr>
<tr>
<td>II</td>
<td>To identify designers' understanding of desired outcomes</td>
<td>Exploratory study based on expert evaluation.</td>
</tr>
<tr>
<td>III</td>
<td>To examine the impact of persuasive on task completion</td>
<td>Mixed-method experimental study.</td>
</tr>
<tr>
<td>IV</td>
<td>To examine the impact of virtual rehearsal on self-efficacy</td>
<td>Mixed-method experimental study.</td>
</tr>
<tr>
<td>V</td>
<td>To analyse the impact of persuasive reminders and virtual rehearsal on efficacy of a health BCSS for sleep deprivation</td>
<td>Qualitative study.</td>
</tr>
<tr>
<td>VI</td>
<td>To analyse the impact of persuasive reminders and virtual rehearsal on efficacy of a health BCSS for depression</td>
<td>Qualitative study.</td>
</tr>
</tbody>
</table>

3.3 Establishing presented work with the IS research field

According to Wade and Hulland (2004), information systems researchers have traditionally been focused on drawing theories from other research fields including and not limited to economics, computing sciences and psychology. Gregor (2006) has outlined key issues in conceptualizing theory i.e. causality, clarification, calculation, and generalization. In her work, Gregor (2006) has used the goals of theory as primary means of classification. Besides from the role of theory in IS discipline, there is a need to pay due attention to IT artefacts.

This doctoral dissertation uses a mixed-method research approach, which is a blend of both qualitative and quantitative research methodologies. As highlighted
by Bryman (1984), a qualitative research methodology is commonly employed to conduct social research that is equally applicable in the research areas of natural sciences as a positivistic style. According to Myers (1987), qualitative research methods are traditionally developed for investigating social sciences and enable researchers to study social as well as cultural constructs. Myers (1987) further adds that qualitative research methods comprise of observations, interviews, documents, texts and finally the researchers’ impressions. It is essential for researchers to understand that qualitative research does not necessarily means interpretive studies. On the contrary, a qualitative research methodology could as well be used as a positivistic approach.

Sidorova et al. (2008) have highlighted what they label as the core properties of the IS research field. They underline IT and organizations, IS development, IT and individual users, IT and the markets and IT and groups of individuals as interest properties for essential IS research. Traditionally, IS research is more or less focused on managerial and decision support areas. However, there is a growing need to expand the research area of IS from more traditional viewpoint to individual level as argued by Berskville (2011).

Conventional research efforts try to verify predefined relationships where exploratory or investigative studies describe impending interplay in a generic form (Boudreau et al. 2001). In the context of investigate and exploratory studies, research methodology and the collected data are used to describe the nature of the interaction as cited by (Boudrea et al. 2001). Additionally, Gregor (2006) has presented a classification of the IS theory. The categories include: (I) theory of analysing, (II) theory of explaining, (III) theory of for prediction, (IV) theory of explanation, and (V) theory of design action (see Gregor 2006).

As outlined by Benbasat and Zmud (2003), “the core of IS research should focus on the IT artefact, the capabilities and practices involved in the development and use of such an IT artefact, and the impacts of IT artefact use”. Benbasat and Zmud (2003) further add that core properties of IS include “the human behaviors reflected within, and induced through both the (1) planning, designing, constructing, and implementing, and (2) direct and indirect usage of these artefacts”. While Benbasat and Zmud (2003) emphasize the significance of studying information systems at micro-level, Agarwal and Lucas (2005) advocate research on a macro-level. Both the approaches are equally suitable, however we have focused on examining specific software features at a micro-level. Keeping our research focus in mind, we believe that presented work fits well within the research discipline of IS.
3.4 Candidate’s own contribution in presented studies

The contribution of the doctoral candidate in all the presented studies in briefly described as below:

For Study I, the candidate was the lead researcher involved in the research design and evaluating the selected native mobile applications. In addition, the candidate jointly designed the key research objective of the study. Further, the candidate was responsible for mapping and formulating the outcomes of the analyses, took active part in documentation and preparing the manuscript. Lastly, the candidate presented the manuscript in the conference.

For Study II, the key contributions of the candidate was to practically apply the Outcome/Change Design matrix in evaluation of available well-being and social mobile applications along with the second co-author thereby demonstrating the practical use of the Outcome/Change Design matrix.

For Study III, the candidate came up with the original idea and jointly designed of the study including the problem domain and to investigate those software features that were recognized as being under-utilized based on Study 1. Further, the candidate conceptualized, developed and implemented the web-based prototype, collected qualitative data, organized and facilitated focus group discussions, and analysed quantitative data. Finally, the candidate prepared the manuscript as the lead author and presented the result findings in the conference.

For Study IV, the candidate helped develop the web-based persuasive system in terms of software functionalities, content of the virtual rehearsal, identifying the problem domain, carrying out the literature review, jointly preparing the questions, data collection, coding of qualitative data, identifying themes, data analysis and documentation and finally taking the lead in preparing the manuscript followed by the formal presentation of the result study in the conference.

For Study V, the candidate was responsible for collaborating with our research partners. Several meetings were held to rigorously discuss and jointly design the research setting. The candidate was also responsible for selecting and implementing studied software features, designing of the content of reminders, managing of the back-end operations of the website, developing of qualitative questionnaires, data collection, data analysis.

For Study VI, the candidate was involved in designing the research setting, documentation, managing the web-based BCSS especially in terms of the successful delivery of reminders, the quality and accessibility of virtual rehearsal
modules, language check, formulating qualitative questionnaires, data collection, facilitating post-study interviews and data analysis. The candidate took the lead for carrying out literature search, and writing the manuscript.

3.5 Professional code of conduct and ethical considerations

In this doctoral thesis, professional code of conduct was strictly followed well in line with guidelines as set by the University of Oulu, Finland. Studies II and I were part of the research project and human subjects were not involved in the studies.

Studies IV and III were investigative/exploratory studies where participants were required to participate on voluntary basis and were asked to play specific roles in the evaluation process. The intent of the studies was explained to the participants in advance. All the collected data was solely used for research purposes. In addition, participants’ information was dealt with strict confidentiality and data privacy was ensured.

For Studies VI and V, human subjects were recruited and voluntary participation was obligatory. Secondly, explicit details about the intent of the studies were provided. Thirdly, participants were required to fill out and return informed consent forms before commencing participation. In Studies VI and V, human subjects were provided information about research outcomes on request. None of the human subjects were put into a situation that could have lead to a harmful consequence either physically or psychologically. We ensured that participants’ data were dealt with utmost security, anonymity and confidentiality. In addition, keeping in mind professional code of conduct, ethical approval was granted by the Ethics Committee of the University of Jyväskylä and the Central Finland Healthcare District (Diary no: 15U/2012).
4 Summary of the six studies

The main focus of this doctoral dissertation is within the research field of Information Systems with an explicit focus on the influence of (1) reminders on task completion and compliance, and (2) virtual rehearsal on acquiring new behaviors through learning skills ideally leading to higher self-efficacy.

4.1 Stage I: Expert evaluation

4.1.1 Study I

Study I (Langrial et al. 2012) is based on expert evaluations in line with guidelines underscored by Jaspers (2009). The study aims to identify and understand design features of native mobile applications for general health by categorizing their persuasive features. Identified persuasive software features in evaluated applications are shown in Fig. 2.
Fig. 2. Persuasive software features observed in evaluated applications.
The methodology adopted for this study is expert evaluation where one or more specialists evaluate a given system or application against a list of design principles (see Nielson 1992; Jaspers 2009). This is similar to heuristic evaluation, which is applied in usability engineering to identify usability problems and testing interactive technologies. Heuristic evaluations can be cost effective and very useful. For example, in Jeffries et al. (1991), four evaluators found more problems than any other evaluation technique including usability testing. The PSD model (Oinas-Kukkonen & Harjumaa 2009) was applied while evaluating selected native mobile applications because it is equally applicable for designing and evaluating persuasive information systems.

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 summarized in the PSD model (Oinas-Kukkonen & Harjumaa 2009). A concise yet illustrative pool of available health and well-being mobile applications were accumulated (see Table 7). All the selected applications were in English language with descriptions about target behavior change. The applications were selected as a part of another research project and the study was focused explicitly on appraising persuasive software features incorporated in the selected applications.

Table 7. An overview of evaluated applications and identified persuasive features from primary task and dialogue support (adopted from Langrial et al. 2012).

<table>
<thead>
<tr>
<th>Application Name</th>
<th>Coded as</th>
<th>Identified persuasive features</th>
</tr>
</thead>
<tbody>
<tr>
<td>AngerCoach</td>
<td>ANG</td>
<td>Self-monitoring, reduction, tunneling.</td>
</tr>
<tr>
<td>Awareness Lite</td>
<td>AWA</td>
<td>Self-monitoring, reduction, rehearsal, reminders.</td>
</tr>
<tr>
<td>Healthy Habits</td>
<td>HEA</td>
<td>Self-monitoring, reduction, personalization.</td>
</tr>
<tr>
<td>Live Happy</td>
<td>LIV</td>
<td>Self-monitoring, reduction, tunneling, personalization, reminders.</td>
</tr>
<tr>
<td>MMood</td>
<td>MIM</td>
<td>Self-monitoring, reduction.</td>
</tr>
<tr>
<td>MoodKit</td>
<td>MOK</td>
<td>Self-monitoring, reduction, personalization, rehearsal.</td>
</tr>
<tr>
<td>Mood Meter Lite</td>
<td>MOM</td>
<td>Self-monitoring.</td>
</tr>
<tr>
<td>Mood Runner</td>
<td>MOR</td>
<td>Self-monitoring, reduction, reminders.</td>
</tr>
<tr>
<td>MyBalance</td>
<td>MYB</td>
<td>Self-monitoring, reduction.</td>
</tr>
<tr>
<td>MyCalmBeat</td>
<td>MYC</td>
<td>Self-monitoring, reduction, tunneling.</td>
</tr>
<tr>
<td>SeeMyCity</td>
<td>SEE</td>
<td>Self-monitoring, reduction, personalization.</td>
</tr>
<tr>
<td>T2Mood Tracker</td>
<td>T2M</td>
<td>Self-monitoring, reduction, reminders, suggestion.</td>
</tr>
</tbody>
</table>
First, we analysed the Persuasion Context (cf: Oinas-Kukkonen & Harjumaa 2009). It was observed that the intentions of the application developers were vaguely specified. According to Oinas-Kukkonen and Harjumaa (2009), the Event is about understanding the user, the technology and the use context. The analysis of the applications revealed that the Event was moderately clear for the users. The PSD model underlines two key features 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 poor 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 relatively compact presentation of messages.

Based on our evaluations, we mapped the applications to the Outcome/Change Design matrix developed by Oinas-Kukkonen (2010a; 2010b; 2013). The Outcome/Change Design 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 (C-change) while majority of the applications apparently targeted behavior change. The results further suggest that there is a scope for improvement in designing and implementing persuasive software features in the evaluated applications for example tailored information, reminders and virtual rehearsal.

Study I has several contributions for the research field of IS. It provides a deeper and comprehensive account of practical use of the PSD model. In addition, it demonstrates that research methodologies that are more commonly used in usability engineering could equally be applied in IS research evaluations. The study exposes weaknesses in the persuasive design of mobile applications that were seemingly designed for personal and general well-being. Lastly, it provides a methodical approach for improving overall persuasiveness of native mobile applications especially through augmented user-system dialogue features (See Oinas-Kukkonen and Harjumaa 2009).
4.1.2 Study II

Study II (Langrial et al. 2013) was carried out to identify design goals and persuasion strategies that could further augment the process of developing effective Behavior Change Support Systems.

We applied heuristic evaluation methodology for this study. Literature provides evidence that heuristic evaluation is a valuable assessment technique because it involves skilled intuitions of multiple experts (Jeffries & Desurvire 1992). The key goal was to highlight the importance of expected outcomes from system designers’ perspective. While significant research has been conducted and available literature lays strong prominence on the importance of persuasive software features, it is surprising to note that intended behavioral change outcomes have received very little attention from researchers. It is therefore essential to have a clear idea of what system designers anticipate in users’ behavioral change when using a given BCSS or persuasive information system. Therefore, we made an effort to utilize the Outcome/Change Design matrix as an evaluation tool for understanding anticipated change type.

Taking a step further from Study I (Langrial et al. 2012), we mapped a number of selected mobile applications to the Outcome/Change Design matrix. The matrix enhances the evaluation process by allowing IS researchers to focus on the anticipated change type: whether the users of a given system comply with newly learned behavior (C-change), whether there is a change in users’ behaviors (B-change), or the system supports users in changing their attitudes (A-change). One of the key factors for improving the process of behavior change in people is to provide them extended support with a specific focus on Attitude change (A-change). We propose that attitude change leads to improved state of self-confidence. Higher state of self-confidence or self-efficacy establishes whether users are actually motivated to change their behaviors (Bandura 1977). The main finding from this study was that social support features were seldom incorporated in the evaluated applications. Fig. 3 provides an overview of intended outcome/change as analysed using the Outcome/Change Design matrix.
Fig. 3. The intended outcome/change as analysed using the O/C Design Matrix.

