Selecting effective persuasive strategies in Behavior Change Support Systems

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Abstract. The Third International Workshop on Behavior Change Support Systems provides a place to discuss recent advances in BCSS research. The selected papers show that research into behavior change support systems is expanding: not only by trying to reach more and other people, but also by expanding the contexts where BCSSs are employed. A key point for all BCSSs, for each target group and for each context, is to select the right persuasive strategies. From the proceedings we can learn that there are several ways to select and evaluate these features, but this remains an issue that deserves continuous research attention.

1 Introduction

Technology is everywhere. Our homes and workplaces are filled with technology and people themselves carry more and more technology with them everywhere they go. Furthermore, persuasion is everywhere. From doing grocery shopping to reading the news online, we are being persuaded to buy certain products or behave a certain way. This persuasion is not new, only the way it is presented to us, is changing. With the ubiquitous presence of technology, there is also ubiquitous presence of persuasion through technology. However, because of the sometimes overwhelming possibilities and instances of persuasion, it is even more important to select the right strategies to actually influence the behavior of people and not just add to the 'noise' of persuasion all around us. This poses real challenges for researchers and practitioners in the field of Behavior Change Support Systems (BCSSs) [1].

The aim of a BCSS is to help people to change their behavior through technology. Two domains that gave gained considerable attention are the health and the energy domain. In the health domain, BCSSs have been developed to support people to become more physically active, or to shop and eat healthier (e.g. [2,3]). In the energy sector, BCSSs have been created to help people become aware of their energy consumption and to reduce this (e.g. [4]). However, BCSSs also hold potential for other domains, e.g. in the context of the workplace [5,6]. BCSSs may support people to work according to protocols or to help them work more efficiently. In all these cases, the BCSS helps people to change their behavior, but there is always a certain level of

motivation to start with. It is the challenge for BCSSs to find the right way and the right moment to persuade the user to reach previously agreed upon goals.

Finding this right way of persuasion is a challenge that can be seen in the development and evaluation of many BCSSs, but has not always received very structured attention. There are multiple ways how to deal with this challenge. For instance, the Persuasive System Design Model (PSD-model) [7] provides guidelines for developing and evaluating BCSSs. It states that for developing BCSSs, the starting point is understanding the postulates that underline each persuasive system. After that, one should analyze the intent, event and strategy. Only then can developers decide on which persuasive features can be used to reach the goals of the BCSS. The persuasive features in the PSD-model are divided into four categories. Primary task support holds strategies that are aimed to make the main task of the BCSS