A key contribution of Study II is that it explains the practical application of the Outcome/Change Design matrix with practical examples. Although the matrix is well received by several researchers, however, we have demonstrated its hands-on

<table>
<thead>
<tr>
<th>Outcome / Change</th>
<th>C-Change</th>
<th>B-Change</th>
<th>A-Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-Outcome</td>
<td>Forming a compliance (F/C) QuitPal not only helps users stop smoking but also supports people conform to new routine i.e. not smoking. It provides reminders, health milestone alerts, tips to overcome cravings and personalized videos from loved-</td>
<td>Forming a behavior (F/B) Healthy Habits supports people to form desirable habits for example eating healthy food.</td>
<td>Forming an attitude (F/A) LiveHappy encourages people to form positive attitudes, keep a record of emotional patterns and try to improve mood through virtual coaching.</td>
</tr>
<tr>
<td>A-Outcome</td>
<td>Altering compliance (A/C) AngerCoach supports people overcome angry behaviors. Users are guided through the change process through expert videos as software feature.</td>
<td>Altering a behavior (A/B) NHS quit smoking app supports users to alter smoking habits. The aim of the app is to support smokers through the process of gradually becoming a non-smoker.</td>
<td>Altering an attitude (A/A) T2 Mood Tracker helps users to monitor emotional experiences such as stress and anxiety.</td>
</tr>
<tr>
<td>R-Outcome</td>
<td>Reinforcing compliance (R/C) WaterWorks supports people conform to consume desirable amount of water by providing visual graphics for motivation and goal achievement.</td>
<td>Reinforcing a behavior (R/B) MoodKit helps people sustain positive moods through learning how to be in control of their lives. It allows people to set their goals and provides personalized content and access to expert publications.</td>
<td>Reinforcing an attitude (R/A) AwarenessLite supports users feel positive through inspirational quotes based on how the users are feeling.</td>
</tr>
</tbody>
</table>
application by selecting health as well as social mobile applications. This scientific knowledge would help system designers and healthcare professionals to identify desired behavioral or attitudinal changes in the target audience and accordingly incorporate software features and persuasive strategies to reach the goals that would benefit individuals as well as societies.

4.1.3 Summarizing Studies I and II

Study I and II reveal interesting findings about underlying persuasive software features employed in existing persuasive applications. We utilized the PSD model and the Outcome/Change Design matrix to perform expert evaluations. The findings suggest that there are evident limitations with regard to the persuasive design in the evaluated applications. In summary, primary task support features were fairly well utilized including self-monitoring, reduction and personalization. In our opinion, it is surprising that none of the evaluated applications used tailoring. This was identified, as a serious limitation when it comes to designing BCSSs. Feedback in the form of praise and reward are essential for developing interactive persuasive information systems. As highlighted by Al-Natour and Benbasat (2009), IT entities are perceived as social actors. Similarly, it is reported that people consider their interactions with IT artifacts on an interpersonal level. In other words, people have a tendency to engage with computing devices as though they are interacting in real life social situations (Lee 2009; Fogg 2009). We therefore propose that improved augmented system-user interaction would lead to higher ratios in task completion and compliance.

The credibility of a BCSS would play a critical role when users decide whether to use and for how long they would be interested to engage with it. Available research provides evidence (cf: King & He 2006) that users engage with information systems that are trustworthy. Therefore, we propose that system designers should pay detailed attention to this particular aspect. Finally, our social relationships are being increasingly maintained through technology-mediated communications. This argument is supported by Oinas-Kukkonen and Oinas-Kukkonen (2013). They maintain that social web has proven its potential to influence and significantly change human lifestyle. Technology-mediated communications can support in forming and maintaining online relationships, which, in turn, could facilitate social support in a given BCSS.

The PSD model and the Outcome/Change Design matrix can help design BCSSs but they do not provide explicit information on which particular software
features could be effective in each case. Nevertheless, they are effective tools that underline techniques, strategies and tactics that would potentially augment the area of BCSSs. Like many research studies, there are certain weaknesses in the first two studies. While we used the PSD model and the Outcome/Change Design matrix as tools to carry out expert evaluations, we do acknowledge that expert evaluations could suffer from potential bias. It was for this particular limitation that we used four evaluators. We also acknowledge that the number of selected applications do not constitute a representative pool. There are thousands of applications that are apparently designed to support people in changing and sustaining healthy routines. Yet it is proposed that identified weaknesses and strengths of the selected applications provide a fair idea of the importance of incorporating carefully selected persuasive software features in the design process.

It would be reasonable to go beyond mere validation of the initial findings. As a matter of fact, further emphasis needs to be laid on investigating software features and persuasive techniques that could facilitate behavior change process. The first two studies provided evaluation of persuasive software features in selected mobile applications using two different evaluation tools i.e. the PSD model for Study I and the Outcome/Change Design matrix for Study II. The first two studies provided a heuristic evaluation of selected mobile-based applications for behavior change. The results indicate that there is room for improvement in designing health BCSSs.

Lack or under-utilization of key persuasive software features could lead to lower task completion or compliance. However, we do not propose that mere presence of persuasive software features would increase a given information system’s persuasiveness. On the contrary, we do maintain that a clear understanding of the target audience, expected behavioral outcomes and utilization of carefully selected persuasive software features would improve efficacy of persuasive information systems and more precisely BCSSs.

4.2 Stage II: Experimental studies

4.2.1 Study III

Study III (Langrial & Oinas-Kukkonen 2012) was conducted to gain a better understanding of the role of reminders on task completion and compliance.
For this study, we sought volunteers who consumed one or more fizzy or soda drinks on an average day and were willing to reduce its consumption. While planning the research setting, we first focused on the Cognitive Dissonance theory (Festinger 1962) because it discusses dissonance among individuals who do not act in accordance with their beliefs. In addition, we employed the Transtheoretical Model (Prochaska & Marcus 1994). Transtheoretical Model was employed because it explains the stages that a user experiences while making a deliberate effort to change her behavior. Participants were recruited through emails and flyers. In all, 29 participants volunteered to partake the study. The entire process of the study was explained to the participants both verbally and in a written format providing a step-by-step guide to use the system.

All the participants were sent a welcome message along with a URL to the system. Participants were required to create an account. Using an activation link, once the participants had activated their account, they were automatically redirected to the system. On the first day of the user-system interaction, participants recorded their average soda consumption. From day two to fourteen, an automated reminder was sent to all the participants in the morning prompting them to record their consumption details over the past day. Each time a participant recorded their soda and fizzy drink consumption, the system responded with instant feedback. The content of the feedback depended on the amount of consumed quantity. We used a simple feedback approach however, with an aim to encourage the participants. For illustration, when a participant recorded a reduced number of drinks, *praise* was instantly prompted in accordance with Oinas-Kukkonen and Harjumaa (2009).

We carried out a mixed-method approach that explored the impact of reminders on the effectiveness of information systems that are developed to facilitate behavior change. Our study explicitly focused on reminders as a key software feature that should be employed to support behavior change. As argued by Oinas-Kukkonen and Harjumaa (2009), a persuasive system needs to remind its users of the target behavior. Equally reminders have been employed in a variety of behavior change applications and their significance is much recognized. For instance, de Oliveira et al. (2010) propose that automated reminders can prove to be a solution to lower adherence rate in medical compliance. Dey and Abowd (2000), comment that reminders comprise of two key features – “a signal which is an indication of an event and description which is about what needs to be done”. They further comment that for a reminder to be effective, it should be proactive and supplemented by related information. Obermair et al. (2008)
studied unobtrusive real time interventions that aimed to motivate office workers to sit with appropriate posture. They maintain that participants of their study were highly responsive to real-time reminders.

Statistical analyses followed by a qualitative focus group indicate that participants found reminders to successfully motivate them to keep a log of their tasks. All the participants complied with a routine of recording their fizzy drinks consumption for the entire duration of the study. From the findings of the study, we safely report that reminders are an essential part of a given persuasive system that is aimed to facilitate behavior change. Persuasive information systems that are developed with an aim to encourage healthy behaviors need to be designed with keeping in mind two all-important considerations: first, they do not necessarily need to be overwhelmingly complex with scores of persuasive features and secondly users’ perceived persuasive elements such as user interface, ease of use, up to date information and features such as reduction and tunneling should be paid due attention. Based on the findings (quantitative and qualitative), we argue that reminders are an essential part of any given persuasive system especially in relation to task completion and compliance.

A key contribution of Study III is that it validates the effect of reminders in helping participants to complete expected tasks. Further, the study demonstrates that a mixed-method approach provides in-depth insights and constructive ideas to further improve simple or more persuasive systems and BCSSs.

4.2.2 Study IV

Study IV (Langrial et al. 2012) evaluates a web-based persuasive system that was developed with an aim to encourage people to gradually improve their sleep behaviors.

The research was focused on the system’s software design and functionalities and not on specific psychological outcomes. Soothing Sleep, a web-based BCSS (Fig. 4) aimed at supporting people in improving their sleep habits primarily through virtual rehearsal as a software feature (Oinas-Kukkonen & Harjumaa 2009). Oddly, information systems and other computing devices have not been fully utilized to address the problems associated with poor sleep habits. However, there are a number of projects that focus on different ways to monitor sleep patterns, for instance, Ballistocardiography (see Mack et al. 2009). It is important to note that rehearsal has been recognized as a very important technique for
learning new behaviors however it is rarely incorporated in persuasive systems (see Kelders et al. 2012).

Fig. 4. Example screen shot from the web interface of the Soothing Sleep system.

We employed the Goal-setting theory (Locke 1994) because it depicts how people behave in response to diverse forms of goals and in what way pre-defined goals could become a motivating factor. It is important that challenging goals are supported through relevant feedback to keep users motivated. In addition, goals need to be meaningful for the users so that there is a stirring desire to achieve them. Secondly, we integrated the Social Identity theory (Hogg 2006) in our research setting. One of the implications of the Social Identity theory is that it promotes inter-group cooperation. We assumed that the effect of inter-group solidarity upon the users would be such that they will encourage each other to conform to their tasks.

The Soothing Sleep drew its functionalities from the PSD model (Oinas-Kukkonen & Harjumaa 2009). We implemented selected persuasive software features i.e. reduction, tunneling, self-monitoring, reminders, virtual rehearsal and social learning. For evaluation purposes, we conducted a seven-day trial study to evaluate the system including eight users where four were information systems researchers and four were graduate students (see Appendix 1 for the survey instrument for Study IV).

The trial study was conducted with an aim to identify users’ perceptions about the incorporated software features. In addition, we wanted to evaluate the
effectiveness and feasibility of persuasive design to promote self-help strategy for people with poor sleep habits. The evaluation process was subdivided into four main steps including (i) scenario completion, (ii) semi-structured surveys, (iii) expert evaluation, and (iv) focus group. Scientists and experts from the research field of persuasive information systems carried out the expert evaluations. Therefore, Face validity and reliability of the questionnaires was performed. The evaluators went through each question and approved them. Further, in the actual trial study, the participants did not have any problems in understanding the questionnaire. According to Nevo (1985), Face validity is a measure of quality of a given text and can therefore be used because of its statistical significance. Face validity is a key tool in socio-psychological disciplines, as highlighted by (Nevo 1985). Several academics have acknowledged the validation and significance of Face validity (see Anatasi 1982; Brown 1976).

The results from the trial study suggested that participants had little if any difficulty in carrying out desired tasks. Majority of the participants found the information and feedback to be useful and engaging. We adopted a mixed-method approach to evaluate design and usability aspects of the system including real user interaction as well as expert evaluations. Among other advantages of using multi-method approach, Wood et al. (1999) propose that it provides reliable and more generalizable results.

Most of the participants recognized goal-setting feature in the system, however it was suggested that a functionality that would empower the user to set their own goals would be desirable. This finding is in parallel with the Goal-setting theory (Locke & Latham 1994). In addition, the participants provided thought provoking comments about the social support features, which justifies use of Social Identity theory in our research setting. Clearly a seven-day trial study was not intended to identify actual effect on sleep habits. With the limited number of participants and given the short period of the trial study, strong statistical analysis could not be performed. Nevertheless, the evaluation process provided comments and valuable feedback that could not be disregarded.

Study IV has several contributions. First, it introduces a novel artifact that addresses a relatively understudied problem domain in the IS research field. Secondly, it demonstrates benefits of using a mixed-method as a rigorous evaluation approach for researchers as well as system designers. And finally, it provides an opportunity to employ the PSD model as a framework to develop and evaluate persuasive IS and BCSSs.

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4.2.3 Summarizing Studies III and IV

We designed two web-based persuasive systems that drew their main functionalities from the PSD model (Oinas-Kukkonen & Harjumaa 2009). Building upon the results from Studies II and I, Study IV and III examine the impact of reminders on task completion and compliance in different domains. The results indicate that there is manifest scope for improvement on state-of-the-art mobile applications and more traditional web-based persuasive systems because some of the critical software features are evidently underutilized.

The studies demonstrate additional effect of reminders on task completion. The evaluation approach was based on mixed-methodology where statistical tests were performed and qualitative measures were recorded using survey tools and focus groups. It is evident from the results that reminders have an added effect on task completion and compliance.

Based on the findings, we cautiously propose that a careful combination of selected persuasive software features could lead to designing and developing effective persuasive systems and BCSSs.

4.3 Stage III: Field studies

4.3.1 Study V

Building upon the findings from Studies IV and III, Study V (Langrial et al. 2014) is reported. The study lasted for six weeks and involved real patients of sleep deprivation and related disorders.

In collaboration with our research partners, we developed a web-based Behavior Change Support System (Tyyne) for people suffering from sleep deprivation and related sleep disorders.
Fig. 5. Example screen shots from the Tyyne BCSS interface.
The objective of the study was to evaluate potential impact of reminders (See Appendix 6 for originally designed reminders and Appendix 7 for the Finnish version of reminders used in the study) and virtual rehearsal on the effectiveness of a BCSS developed for people suffering from sleep deprivation. The content of virtual rehearsal modules were derived from the Acceptance and Commitment Therapy (Hayes et al. 2006). Table 8 presents a brief description of the weekly rehearsals themes.

Table 8. An overview of Acceptance and Commitment Therapy themes and content (Adapted from Langrial et al. 2014).

<table>
<thead>
<tr>
<th>Intervention Week</th>
<th>Theme</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Values and value-based actions.</td>
<td>Realizing what matters most for an individual in her life and acting in accordance.</td>
</tr>
<tr>
<td>2</td>
<td>The present moment.</td>
<td>Living in the present moment.</td>
</tr>
<tr>
<td>3</td>
<td>Cognitive defusion.</td>
<td>Understanding that thought's can vary from individual to individual.</td>
</tr>
<tr>
<td>4</td>
<td>The observer stance.</td>
<td>Learning to observe one's own thoughts and feelings from distance.</td>
</tr>
<tr>
<td>5</td>
<td>Acceptance.</td>
<td>Accepting facts and admitting that one cannot change things.</td>
</tr>
<tr>
<td>6</td>
<td>Summary.</td>
<td>Rehearsing ACT exercises from previous weeks.</td>
</tr>
</tbody>
</table>

Virtual rehearsal has been outlined as a software feature that enables users to complete primary tasks (Oinas-Kukkonen & Harjumaa 2009). Reminders are aimed at prompting interaction between users and a given information system. Reminders could vary in design and form; for instance, they could be incorporated as guileless messages or feedback (see Fry & Neff 2009) and delivered through different means with varying frequencies. In this study, we employed reminders to prompt interaction between participants and the system. The main objective of sending reminders was to encourage the participants to interact with the intervention. Each week three email-based reminders were sent out to the participants. The first reminder was to praise those participants who had completed their tasks, the second reminder was sent to motivate participants to keep practicing skills that they had learnt from rehearsal modules and the third reminder was sent to inform the participants that the next rehearsal module was accessible. The basic approach in developing the content of the reminders was two fold. First, we wanted to motivate participants to interact with the system.
Second, we wanted to facilitate the participants to reach the system through a URL in an effort to reduce cognitive burden.

Previously, reminders have been employed in persuasive systems and health informatics. To date, different techniques have been employed to improve the effectiveness of reminders, for example, with tailored content. One of the ongoing challenges for eHealth interventions is low adherence and learning new behaviors to tackle health issues (Mohr et al. 2010). System usefulness and users’ overall experience with the BCSS were evaluated using Likert-scale questionnaires at the beginning and end of the study (See Appendices 2 & 3 for Pre and Post Study survey instruments in Finnish; Appendices 4 & 5 in English).

The recruitment for Study V was conducted between October 2013 and November 2013. Participants were recruited through newspaper advertisements in Jyväskylä and Oulu, Finland. It was explicitly stated in the newspaper advertisements that only those people were invited to partake the study that felt that they had sleep deprivation and other related sleep disorders. In response to the advertisements, a total of 122 (76 via email and 46 via telephone) contacted the university clinic based at the department of Psychology, the University of Jyväskyla. Of the 122 potential participants, 86 fulfilled the eligibility criteria. Measurement packages were sent out to the eligible participants along with informed consent forms.

A randomization process followed this. Randomization was performed using the randomizing toll (http://www.randomization.org/lists). Participants were allocated into two groups: (1) Intervention group (n = 43) that received the measurements, had access to the BCSS, received weekly reminders (via email) and had access to weekly virtual rehearsal modules, and (2) Wait-list control group (n = 43). For ethical reasons, the wait-list control received the same program (but no reminders were sent) and URL as an access point to the BCSS was sent out after the intervention group had completed the program.

The usefulness of the BCSS and users’ overall experiences were evaluated using Likert-scale (Likert 1932) questionnaires and post-study face-to-face interviews. The questionnaires comprised of two parts. The first part included basic demographics questions that were devised to collect information about participants, their computing skills and familiarity with using Internet. The second part included questions about participants’ expectations and perceived usefulness of the BCSS with a specific focus on the reminder (task completion) and virtual rehearsal (learning through practice). Table 9 summarizes the
questions (constructs) with relevant literature highlighting validation of the questionnaires employed.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Representative Question</th>
<th>Literature Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Acceptance Model</td>
<td>Computer expertise</td>
<td>Davis et al. (1989)</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>In my opinion, using Tyyne BCSS will help improve my sleep habits</td>
<td>Vanketesh (2000)</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>In my opinion, Tyyne BCSS would be easy to interact with</td>
<td>Vanketesh (2000)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>In my opinion, Tyyne BCSS will be fun to interact with</td>
<td>Padilla-Meléndez et al. (20)</td>
</tr>
<tr>
<td>Attitude towards use of technology</td>
<td>In my opinion, using web-based BCSS for sleep deprivation is a good idea</td>
<td>Venkatesh et al. (2003)</td>
</tr>
<tr>
<td>Behavioral intention to use technology</td>
<td>I am highly willing to use the Tyyne BCSS</td>
<td>Jackson et al. (1997)</td>
</tr>
<tr>
<td>Task completion</td>
<td>In my opinion, generally people do not complete web-based programs because of forgetfulness</td>
<td>Bickmore et al. (2007)</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>In my opinion, after using the Tyyne BCSS, I will be able to better manage my sleep problems</td>
<td>Bandura (1977)</td>
</tr>
</tbody>
</table>

And lastly, a post study satisfaction survey (face-to-face interviews) was conducted. The Likert-scale questionnaires are briefly described in Appendices 2 and 3. We formulated the following research questions for the study.

**RQ1.** How do participants perceive persuasive reminders to help them complete virtual rehearsal tasks?

**RQ2.** How do participants perceive usefulness of virtual rehearsal in helping them overcome sleep difficulties?

The findings revealed that majority of the participants found the BCSS being useful and acknowledged that the study was a good idea. Almost all the participants agreed that learning new skills through web-based systems was a good idea. Although almost all of the participants agreed at the beginning of the intervention that reminders would help them in task completion, however, the number decreased significantly upon completion of the intervention. A high majority of the participants anticipated that upon completion of the intervention, they would be able to manage their sleep problems better. However, it was
observed that several participants’ expectations were not met. Nevertheless, 16
participants agreed that they could better manage their sleep problems, 22
participants were unsure and 3 participants disagreed upon completion of the
intervention. The findings further reveal that participants had high expectations
from the BCSS. A majority reported that their expectations were not met at the
end of the intervention. One major reason for this outcome could be the relatively
short time period of the intervention. Despite the fact that the study lasted for a
period of six weeks, the findings are evidently encouraging especially for the fact
that the entire intervention was carried without face-to-face therapy and a
significant number of participants evaluated the intervention positively i.e. the
system was easy to use and using web-based BCSSs was a good initiative.

In order to measure the participants’ well-being, we employed Beck
Depressive Inventory (Beck et al. 1961) and Epsworth Sleepiness Scale (ESS)
(Johns 1991). Symptoms of sleeplessness were assessed at the beginning and at
the end of the intervention. Outcomes from the analyses for pre and post- BDI-II
measurements revealed statistically significant decrease in the Intervention group
where mean values dropped from 12.20 to 8.15 (t = 5.54, df = 38, p < 0.05).
Mean values for the psychological measures support overall effectiveness of the
BCSS that was augmented with Acceptance and Commitment Therapy. A detailed
account of the findings can be found in the published articles in the presented
doctoral dissertation.

Study V evaluates a web-based BCSS for sleep deprivation. Sleep deprivation
despite being a serious issue has not received significant attention from IS
researchers over the past years. Therefore, it would be reasonable to propose that
presented work is among the very few that studies the effect of IS on this critical
health problem. The BCSS drew software functionalities from the PSD model
(Oinas-Kukkonen & Harjumaa 2009). However, in this particular study, we
investigated the potential effect of reminders and virtual rehearsal. We observed
encouraging outcomes at the end of the study. A high majority of the participants
agreed that learning new skills through virtual rehearsal was a positive idea.
Similarly, reminders as a mean to task completion were well received. Some of
the participants reported that they were not satisfied with the intervention and
expressed a desire to continue using the BCSS for a prolonged period of time.
This reservation is truly understandable merely because the entire intervention
lasted for a period of six weeks. We believe that presented work is a decent
starting point to further develop and examine BCSSs that could support people
with sleep deprivation and other mental health issues for an extended period of time.

A key contribution of Study V in the area of IS in general and BCSSs in particular is that it provides researchers to identify and further investigate reminders and virtual rehearsal as effective software features that might create grounds for reducing high drop out rates (via carefully designed reminders) and higher state of self-efficacy (via virtual rehearsal) leading to a successful process of enduring behavior change.

### 4.3.2 Study VI

Study VI (Langrial et al. 2014) investigates potential impact of reminders on task completion and influence of virtual rehearsal on learning new behaviors.

In collaboration with our research partners from the University of Jyväskylä, Finland, we developed a Behavior Change Support System (Kompassi) to help people in overcoming depressive symptoms.
Fig. 6. Example screen shots from Kompassi BCSS interface.

For this study, we investigated selected software features to determine their potential effectiveness. Again, reminders and virtual rehearsal were the focal points for this study. The frequency and content of reminders were carefully designed (see Appendix 10 for originally designed reminders and Appendix 11 for Finnish version of the reminders used in this study). Each week, email-based automated reminders were sent to the participants. The first reminder described
that particular week’s core message and contained a URL to the BCSS thereby bringing in the element of tunneling. Each reminder included a motivational quote that was tailored to that week’s theme. The second reminder informed the participants of the deadline for submission of their homework. In a rare situation where a given participant did not complete her home assignment, an additional reminder was sent out.

As a software, virtual rehearsal drew its content from the Acceptance and Commitment Therapy (Hayes et al. 2006). Weekly rehearsals provided depression management skills and were designed to improve mindfulness, acceptance skills and commitment towards value-based actions by utilizing a variety of metaphors, experiential exercises and behavioral activation (see Hayes et al. 2006). Table 10 provides a brief overview of the weekly rehearsal modules with descriptions.

Table 10. An overview of Acceptance and Commitment Therapy modules (Adapted from Langrial et al. 2014).

<table>
<thead>
<tr>
<th>Week No</th>
<th>Acceptance and Commitment Therapy module</th>
<th>Brief explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Creative hopelessness and values.</td>
<td>To offer specific verbal and experiential methods to help determine patient’s goals.</td>
</tr>
<tr>
<td>2</td>
<td>Value-based actions.</td>
<td>Values are chosen qualities of purposive action that can never be obtained as an object but can be instantiated moment by moment.</td>
</tr>
<tr>
<td>3</td>
<td>Contact with the present moment.</td>
<td>Promotion of on-going non-judgemental contact with psychological and environmental events.</td>
</tr>
<tr>
<td>4</td>
<td>Cognitive defusion.</td>
<td>To alter the undesirable functions of thoughts and other personal events, rather than trying to alter their form, frequency or situational sensitivity.</td>
</tr>
<tr>
<td>5</td>
<td>Self as context.</td>
<td>Helps one become aware of her experiences without any attachment leading improved acceptance.</td>
</tr>
<tr>
<td>6</td>
<td>Acceptance.</td>
<td>Involves ability to contact the present moment as a conscious human being, and to change or persist in a behavior.</td>
</tr>
</tbody>
</table>

Study VI was conducted between September 2012 and January 2013. Recruitment advertisements were published in local newspapers both in the city of Jyväskylä and Oulu, Finland. The advertisements highlighted that for this particular research, we were looking for those individuals who felt depressed and volunteered to partake the study. In response, a total of 42 potential participants contacted the university clinic either through email or by telephone. Graduate trained
psychologist therapists performed the pre-study screening process. It was explicitly restated that the participation in the research is on volunteer basis.

Randomization of the eligible participants was performed on the 13th of September 2012 followed by pre-intervention interviews. Later, the participants were randomized into two groups: (1) an Intervention group 1 (n = 19) that received measurement packages, automated weekly reminders (via email) and had access to weekly rehearsal exercises, and (2) an Intervention group 2 (n = 20) that first served as a wait list control group and had to wait for a period of 6 weeks before they were allowed access to the BCSS.

The Department of Psychology, University of Jyväskylä, Finland developed the BCSS and the research team from the Department of Information Processing Science, University of Oulu, Finland, incorporated persuasive software features. The Acceptance and Commitment-based rehearsal exercises (virtual rehearsal) provided depression management skills, facilitated enhanced mindfulness, acceptance techniques and commitment towards value-based actions for the participants by utilizing a variety of metaphors, experiential exercises for mindfulness and behavioral activation (Hayes et al. 2006).

Upon completion of the study, participants were asked questions about their experiences with the BCSS (see Appendix 8 for survey instrument in English and Appendix 9 for survey instrument in Finnish that was actually used in the study). The questionnaires consisted of two parts. IS and HCI research scientists and experts carried out the expert evaluations. Therefore, Face validity and reliability of the questionnaires were performed. The evaluators went through each question and approved them. Further, in the actual study, the participants did not have any problems in understanding the questionnaire. Face validity is reported as a significant method in areas such as psychology and education tests with intent for validating practical use (Nevo 1985).

The first part included demographic questions devised to collect information about the participants, their computing skills and familiarity with Internet. The second part included questions about participants’ views about system usefulness, ease of use, and potential impact of reminders on task completion, impact of virtual rehearsal on self-confidence and intention to rehearse newly learned behaviors. We employed five-point Likert (Strongly agree = 1 to Strongly disagree = 5) scale questions. Finally, participants were interviewed in person to determine post-study satisfaction and suggestions. The responses were recorded, coded and analysed upon the completion of structured interview.
Symptoms of depression and self-reported confidence were assessed at the beginning and end of the study. We used BDI-II and Self-confidence to measure psychological well-being. BDI-II (Beck et al. 1961) has been recognized to have reliability and validity in both clinical and non-clinical settings. Likewise, Finnish Descriptive Virtual rating Scale has also shown test and retest reliability (Sjögren-Rönkä et al. 2002). In order to verify Hypothesis 5, we used SPSS v. 20 to perform Paired Sample T-tests for both BDI-II and Self-confidence with post measurement as variable 1, and pre measurement as variable 2. The analyses for BDI-II highlight mean values and Standard Deviations for the measurements (where Mean value represents the difference). Outcomes from the T-test for pre and post BDI-II measurement reveal a significant decrease in both Intervention groups. P-values for the Intervention and Control group were recorded as $p < 0.001$. Likewise, promising results were noted when Self-confidence was analysed for both the Intervention and Control group. Results from the T-test for pre and post measurements revealed noteworthy improvement in Self-confidence in both groups with a p-value of $p < 0.005$. Statistical findings provide convincing evidence for the success of the BCSS thereby supporting H5.

As mentioned earlier, we employed semi-structured questionnaires and post-study interviews. The questionnaire involved items related with (i) demographics, (ii) system usefulness, (iii) role of reminders in task completion, (iv) unobtrusiveness, (v) influence of virtual rehearsal on learning new behaviors, (vi) influence of virtual rehearsal on self-efficacy, and (vii) intention to rehearse in future. All the items were constructed based on existing theories and models. For the study, we formulated following hypotheses:

$H1$. Persuasive reminders help users in task completion.

$H2$. Users would perceive persuasive reminders as a desirable feature.

$H3$. Virtual rehearsal helps users achieve improved self-confidence.

$H4$. Users with improved self-confidence continue to rehearse newly learned skills.

$H5$. The overall affect of the BCSS would lead to significant decrease in depression.

Hypotheses H1 and H2 were derived from the PSD model (Oinas-Kukkonen & Harjumaa 2009). According to the PSD model, persuasive systems should prompt users for continuous interaction thereby improving user-system dialogue. Based
on the theory of Self-efficacy (Bandura 1977), we developed H3, and H4 was derived from the Technology Acceptance Model (Davis 1989).

Participants’ reflections about system usefulness, reminders and virtual rehearsal reveal that it was well received. Further, significant improvements were observed in post study psychological measurements where depressive symptoms decreased noticeably while in parallel participants’ self-confidence improved considerably. However, reminders seem not to have an added effect on the efficacy of the BCSS (compared to using rehearsal only) as measured by observing changes in depression and self-confidence scores.

This is an interesting finding. One reason for lack of effect of reminders could be that the Acceptance and Commitment Therapy-based rehearsals modules were so effective and the exercises engaged users and motivated them intrinsically. Responses from the participants indicate that they learned new skills for managing depression. We suggest that this is essential for behavior change process. In addition, a high majority of participants felt self-confident in tackling depressive symptoms at their own indicating their intentions to continue practicing newly learned skills. On the whole, a significant reduction in depressive symptoms was detected at the end of the study after performing post-study psychological analyses.

Study VI has several contributions for researchers and academics both from the research fields of IS and eHealth. To the best of our knowledge, it is among very few studies that have examined a BCSS incorporated with Acceptance and Commitment-based virtual rehearsal without face-to-face therapy. Equally importantly, the participants were real people who fulfilled the criteria of depressive symptoms. The findings indicate that reminders were perceived to be useful by the participants. However, post study analyses revealed that there were no additional effects of reminders on task completion. This is a surprising outcome but at the same time opens up opportunities to design and conduct further research in this particular context. Briefly, two key contributions of Study VI are: (1) It is among a few studies that combine Acceptance and Commitment Therapy with IS for well-being and, (2) the effect of reminders in terms of task completion and compliance was minimal that is well in contrast with previously published articles (see Kooji et al. (2010); Vervloet et al. (2012); Lawson et al. (2007). This calls for further research in developing and investigating reminders that are more persuasive in nature, for instance using techniques such as personalization (Oinas-Kukkonen & Harjumaa 2009), appropriate timing (Fogg 2009) and adequate frequency (Fry & Neff 2009).
4.3.3 Summarizing Studies V and VI

Studies V and VI have opened up further research opportunities for behavioral change and eHealth researchers in general and information systems researchers in particular to investigate persuasive information systems and BCSSs to improve task completion via reminders or to investigate the impact of virtual rehearsal on the overall efficacy of health BCSSs (Oinas-Kukkonen 2013). From a practical viewpoint, it is important to better understand and employ carefully selected persuasive software features that could lead to the development of effective behavior change interventions. In this work, the key finding is that virtual rehearsal that is evidently an understudied feature, leads to desired outcomes where users not only learn new behaviors but also gain higher self-confidence. The findings will help researchers and designers develop and implement augmented BCSSs. A detailed summary of the findings and limitations are presented in the next chapter.
5 Discussion

This doctoral dissertation examines the impact of reminders and virtual rehearsal on the efficacy of health Behavior Change Support Systems. Eysenbach (2005) and Kelders et al. (2012) have highlighted attrition or low adherence respectively as a major issue for eHealth researchers. Therefore, we aspired to investigate the effect of reminders on task completion and compliance. In addition, persuasive software features are expected to enhance the overall effectiveness of a given BCSS leading to improved user-system interaction (Kelders et al. 2012). We also attempted to investigate the effect of virtual rehearsal on the efficacy of health BCSSs. It is important to note that virtual rehearsal has been identified as one of the least studied persuasive software feature as pointed out by Kelders et al. (2012).

Keeping in mind the aforesaid, Studies II and I were carried out to categorically identify incorporated persuasive features and strategies in selected mobile-based applications for well-being using the PSD model (Oinas-Kukkonen and Harjumaa 2009) and the Outcome/Change Design matrix (Oinas-Kukkonen 2010) respectively. Both Studies II and I were carried out using heuristic evaluation methodology and were descriptive in nature. While Study I was purely based on heuristic evaluation approach, Study II outlined the use of the Outcome/Change Design matrix with demonstration of practical examples of selected mobile applications.

Findings from Studies II and I reveal that there is evident scope for improvement in abstracting, designing and implementing software features and persuasive strategies in health BCSSs. More specifically, findings from Study I revealed that key persuasive features such as reminders and virtual rehearsal are underutilized and results from Study II suggest that designers of health BCSSs have a relatively vague idea about expected outcomes in terms of behavior or attitude changes or compliance. Additionally, social support features were seldom employed in the evaluated applications. Although, presented dissertation does not focus on social support features.

Study III was carried out to gain a deeper understanding of how and to what extent reminders help users in task completion and compliance. For this study, we used a mixed-method approach for collecting and analysing data. A key finding from Study III indicates that reminders played a significant role in helping users in task completion and compliance. Further, based on the findings from Study III, we propose that while reminders are an essential component of a given health
BCSS, however they do not necessarily have to be designed in an overwhelmingly complicated manner. As a matter of fact, guileless reminders that are delivered on appropriate time might as well be equally effective. Previously, researchers (see Räisanen et al. 2008) have highlighted the importance of appropriate timing for success of reminders.

Studies II and I helped us to pay specific focus to selected persuasive software features and created grounds for carrying out Studies III, IV, V and VI. It is worth noting that Studies III and IV were experimental studies using mixed-methodology while Studies V and VI were field studies that were more of qualitative in nature. The main research question was investigated through Studies V and VI where the entire focus was on the potential impact of reminders and virtual rehearsal on the overall efficacy of health BCSSs.

Study IV evaluated a web-based BCSS system that was developed to help users overcome sleep problems primarily through virtual rehearsal and subtle reminders. The evaluation was performed through four steps: (i) scenario completion, (ii) semi-structured surveys, (iii) expert evaluation, and (iv) focus group. The findings from Study IV indicate that the users found the system to be engaging and easy to use. Further, virtual rehearsal was well received and valuable remarks were noted in favour of virtual rehearsal as an effective technique to overcome poor sleep habits.

Outcomes from the Study IV encouraged us to carry out more sophisticated and carefully designed research in order to examine additional effect of reminders on task completion and compliance and virtual rehearsal on the overall efficacy of a health BCSS. Study V was conducted in collaboration with professional psychologists. We developed a web-based health BCSS for patients suffering from sleep deprivation and other sleep disorders.

Study V lasted for a period of six weeks. The key objective of the study was to analyse potential impact of incremental reminders and Acceptance and Commitment Therapy - based virtual rehearsal. One of the most challenging issues that researchers face in eHealth and BCSSs is non-compliance resulting in difficulties to learn new behaviors as pointed out by Mohr et al. (2010). When designing the BCSS for Study V, we paid detailed attention to reminders and virtual rehearsal on a much deeper level. While designing the reminders, we made an effort to avoid obtrusiveness and bring in the element of incrementally as proposed by Oinas-Kukkonen and Harjumaa (2009). For virtual rehearsal, with the help of professional psychologists, we prepared the content from evidence-based psychological practices. More precisely, content of virtual rehearsal was
prepared using the Acceptance and Commitment Therapy, which is the latest wave of more traditional Cognitive Behavioral Therapy.

Prior research highlights the effectiveness of Cognitive Behavioral Therapy-based Internet interventions for mental well-being (Coull et al. 2011; Veehof et al. 2011 and Currier et al. 2010). The findings from Study V revealed that majority of the participants found the BCSS to be useful, easy to use and that virtual rehearsal was a good technique to learn new skills and behaviors. Although at the beginning of the intervention, almost all the participants had very high expectations from the BCSS however, at the end of the intervention, a significant number of participants were not satisfied.

A key reason for this outcome could be the duration of the study that was only six weeks and we therefore propose that well-being issues including sleep deprivation require much longer interaction between users and a given system to observe better results. One of the highlights of Study V was that it employed Acceptance and Commitment therapy in developing virtual rehearsal and that there was no face-to-face therapy involved. Keeping in mind the importance of incremental persuasive strategy as proposed by Oinas-Kukkonen and Harjumaa (2009), weekly rehearsals were made accessible to the participants.

Study VI examined the impact of reminders and Acceptance and Commitment Therapy-based virtual rehearsal on the efficiency of health BCSS. The system was developed with an aim to support patients of mild to moderate depression without face-to-face therapy. For this study, we used the PSD model (Oinas-Kukkonen & Harjumaa 2009), theory of Self-efficacy (Bandura 1977) and the Technology Acceptance Model (Legris et al. 2003) as theoretical grounds to develop the hypotheses. Recently, Kelders et al. 2012 has called for developing easily accessible interventions for managing depression.

Studies VI and V gave us an opportunity to not only examine the impact of reminders but also to further verify the PSD model (Oinas-Kukkonen & Harjumaa 2009) as a valuable tool for the evaluation of persuasive information systems and health BCSSs. The findings of the studies reveal that both persuasive reminders and virtual rehearsal were well received. We observed significant improvements in the post intervention measurements improvements were observed in psychological symptoms and participants’ self-confidence increased meaningfully.

Another interesting finding from Study VI was that reminders seemed not to have an additional effect on the efficacy of the BCSS as measured by observing changes in depression and self-confidence scores. Possible reasons for this
unexpected outcome could be that the Acceptance and Commitment Therapy-based virtual rehearsals were very effective and engaging, leading the participants to a state of higher intrinsic motivation. However, we propose that these findings open up an opportunity for further research in this particular area.

5.1 Assessing rigor

Presented studies in this thesis comprise of mixed-method and qualitative approaches. Rigor is assessed in line with research gap identification, research design, data collection and methodologies employed for data analyses. Although natural science models are generally accepted for carrying out IS research, however this particular approach presents several challenges too. For example, it is fairly hard to create a controlled environment that is needed for research methodologies such as experimentations. Further, deductions in research studies are more of verbal and textual propositions rather than quantitative measures. Generalizability of the research outcomes is somehow limited to similar contexts as highlighted by Lee (1989). Regardless of the caveats that IS research presents, its findings are much appreciated and valued in the IS research field (see Myers 1997). In a mixed-method approach or more precisely, qualitative methodology, generalizations from the collected samples are not the focal point. On the contrary, the presented work aims to provide a richer understanding of a phenomenon that could be effectively applied in other research settings (see Orlikowskki & Barodi 1991). Today we have a considerable body of knowledge that supports the reliability and validity of qualitative research methods. According to Seale and Solverman (1997), rigor is essential in qualitative research and there are several qualitative methods that help researchers achieve rigor. Several techniques are available to ensure rigor and avoid bias in qualitative research leading to enhanced reliability (Mays & Pope 1995). They highlight that systematic research approach, research design, data collection, and interpretation makes qualitative research rigorous. In addition, Mays and Pope (1995) state that to enhance rigor, “there is a need to create an account of method and data which can stand independently”. This way the integrity and rigor of qualitative methods would continue to prevail.
5.2 Implications for researchers

Presented work contributes to the existing body of knowledge by highlighting the significance of the PSD model (Oinas-Kukkonen & Harjumaa 2009) as a framework for both designing and evaluating persuasive IS and BCSSs. More precisely, it highlights the significance of reminders in relation to task completion and compliance. Further, the research outlines the impact of virtual rehearsal on improved learning leading to a higher state of self-confidence in users.

In terms of research methodologies, we propose that qualitative research methodology comprising of heuristic evaluations and mixed-methods provide opportunities for information systems researchers to gain richer insights when evaluating health BCSSs. These systems whether web-based or mobile-based are implemented to support users acquire enduring changes in their behaviors or attitudes.

Health BCSSs have a potential to help users acquire desirable behaviors. It is evident from available literature that persuasive software features improve effectiveness of behavior change interventions (see Kelders et al. 2012). In this dissertation, we focused specifically on the impact of reminders and virtual rehearsal on the ability of health BCSSs in terms of task completion, compliance and self-efficacy.

As stated earlier, incorporation of each of the persuasive software features in a given BCSS by no means warrants its efficacy. Quite on the contrary, it is the careful selection and implementation of software features that could make eHealth interventions more successful. However, as highlighted by Hardiker and Grant (2011), content of a given digital intervention should also receive more attention from system designers. One of the keys to success for eHealth interventions is provision of easy to understand and credible content (Hardikar & Grant 2011).

One implication for IS researchers is the use of virtual rehearsal which despite being under-studied, has markedly proven to be an effective software feature because it helps users learn new behaviors leading to an improved state of self-confidence. Although much research has focused on adherence and attrition, we have attempted to highlight that there is a fine line between adherence and task completion. While adherence has been explained as continued usage of an intervention, task completion and compliance is about completing an expected task irrespective of the time frame. We argue that researchers should consider task completion and compliance as a first step towards achieving higher adherence.
Another key issue is the role of reminders and their impact on the efficacy of persuasive IS and health BCSSs. Available literature strongly supports the positive effect of reminders. However, this dissertation highlights an unexpected finding relating to the additional weight of reminders. Findings from Studies VI and V indicate that reminders had no additional effect on the detected outcomes, which was a surprising result. There could be several reasons for this and therefore it opens opportunities for researchers to investigate and improve the effectiveness of reminders.

Incremental persuasion and unobtrusiveness are also critical research issues. The PSD model (Oinas-Kukkonen & Harjumaa 2009) highlights the importance of both incremental persuasion and unobtrusiveness. In addition, it should be noted that the Intent, the Event and the Strategy (Oinas-Kukkonen & Harjumaa 2009) are key for designing effective health BCSSs. Having a clear idea of expected behavior or attitude change when designing a health BCSS would help designers foster systems that are tailored for a specific health problem domain. This is because the problem domain of health and general well-being could vary significantly. For illustration, systems designed to motivate users to walk more or consume less soda drinks would need different persuasive approaches when compared with systems that are developed for providing extended support to users with mental disorders.

It is essential for the designers and researchers of health BCSSs to understand and acknowledge the fact that technology is merely a tool as stated by Fogg (2003). However, in the research field of persuasive systems and eHealth, the way designers and researchers use a given technology would have a significant impact on the actual interventions. The content of a given health BCSS holds the key for reaching anticipated outcomes. As highlighted by Guerini et al. (2007), designing the content of a persuasive message carefully is very important and further it is essential to pay detailed attention to the context of user-system interaction. This is in line with the propositions put forward by Oinas-Kukkonen and Harjumaa (2009) and further Kaptein et al. (2010) who have highlighted the significance of the content of persuasive messages.

### 5.3 Implications for practitioners

Health Behavior Change Support Systems are augmented persuasive systems that are developed with an aim to support people learn and adopt new behaviors. These systems have the potential to bring several benefits for individuals as well
as for societies in general. From a practical perspective, it is essential to have a richer understanding of the underlying dynamics that lead to higher rates of task completion and general acceptance of such systems. Developing health BCSSs that facilitate learning process and result in higher task completion is highly desirable. Based on the findings from Studies VI and V, it is proposed that even relatively simple interventions could be of great value as long as the content is carefully designed and that users gain some value from it. The overall design of a given information system is also described by Sillence and Briggs (2006). Hardiker and Grant (2011) have also pointed out the importance of health-related interventions and maintain that health-related services are more effective when the content is designed with rigor.

Presented work provides a unique opportunity for health practitioners who wish to investigate the effectiveness of information systems that are developed to support people with mental disorders. To the best of our knowledge, there are only a few studies that have used the Acceptance and Commitment Therapy-based interventions. Therefore, we propose that the dissertation provides strong evidence that reflect success of two distinctive BCSSs. Despite a relatively low number of real patients involved in the studies, the findings cannot be overlooked. Lastly, presented work reflects successful combination of technology and Cognitive Behavioral Therapy-based techniques. It is expected that our work will add value to the available knowledge base for health practitioners and researchers.

5.4 Implications for Software practitioners

Health Behavior Change Support Systems are an emerging research area. There are a growing number of studies being carried out with an aim to investigate BCSSs as IT artifacts. William and Pollock (2012) recommend that IS researchers and software practitioners should look at the profile of IT as a particular package of software product. Presented work has evident implications for software practitioners in terms of investigating and developing innovative BCSSs with a specific focus on core software functionalities, mode of interaction, user-system dialogue, software architecture, scalability and appropriation (see Lyytinen & Damsgaard 2011). Indeed, software practitioners would play a central role in the development of functional and effective BCSSs, for instance, through the use of text for data analyses (Tsui et al. 2009). In addition, software practitioners would promote advancement of theoretical, practical and SW methodical practices that would bring rigor to BCSSs for health and wellness for the society.
5.5 Limitations and future research

One of the major limitations in this dissertation is that time duration for Studies VI and V were relatively short given the nature of problem domain being investigated. However, the said limitation could be taken as an opportunity for future research where mixed-method longitudinal studies highlighting objective, qualitative and quantitative data could prove to be highly useful in understanding the underlying dynamics for developing effective health BCSSs. For example, reasons for lack of additional effects of reminders in psychological outcomes could be uncovered through further research. In addition, more attention could be paid to the Intent, the Event and the persuasive Strategy in future studies. Although Studies VI and V illustrate actual change in psychological outcomes but given the time period of the interventions, it could be assumed that the outcomes might not reflect the true picture. Therefore, longitudinal field studies with follow-ups would reveal much more credible results as to whether the detected psychological and behavioral improvements were temporary or permanent. Finally, socio-psychological and cognitive behavioral theories need more attention and implementation for further refining health BCSSs.
6 Conclusions

This dissertation explored the potential impact of reminders on task completion and compliance. In addition, it investigated influence of virtual rehearsal on users’ self-efficacy. The key aim of the presented work was to analyse how specific persuasive software features could enhance efficacy of health BCSSs. Mental well-being was chosen as the central domain for research because of its obvious significance for individuals’ health and overall societal well-being.

Although reminders have been well studied in persuasive information systems, virtual rehearsal has received little attention from IS and HCI researchers. It was this particular gap that initiated this dissertation. To address the above said research gap, we investigated efficacy of health BCSSs primarily through qualitative research approach. Overall, the research presented in this dissertation could be categorized as a mix-method approach.

In Studies II and I, we employed heuristics and (Jaspers 2009), Studies IV and III were conducted using mixed-method approach and Studies VI and V were primarily based on qualitative evaluations. The contribution of the presented work could be reported in multiple contexts. Studies II and I provide practical illustration of using the PSD model (Oinas-Kukkonen & Harjumaa 2009) and the Outcome/Change Design matrix (Oinas-Kukkonen 2010, 2013) as well established evaluation tools for analysing persuasive software features and importance of intended behavioral outcomes respectively. Studies IV and III outline impact of reminders on task completion and virtual rehearsal on acquiring higher self-confidence. Studies VI and V highlight the effect of reminders and virtual rehearsal on the overall efficacy of health BCSSs.

Another key contribution of the presented work is that it provides empirical validation of some of the key software features that are outlined in the PSD model (Oinas-Kukkonen & Harjumaa 2009) and the Outcome/Change Design matrix (Oinas-Kukkonen 2010). The presented work provides evidence that it is not necessary to employ all the persuasive features for developing an effective health BCSSs. On the contrary, careful selection and implementation of such features could prove to be more effective.

Further, presented work demonstrates that effective health BCSSs could be developed when technology and evidence-based psychological techniques (e.g. Cognitive Behavioral Therapy and Acceptance and Commitment Therapy) are combined. The dissertation also presents the idea of task completion as a different construct when compared with adherence. Drawing a fine line between task
completion and adherence would ideally pave the way for further research in understanding reasons for non-adherence that has been reported as a persistent problem for web-based eHealth interventions (cf. Kelders 2012).

Finally, the dissertation opens up opportunities for IS, HCI and eHealth researchers to abstract, implement and evaluate health BCSSs that are not complex in nature yet significantly beneficial in tackling mental and general health issues. In future, it would be important to keep in mind that persuasive technology has the potential to enhance the effectiveness of health BCSSs however, to fully exploit the potential of persuasive technologies, researchers would need to pay considerable attention to software features and strategies at a micro-level.

In this dissertation, we paid specific attention to reminders and virtual rehearsal and uncovered promising outcomes. Future research direction lies in the development of health BCSSs incorporated with varying software features and persuasive strategies to understand how and why different features and strategies could support people in overcoming general and mental health problems.
List of references


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## Appendix 1 Survey instrument for study IV

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Measurement Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User interface was appealing.</td>
<td>Strongly disagree, Disagree, Disagree to some extent, Not sure, Agree to some extent, Agree, Strongly agree</td>
</tr>
<tr>
<td>2</td>
<td>System was easy to use</td>
<td>-do-</td>
</tr>
<tr>
<td>3</td>
<td>Scenarios helped me improve my sleep patterns</td>
<td>-do-</td>
</tr>
<tr>
<td>4</td>
<td>Scenarios were engaging</td>
<td>-do-</td>
</tr>
<tr>
<td>5</td>
<td>Progress bar encouraged me to continue complete tasks</td>
<td>-do-</td>
</tr>
<tr>
<td>6</td>
<td>Seeing others' performance was motivating</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>I knew what to achieve by using the system</td>
<td>-do-</td>
</tr>
<tr>
<td>8</td>
<td>What was your overall experience with the system</td>
<td>Open-ended text box</td>
</tr>
</tbody>
</table>
### Appendix 2 Pre-study survey instrument in Finnish version used in study V

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Measurement Tool/Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sukupuoli</td>
<td>Mies, Nainen</td>
</tr>
<tr>
<td>3</td>
<td>Ammatti</td>
<td>Kokopäiväinen opiskelija, Osa-aikainen opiskelija, Osa-aikaisesti työssä, Kokopäiväisesti työssä, Työtön, Muu, mikä:</td>
</tr>
<tr>
<td>4</td>
<td>Tietokoneosaamiseni on</td>
<td>Erittäin heikkoa, Melko heikkoa, Keskimääräinen, Melko hyvä, Erittäin hyvä</td>
</tr>
<tr>
<td>5</td>
<td>Odotan Tyyne -Internet-sovelluksen auttavan minua parantamaan nukkumistottumuksiani</td>
<td>Täysin eri mieltä, Eri mieltä, Jokseenkin eri mieltä, Ei samaa eikä eri mieltä, Jokseenkin samaa mieltä, Samaa mieltä, Täysin samaa mieltä</td>
</tr>
<tr>
<td>6</td>
<td>Odotan Tyyne-sovelluksen auttavan parantamaan elämäntapojani</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>Odotan Tyyne-sovelluksen auttavan parantamaan terveyttäni</td>
<td>-do-</td>
</tr>
<tr>
<td>8</td>
<td>Odotan Tyyne-sovelluksen käytön olevan helppoa</td>
<td>-do-</td>
</tr>
<tr>
<td>9</td>
<td>Odotan Tyyne-sovelluksen käytön oppimisen olevan helppoa</td>
<td>-do-</td>
</tr>
<tr>
<td>10</td>
<td>Odotan Tyyne-sovelluksen informaattiosäiliön hahmottamisen ja sovelluksessa liikkumisen olevan minulle helppoa</td>
<td>-do-</td>
</tr>
<tr>
<td>11</td>
<td>Odotan Tyyne-sovelluksen käytön tulevan olemaan miellyttävää</td>
<td>-do-</td>
</tr>
<tr>
<td>12</td>
<td>Odotan Tyyne-sovelluksen käytön olevan nauittavaa</td>
<td>-do-</td>
</tr>
</tbody>
</table>
No | Question | Measurement Tool/Options
--- | --- | ---
13 | Tyyne-sovelluksen käyttö oli jännittävää | -do-
14 | Mielestäni Internet-sovellusten käyttämien nukkumisongelmien hoito on myönteinen idea | -do-
15 | Mielestäni Internet-sovellusten käyttämien nukkumisongelmien hoito on erittäin hyvä idea | -do-
16 | Mielestäni uusien taitojen opettelu Internet-sovellusten avulla on myönteinen idea | -do-
17 | Mielestäni uusien taitojen opettelu Internet-sovellusten avulla on erittäin hyvä idea | -do-
18 | Aion käyttää Tyyne-sovellusta säännöllisesti tutkimuksen aikana | -do-
19 | Olen erittäin innokas käyttämään Tyyne-sovellusta | -do-
20 | Tulen käyttämään Tyyne-järjestelämää usein | -do-
21 | Mielestäni ihmiset elvät yleensä suorita loppuun nettipohjaisia tukiohjelmia, koska he unohtelevat asiota | -do-
22 | Odotan pystyvänin hallitsemaan paremmin nukkumisongelmiani Tyyne-sovelluksen käyttämisen jälkeen | -do-
23 | Odotan pystyvänin hallitsemaan paremmin nukkumisongelmiani Tyyne-sovelluksen käyttämisen jälkeen | -do-
24 | Odotan tulevani taitavamaksi nukkumisongelmien torjumisessa Tyyne-sovelluksen käyttämisen jälkeen | -do-
25 | Odotan että minulla tulee olemaan tarpeeksi tietoa nukkumisongelmien ratkaisemiseen Tyyne-sovelluksen käyttämisen jälkeen | -do-
26 | Odotan että minulla tulee olemaan tarpeeksi tietoa nukkumisongelmien ratkaisemiseen Tyyne-sovelluksen käyttämisen jälkeen | -do-
27 | Mitä odotat järjestelmältä? Voit kuvailla odotuksiasi vapaasti omin sanoin | -do-
Appendix 3 Post-study survey instrument in Finnish version used in study V

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Measurement Tool/Options</th>
</tr>
</thead>
</table>
| 1  | Sukupuoli | Mies  
Nainen |
| 2  | Ikä | Alle 20  
20–24  
25–29  
30–34  
35–39  
40–44  
45–49  
50–54  
55–59  
60 tai enemmän |
| 3  | Ammatti | Kokopäiväinen opiskelija  
Osa-alkainen opiskelija  
Osa-aikaisesti työssä  
Kokopäiväisesti työssä  
Työttön |
| 4  | Tietokoneosaamisen i on | Erittäin heikko  
Melko heikko  
Keskimääräinen  
Melko hyvä  
Erittäin hyvä |
| 5  | Tyyne -internet-sovellus auttoi minua parantamaan nukkumistottumuksiani | Täysin eri mieltä, Eri mieltä,  
Jokseenkin eri mieltä, Ei samaa  
eikä eri mieltä, Jokseenkin samaa mieltä, Samaa mieltä, Täysin samaa mieltä |
<p>| 6  | Tyyne-sovellus auttoi minua parantamaan elämäntapojani | -do- |
| 7  | Tyyne-sovellus auttoi minua parantamaan terveyttäni | -do- |
| 8  | Tyyne-sovelluksen käyttö oli helppoa | -do- |
| 9  | Tyyne-sovelluksen käyttön oppiminen oli helppoa | -do- |
| 10 | Tyyne-sovelluksen informaatioisältöön hahmottaminen ja sovelluksessa liikkuminen oli minulle helppoa | -do- |
| 11 | Tyyne-sovelluksen käyttö oli miellyttävää | -do- |
| 12 | Tyyne-sovelluksen käyttö oli nautittavaa | -do- |
| 13 | Tyyne-sovelluksen käyttö oli jännittävää | -do- |</p>
<table>
<thead>
<tr>
<th>No</th>
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<th>Measurement Tool/Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Mielestäni Internet-sovellusten käyttäminen nukkumisongelmien hoitoon on myönteinen idea</td>
<td>-do-</td>
</tr>
<tr>
<td>15</td>
<td>Mielestäni Internet-sovellusten käyttäminen nukkumisongelmien hoitoon on erittäin hyvä idea</td>
<td>-do-</td>
</tr>
<tr>
<td>16</td>
<td>Mielestäni uusien taitojen opettelu Internet-sovellusten avulla on myönteinen idea</td>
<td>-do-</td>
</tr>
<tr>
<td>17</td>
<td>Mielestäni uusien taitojen opettelu Internet-sovellusten avulla on erittäin hyvä idea</td>
<td>-do-</td>
</tr>
<tr>
<td>18</td>
<td>Käytin Tyyne-sovellusta säännöllisesti tutkimuksen aikana</td>
<td>-do-</td>
</tr>
<tr>
<td>19</td>
<td>Olin erittäin innokas käyttäessäni Tyyne-sovellusta</td>
<td>-do-</td>
</tr>
<tr>
<td>20</td>
<td>Käytin Tyyne-sovellusta usein</td>
<td>-do-</td>
</tr>
<tr>
<td>21</td>
<td>Ihmiset eivät yleensä suorita loppuun nettipohjaisia tukiohjelma Tyyne-sovelluksella</td>
<td>-do-</td>
</tr>
<tr>
<td>22</td>
<td>Asiasta muistutaminen auttaa suorittamaan loppuun tällaiset ohjelmat</td>
<td>-do-</td>
</tr>
<tr>
<td>23</td>
<td>Pystyn hallitsemaan paremmin nukkumisongelmien Tyyne-sovelluksen käyttämisessä jälkeen</td>
<td>-do-</td>
</tr>
<tr>
<td>24</td>
<td>Olen taitavampi nukkumisongelmien torjumisessa Tyyne-sovelluksen käyttämisessä jälkeen</td>
<td>-do-</td>
</tr>
<tr>
<td>25</td>
<td>In my opinion, after using the Tyyne system, I will be more skillful in tackling sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>26</td>
<td>Minulla on tarpeeksi tietoa nukkumisongelmien ratkaisemiseen Tyyne-sovelluksen käyttämisessä jälkeen</td>
<td>-do-</td>
</tr>
<tr>
<td>27</td>
<td>Toteutiko Tyyne-sovellus odotuksesi? Voit kuvailla kokemuksiasi viimeisen kuuden viikon ajalta omin sanoin</td>
<td>Open-ended</td>
</tr>
</tbody>
</table>
Appendix 4 Pre-study survey instrument in English version for study V

<table>
<thead>
<tr>
<th>No</th>
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</tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>2</td>
<td>Please select your age group</td>
<td>Under 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20–24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25–29</td>
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<td>60 or over</td>
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<tr>
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<td></td>
<td>Part time student</td>
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<tr>
<td></td>
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<tr>
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<tr>
<td></td>
<td></td>
<td>Other (Please specify):</td>
</tr>
<tr>
<td>4</td>
<td>My computer expertise are</td>
<td>Very weak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fairly weak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average</td>
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<tr>
<td></td>
<td></td>
<td>Fairly good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>5</td>
<td>In my opinion, using the Tyyne BCSS will help me improve my sleep habits</td>
<td>Strongly disagree, Disagree, Disagree to some extent, Note sure, Agree to some extent, Agree, Strongly agree</td>
</tr>
<tr>
<td>6</td>
<td>In my opinion, using the Tyyne BCSS will improve my lifestyle.</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>In my opinion, using the Tyyne system will improve my health.</td>
<td>-do-</td>
</tr>
<tr>
<td>8</td>
<td>In my opinion, Tyyne system would be easy to interact with.</td>
<td>-do-</td>
</tr>
<tr>
<td>9</td>
<td>In my opinion, using the Tyyne BCSS will help me improve my sleeping habits.</td>
<td>-do-</td>
</tr>
<tr>
<td>10</td>
<td>In my opinion, interaction with the Tyyne BCSS will be easily understandable.</td>
<td>-do-</td>
</tr>
<tr>
<td>11</td>
<td>On the whole, I will find it easy to use the Tyyne BCSS.</td>
<td>-do-</td>
</tr>
<tr>
<td>No</td>
<td>Question</td>
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<tr>
<td>----</td>
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<tr>
<td>12</td>
<td>In my opinion, using the Tyyne BCSS will be enjoyable.</td>
<td>-do-</td>
</tr>
<tr>
<td>13</td>
<td>In my opinion, using the Tyyne BCSS will be pleasant.</td>
<td>-do-</td>
</tr>
<tr>
<td>14</td>
<td>In my opinion, using the Tyyne BCSS will be exciting.</td>
<td>-do-</td>
</tr>
<tr>
<td>15</td>
<td>In my opinion, using web-based systems for sleep deprivation is a very good idea</td>
<td>-do-</td>
</tr>
<tr>
<td>16</td>
<td>In my opinion, using web-based systems for sleep deprivation is a positive idea</td>
<td>-do-</td>
</tr>
<tr>
<td>17</td>
<td>In my opinion, learning new skills through web-based systems is a very good idea</td>
<td>-do-</td>
</tr>
<tr>
<td>18</td>
<td>In my opinion, learning new skills through web-based systems is a positive idea</td>
<td>-do-</td>
</tr>
<tr>
<td>19</td>
<td>I will use the Tyyne system frequently during the study period</td>
<td>-do-</td>
</tr>
<tr>
<td>20</td>
<td>I am highly willing to use the Tyyne system</td>
<td>-do-</td>
</tr>
<tr>
<td>21</td>
<td>I will use the Tyyne system often</td>
<td>-do-</td>
</tr>
<tr>
<td>22</td>
<td>In my opinion, generally people do not complete web-based programs because of forgetfulness</td>
<td>-do-</td>
</tr>
<tr>
<td>23</td>
<td>In my opinion, reminding people will help them complete web-based programs</td>
<td>-do-</td>
</tr>
<tr>
<td>24</td>
<td>In my opinion, after using the Tyyne system, I will be able to better manage my sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>25</td>
<td>In my opinion, after using the Tyyne system, I will be more skillful in tackling sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>26</td>
<td>In my opinion, after using the Tyyne system, I will have enough knowledge about handling sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>27</td>
<td>What are your expectations from the system? You can use your own words.</td>
<td>Open-ended</td>
</tr>
<tr>
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<tr>
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<tr>
<td>3</td>
<td>Occupation</td>
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</tr>
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<td></td>
<td></td>
<td>Very good</td>
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<tr>
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<td>Using the Tyyne BCSS helped me improve my sleep habits</td>
<td>Strongly disagree, Disagree,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disagree to some extent, Note sure,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agree to some extent, Agree,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly agree</td>
</tr>
<tr>
<td>6</td>
<td>Using the Tyyne BCSS helped improve my lifestyle.</td>
<td>-do-</td>
</tr>
<tr>
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<tr>
<td>8</td>
<td>Tyyne system was easy to interact with.</td>
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<td>-do-</td>
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<tr>
<td>10</td>
<td>In my interaction with the Tyyne BCSS was easily understandable.</td>
<td>-do-</td>
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<tr>
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<td>On the whole, I found it easy to use the Tyyne BCSS.</td>
<td>-do-</td>
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<td>-do-</td>
</tr>
<tr>
<td>13</td>
<td>In my opinion, using the Tyyne BCSS was pleasant.</td>
<td>-do-</td>
</tr>
<tr>
<td>14</td>
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<td>-do-</td>
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<td>16</td>
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<td>-do-</td>
</tr>
<tr>
<td>17</td>
<td>In my opinion, learning new skills through web-based systems is a very good idea</td>
<td>-do-</td>
</tr>
<tr>
<td>18</td>
<td>In my opinion, learning new skills through web-based systems is a positive idea</td>
<td>-do-</td>
</tr>
<tr>
<td>19</td>
<td>I used the Tyyne BCSS frequently during the study period</td>
<td>-do-</td>
</tr>
<tr>
<td>20</td>
<td>I was highly willing to use the Tyyne BCSS</td>
<td>-do-</td>
</tr>
<tr>
<td>21</td>
<td>I used the Tyyne BCSS often</td>
<td>-do-</td>
</tr>
<tr>
<td>22</td>
<td>In my opinion, generally people do not complete web-based programs because of forgetfulness</td>
<td>-do-</td>
</tr>
<tr>
<td>23</td>
<td>In my opinion, reminding people will help them complete web-based programs</td>
<td>-do-</td>
</tr>
<tr>
<td>24</td>
<td>In my opinion, after using the Tyyne system, I am able to better manage my sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>25</td>
<td>In my opinion, after using the Tyyne system, I am more skillful in tackling sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>26</td>
<td>In my opinion, after using the Tyyne system, I have enough knowledge about handling sleep problems</td>
<td>-do-</td>
</tr>
<tr>
<td>27</td>
<td>What are your expectations from the system? You can use your own words.</td>
<td>Open-ended</td>
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</table>
Appendix 6 Originally designed content of reminders for study V

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<thead>
<tr>
<th>Week No</th>
<th>Reminder No</th>
<th>Content</th>
</tr>
</thead>
</table>
| 1       | 1           | Dear User,  
Welcome to Tyyne – Parempaa unta. We thank you for partaking the study and wish you all the best for the upcoming 6 weeks. Each week you will be able to rehearse and learn new skills that will help you feel better and overcome poor sleep habits. To begin the program, please click on the link below and register yourself with the system:  
http://projectsleepingsimple.appspot.com  
IMPORTANT: We’d like to ask you fill in you sleep diary each day this week. We wish you a beautiful day. |
| 1       | 2           | Dear User,  
Greetings!  
This is a friendly reminder for you to complete the first weekly tasks. In case you have already completed the allocated tasks, please ignore this message. We’d like to remind you, once again, of filling in the sleep diary each day this week.  
All the best, |
| 1       | 3           | Dear User,  
We hope that you have completed the first week’s task. This is a friendly reminder and we wish to recommend that please practice the skills that you have learnt. This will help improve your sleep patterns. In addition, please do not forget to complete your Sleep Diary. Till next week, have a nice one. |
| 2       | 1           | Dear User,  
Greetings!  
This is a friendly reminder for you to complete the second weekly tasks. In case you have already completed the allocated tasks, please ignore this message. If you wish, you can continue filling out the Sleep Diary throughout the entire study.  
All the best |
| 2       | 2           | Dear User,  
We hope that you have successfully completed second week’s task. This is a polite reminder and we wish to recommend that please practice the skills that you have learnt. Try the exercises out and apply them into your daily life. This will help improve your sleep patterns.  
We will be in touch next week! |
<table>
<thead>
<tr>
<th>Week</th>
<th>Reminder</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>Dear User,&lt;br&gt;Greetings!&lt;br&gt; We have now reached week three of the program. We believe that if you rehearse actively and apply these principles into your daily life, you can improve your well-being. It is now time that you continue with your work and complete the exercises for week three. Until next week!</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>Dear User,&lt;br&gt;This is a polite reminder and we wish to recommend that please practice the skills that you have learnt. You can also rehearse previous exercises and apply them into your daily life.&lt;br&gt;In addition, please do not forget to complete your Sleep Diary. We will be in touch next week!</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Dear User,&lt;br&gt;Greetings!&lt;br&gt;We have now reached week four of the program. Go on doing the exercises; especially those, which help you, feel better. Until next week!</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Dear User,&lt;br&gt;This is a polite reminder and we wish to recommend that please practice the skills that you have learnt. This will further help improve your well-being and have an impact on your sleep patterns.&lt;br&gt;In addition, please do not forget to complete your Sleep Diary. See you next week!</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Dear User,&lt;br&gt;Greetings!&lt;br&gt;Congratulations for making it to week five. You are almost there. Go on practicing, preferably every day.&lt;br&gt;We wish to politely remind you to complete your weekly exercise. Keep up the good work!</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>Dear User,&lt;br&gt;This is a polite reminder and we wish to recommend that please practice the skills that you have learnt. This will further help improve your well-being and sleep patterns.&lt;br&gt;See you next week!</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Dear User,&lt;br&gt;Congratulations!&lt;br&gt;You have made it to the last week. That is wonderful indeed. Now let us complete the final exercises.&lt;br&gt;In case you have already completed the allocated tasks, please ignore this message. Well done!</td>
</tr>
<tr>
<td>Week</td>
<td>Reminder</td>
<td>Content</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| No   | No       | Dear User,  
This is a polite reminder and we wish to recommend that please practice the skills that you have learnt during the past 5 weeks.  
Please note that it is critical that you fill out both daily and weekly diaries.  
We wish you all the very best! |
## Appendix 7 Finnish version of reminders used in Study V

<table>
<thead>
<tr>
<th>Week</th>
<th>Reminder No</th>
<th>Content</th>
</tr>
</thead>
</table>
| 1    | 1           | "Loppujen lopuksi ei merkitsevintä elämässä ole elinvuosien määrä, vaan elämän määrä noissa vuosissa."
          – Abraham Lincoln
          Hyvä Tyyne-ohjelmaan osallistuva,
          Tervetuloa Tyynen pariin ja kiitos halukkuudestasi osallistua tutkimukseemme!
          Toivomme sinun viihtyvän ohjelmamme äärellä seuraavien kuuden viikon ajan.
          Viikoltain harjoittelussa voit oppia uusia taitoja, jotka voivat vaikuttaa hyvinvointiisi ja
          parantaa uniasi.
          Käyttäjätunnuksesi Tyynen-ohjelmaan on "XXX" ja salasanasi "SSSYYAA". Säilytän tämän
          viestin ja tallennat käyttäjätunnuksesi sekä salasanasi turvalliseen paikkaan, sillä
          tulevat tarvitsemaan niitä koko ohjelman ajan.
          Aloitetaan ohjelman käynnistämällä alla olevaa linkkiä ja kirjaudu järjestelmään.
          Huomaathan, että Tyyneen käyttäminen onnistuu parhaiten käyttämällä Mozilla Firefoxin,
          Chromen, Internet Explorerin tai Safariin viimeisintä versiota.
          [http://projectsleepingsimple.appspot.com](http://projectsleepingsimple.appspot.com)
          Muistathan myös täyttää unipäiväkirjasi lähimmästä viikolla joka päivä.
          Parhain terveisin,
          Tyyne-tiimi |
| 1    | 2           | Tervehdys hyvä Tyyne käyttäjä,
          Haluamme ystävällisesti muistuttaa Sinua ensimmäisen viikon tehtävien ja harjoitusten
          tekemisestä.
          Samoin muistathan täyttää unipäiväkirjan lähimmästä viikolla joka päivä.
          [http://projectsleepingsimple.appspot.com](http://projectsleepingsimple.appspot.com)
          Ystävällisin terveisin,
          Tyyne-tiimi |
| 1    | 3           | Tervehdys hyvä Tyyne käyttäjä,
          Haluamme ystävällisesti muistuttaa Sinua ensimmäisen viikon tehtävien ja harjoitusten
          tekemisestä.
          Samoin muistathan täyttää unipäiväkirjan lähimmästä viikolla joka päivä.
          [http://projectsleepingsimple.appspot.com](http://projectsleepingsimple.appspot.com)
          Ystävällisin terveisin,
          Tyyne-tiimi |
Hyvä Tyynen käyttäjä,

Pääset nyt tekemään toisen viikon harjoituksia kirjaamalla Tyyne-järjestelmään.

Tässä vielä Tyynen osoite:
http://projectsleepingsimple.appspot.com

Kaikkea hyvää!

Ystävällisin terveisin,

Tyyne-tiimi

"Älä katso menneeseen vihaten tai tulevaan peläten.
Katso ympärillesi nyt, tässä hetkessä, tielessäsi."
– James Thurber

"On vain yksi tärkeä aika – se on NYT!"
– Leo Tolstoi

Hyvä Tyynen käyttäjä,

Haluamme muistuttaa sinua ohjelmamme toisen viikon tehtäviistä. Jos olet jo tehnyt annetut tehtävät, voit jättää tämän viestin huomiotta.

Halutessasi voit jatkaa unipäiväkirjan täyttämistä koko kokeilun ajan.

Parhain terveisin,

Tyyne-tiimi

Tervehdys Tyynen käyttäjä!

Toivottavasti kaikki on mennyt hyvin. Pääset nyt tekemään kolmannen viikon harjoituksia.

Kaikkea hyvää toivotellen,

Tyyne-tiimi

Hyvä ohjelman käyttäjä,

Olestan muistanut harjoitelta ja soveltaa oppimiasi taitoja? Suosittelemme lämpimästi vipymään harjoituksen parissa.

Voit myös jatkaa aiempia harjoituksia, kokeilla ja soveltaa niitä omaan arkeesi.

Kuuleminen ensi viikokoon!

Terveisin,

Tyyne-tiimi

Viikon 4 harjoitukset ovat nyt auki. Viikon 4 harjoitusten lisäksi suosittelemme tekemään myös aiempien viikkojen harjoituksia.

Kaikkea hyvää,

Tyyne-tiimi
<table>
<thead>
<tr>
<th>Week</th>
<th>Reminder</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 1</td>
<td>Hyvä käyttäjä, Viikon 5 harjoitukset ovat nyt auki. Viikon 5 harjoituksen lisäksi suosittelemme tekemään myös aiempien viikon jälkeen harjoituksia. Kaikkea hyvää, Tyyne-tili</td>
<td></td>
</tr>
<tr>
<td>6 1</td>
<td>Hyvä käyttäjä, Viikon 6 harjoitukset ovat nyt auki. Viikon 6 harjoituksen lisäksi suosittelemme tekemään myös aiempien viikon jälkeen harjoituksia. Kaikkea hyvää, Tyyne-tili</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 8 English version survey instrument for study VI

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Measurement Tool/Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Please select you gender</td>
<td>Male, Female</td>
</tr>
<tr>
<td>2</td>
<td>Please select your age group</td>
<td>Under 22, 22–31, 32–41, 42–51, 51 and over</td>
</tr>
<tr>
<td>3</td>
<td>My expertise to use Internet are</td>
<td>Very weak, Fairly weak, Average, Fairly good, Very good</td>
</tr>
<tr>
<td>4</td>
<td>I found the BCSS to be useful</td>
<td>Strongly disagree, Disagree, Disagree to some extent, Note sure, Agree to some extent, Agree, Strongly agree</td>
</tr>
<tr>
<td>5</td>
<td>The BCSS was easy to interact</td>
<td>-do-</td>
</tr>
<tr>
<td>6</td>
<td>Reminders helped me complete weekly exercises</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>Reminders did not interrupt my routine</td>
<td>-do-</td>
</tr>
<tr>
<td>8</td>
<td>Varying content of reminders was effective</td>
<td>-do-</td>
</tr>
<tr>
<td>9</td>
<td>Weekly exercises &amp; rehearsals have improved my confidence to tackle depressive symptoms</td>
<td>-do-</td>
</tr>
<tr>
<td>10</td>
<td>Information presented in the BCSS influenced my behavior</td>
<td>-do-</td>
</tr>
<tr>
<td>11</td>
<td>Weekly rehearsals influenced my confidence to manage depressive symptoms</td>
<td>-do-</td>
</tr>
<tr>
<td>12</td>
<td>I would like to share my progress with fellow users</td>
<td>-do-</td>
</tr>
<tr>
<td>13</td>
<td>In your own words, please describe your experience with the BCSS</td>
<td>Open-ended</td>
</tr>
</tbody>
</table>
## Appendix 9 Finnish version survey instrument in for study VI

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Measurement Tool/Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sukupuoli</td>
<td>Mies, Nainen</td>
</tr>
<tr>
<td>2</td>
<td>Ikä</td>
<td>Under 22, 22–31, 32–41, 42–51, 51 and over</td>
</tr>
<tr>
<td>3</td>
<td>Minkälaiseksi arvioisit oman tietokoneen käyttötaitoisi?</td>
<td>Hyvin heikko, Heikko, Normaali, Hyvä, Todella hyvä</td>
</tr>
<tr>
<td>4</td>
<td>Pidin Kompassi-järjestelmää hyödyllisenä</td>
<td>Täysin samaa mieltä, Samaa mieltä, En osaa sanoa, Eri mieltä, Täysin eri mieltä</td>
</tr>
<tr>
<td>5</td>
<td>Kompassi-järjestelmässä oli helppo toimia</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>6</td>
<td>Viikoittaiset muistutukset auttoivat minua tekemään viikoittaiset harjoitukset</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>7</td>
<td>Muistutukset eivät häirinneet rutinejani</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>8</td>
<td>Muistutusten sisältö vaihteli viikosta toiseen. Pidin tätä tapaa hyvin tehokkaana</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>9</td>
<td>Viikoittaiset harjoitukset vaikuttivat käyttäytymiseeni ja minusta tuntuu, että kykenen käsittelemään paremmin masennustani</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>10</td>
<td>Kompassissa esitetyt tieto vaikutti käyttäytymiseeni</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>11</td>
<td>Viikoittaiset harjoitukset ovat vaikuttaneet itseluottamukseeni siten, että kykenen tulevaisuudessa paremmin käsittelemään masennusoihtoja</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
<tr>
<td>12</td>
<td>Olisin halunnut jakaa kokemuksia toisten Kompassin käyttäjien kanssa</td>
<td>Samat vastausvaihtoehdot kuin yllä</td>
</tr>
</tbody>
</table>
Kuvaile omin sanoin kokemuksesi Kompassi-järjestelmästä. (Esim. mitkä ohjelman ominaisuuksista olivat hyödyllisiä, mitkä eivät; olko jokin tietty harjoitus tehokkaampi kuin jokin toinen jne.)
Appendix 10 Originally designed content of reminders for study VI

<table>
<thead>
<tr>
<th>Week No</th>
<th>Content</th>
</tr>
</thead>
</table>
| 1       | “Believe in yourself! Have faith in your abilities! Without a humble but reasonable confidence in your own powers you cannot be successful or happy.” - Norman Vincent Peale  
Dear User,  
Welcome to Kompassi!  
We hope that you are having a good day. This is a gentle reminder for you to complete the first exercise tomorrow. In case you have already done that, please ignore this message.  
If you wish to log into the Kompassi System, please click on the link below and you will be redirected to the Kompassi web site:  
Kompassi System (hyperlink)  
Good luck with the exercises and we look forward to be in touch with you next week. |
| 2       | “Always continue the climb. It is possible for you to do whatever you choose, if you first get to know who you are and are willing to work with a power that is greater than ourselves to do it.” - Ella Wheeler Wilcox  
Dear User,  
We hope to have reached you at a convenient time. Congratulations on completing the exercise for Week 1.  
This is a reminder for you to complete your exercise for Week 2. In case you have already completed the exercise, please ignore this message.  
We would further like to advise you to keep checking your email on a regular basis as we might wish to contact you.  
For your convenience, we have added the link to Kompassi system below. Simply click on the link below and you will be redirected to the web site:  
Kompassi System (hyperlink)  
Good luck with the exercises and we look forward to be in touch with you next week. |
| 3       | “Act as if what you do makes a difference. It does.” - William James  
Dear User,  
Hoping that you are having a good day, we wish to congratulate you upon successfully completing exercise for Week 2. You are making great progress and we truly hope that you are happy with your performance!  
We hope that you will complete upcoming exercise for Week 3 well in time. When you feel convenient, please click on the link provided below and you will be redirected to the Kompassi website:  
Kompassi System (hyperlink)  
Good luck with the exercises and we look forward to be in touch with you next week. |
Week No | Content
--- | ---
4 | "Do you want to know who you are? Don’t ask. Act! Action will delineate and define you.”  
- Thomas Jefferson

Dear User,

We wish you a good day.

We are now in week 4 and are delighted to inform you that you are making great progress by completing your weekly exercises. We further hope that you find the exercises to be of great use.

This is a gentle reminder that the exercise for week 4 is due tomorrow. Please keep up the good work and complete your weekly exercise in time.

If you have already completed it, please ignore this message. For your convenience, clicking on the link below can access Kompassi system:
Kompassi System (hyperlink)

Good luck with the exercises and we look forward to be in touch with you next week.

5 | “Follow your dreams, work hard, practice and persevere. Make sure you eat a variety of foods, get plenty of exercise and maintain a healthy lifestyle.” - Sasha Cohen

Dear User,

Greetings from Kompassi!

You have now completed four exercises. It shows your commitment and resilience. Well done.

We are sure that you are finding the exercises to be of great use.

We are now in week 5 of the program and this is a reminder for you to complete this week’s exercise. At your convenience, simply click on the link provided and you shall be redirected to the website.

In case you have already completed this week’s exercise, please ignore this message.
Kompassi System (hyperlink)

Keep up the good work and we shall be in touch with you next week.

Have a wonderful day!

6 | "The will to win, the desire to succeed, the urge to reach your full potential... these are the keys that will unlock the door to personal excellence.” - Confucius

Dear User,

Greetings from Kompassi!

Let us congratulate you for completing 5 exercises over the past weeks. We hope that you have found the exercises to be useful!

You also deserve a special applause for your commitment and persistence with the program!

This is a reminder for you to complete the last exercise that is due tomorrow. If you feel convenient and wish to complete the exercise right now, simply click on the link provided below and you shall be redirected to the website:
Kompassi System (hyperlink)

In case you have already completed this week’s exercise, please ignore this message.

Let us take this opportunity to thank you for being part of the study and one more time, congratulations on completing the program!
### Appendix 11 Finnish version of reminders used in study VI

<table>
<thead>
<tr>
<th>Vikko</th>
<th>Content</th>
</tr>
</thead>
</table>
| 1 (Arvot) | Loppujen lopuksi ei merkitsevintä elämässä ole elinvuoden määrä, vaan elämän määrä noissa vuosissa. – Abraham Lincoln  
Hyvää Vastaanottajaa,  
Tervetuloa Kompassi-ohjelman pariin!  
Tällä viestillä haluamme muistuttaa, että huomenna on ensimmäisen harjoituksen palauttamispäivä. Jos olet jo palauttanut tehtävän, Sinun ei tarvitse huomioida tätä viestää.  
Muista kokeilla esitettyjä ajatuksia ja periaatteita käytännössä.  
Jos haluat siirtyä Kompassi-sivustolle nyt, pääset sinne klikkaamalla alla olevaa linkkiä.  
Kompassi-sivusto (hyperlinkki)  
Ensii viikolla olemme taas yhteydessä Sinuun. Siihen asti: tsemppiä!  
Parhain terveisin,  
Kompassi |
| 2 (Arvojen mukainen toiminta) | Toimi siten, että sillä mitä teet on merkitystä. Sillä on.  
Hyvää Kompassi-ohjelman osallistuvaa,  
Ensimmäisen viikon harjoitus on nyt onnistuneesti takana – onnittelut siitä.  
Tällä viestillä haluamme muistuttaa Sinua viikon 2 harjoituksen tekemisestä. Siinä tapauksessa, että olet jo tehtävän tehnyt, sinun ei tarvitse välittää tästä viestistä.  
Saatamme ottaa Sinuun yhteyttä ja sen vuoksi neuvommekin Sinua säännöllisesti tarkastamaan sähköpostisi.  
Jos haluat nyt siirtyä Kompassiin, klikkaa vain linkkiä.  
Kompassi-sivusto (hyperlinkki)  
Onnea harjoitusten tekoon – olemme yhteydessä taas ensi viikolla.  
Parhain terveisin,  
Kompassi |
3 (Tietoinen läsnäolo)

Ala katso menneeseen vihaten tai tulevaan peläten.
Katso ympäriillesi nyt, tässä hetkessä, tietoisesti. – James Thurber
On vain yksi tärkeä aika – se on NYT! – Leo Tolstoi

Hyvä Kompassin käyttäjä,


Klikkaamalla alla olevaa linkkiä pääset Kompassiin silloin kun Sinulle sopii.

Kompassi-sivusto (hyperlinkki)

Toivomme että viihdyt ohjelman parissa. Kuulemiin ensi viikkoon!

Parhain terveisin,
Kompassi

4 (Havainnoinva minä)

Kun muutat tapaa, jolla katsot asioita, muuttuvat asiatkin. – W. Dyer

Hyvä Kompassin käyttäjä,


Tällä viestillä haluamme ystävällisesti muistuttaa, että huomenna on tämän viikon harjoituksen viimeinen palautuspäivä.

Jos olet jo palauttanut tehtävää, voit jättää tämän viestin huomiotta. Alla olevasta linkistä pääset napinpäällä Kompassi-sivustolle.

Kompassi-sivusto (hyperlinkki)

Toivotamme tsemppiä harjoituksiin. Olemme yhteydessä Sinuun taas ensi viikolla.

Parhain terveisin,
Kompassi
Viikko 5 (Mielen kontrollin heikentäminen) – Williams, Teasdale & Kabat-Zinn

Hyvä Kompassi-ohjelman käyttäjä,

Olet nyt suorittanut neljä harjoitustehtävää - hienoa! Arvostamme sitä, että olet panostanut aikaasi tähän. Uskomme, että harjoituksen tekemisestä on Sinulle hyötyä. Muista kokeilla näitä asioita ja periaatteita käytännössä.

Kompassi-ohjelman viides viikko on käynnissä ja tämä viesti on muistutuksena Sinulle tämän viikon harjoituksen tekemisestä. Alla olevaa linkkiä klikkaamalla pääset helposti Kompassi-sivustolle.
Jos olet jo tehnyt tämän viikon tehtävän, voit jättää viestin huomioimatta.

Mukavia hetkiä Kompassin parissa! Otamme yhteyttä Sinuun taas ensi viikolla.
Oikein mukavaa päivänjatkoa!
Kompassi

6 (Hyväksy) *Tule ystäväksi tunteissasi kanssa. Toivota ne kaikki – niin ilo, masennus kuin ahdistuskin tervetulleeksi.

Tervehdys Kompassista!
Onnittelut – olet suorittanut jo viisi viikoharjoitusta! Olet panostanut ohjelmaan hienosti ja toivomme, että ohjelmasta ja sen harjoituksista on ollut Sinulle hyötyä.
Tällä viestillä muistutamme Sinua vielä viimeisen harjoituksen tekemisestä. Toivomme, että palautat sen huomiseen mennessä. Jos haluat, voit siirtyä Kompassi-ohjelmaan alla olevasta linkistä:
Kompassi-sivusto (hyperlinkki)
Jos olet jo tehnyt tämän viikon tehtävän, voit jättää viestin huomioimatta.
Parhain terveisin,
Kompassi
Original publications


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Original publications are not included in the electronic version of the dissertation.
610. Lehto, Tuomas (2013) The importance of persuasive systems design in enhancing consumers’ perceptions and adoption of health behavior change support systems


612. Lawrence, Carl (2013) Innovating with information technology in a globalized world: being proactive about culture

613. Ardanov, Pavlo (2013) Priming capacities of endophytic Methylobacterium sp. on potato (Solanum tuberosum L.)


615. Holm, Jana (2013) Catalytic pretreatment and hydrolysis of fibre sludge into reducing sugars

616. Kemi, Ulla (2013) Adaptation to growing season length in the perennial Arabidopsis lyrata


618. Rodríguez, Pilar (2013) Combining lean thinking and agile software development: how do software-intensive companies use them in practice?

619. Vatka, Emma (2014) Boreal populations facing climatic and habitat changes

620. Isomursu, Marja (2014) Host–parasite interactions of boreal forest grouse and their intestinal helminth parasites


622. Matusek, Florian (2014) Selective privacy protection for video surveillance

623. Virtanen, Elina (2014) Effects of haulm killing and gibberellic acid on seed potato (Solanum tuberosum L.) and techniques for micro- and minituber production in northern latitudes

624. Kopatz, Alexander (2014) Genetic structure of the brown bears (Ursus arctos) in Northern Europe

625. Loukola, Olli (2014) Information networks among species: adaptations and counter-adaptations in acquiring and hiding information

Book orders:
Granum: Virtual book store
http://granum.uta.fi/granum/
Sitwat Langrial

EXPLORING THE INFLUENCE OF PERSUASIVE REMINDERS AND VIRTUAL REHEARSAL ON THE EFFICACY OF HEALTH BEHAVIOR CHANGE SUPPORT SYSTEM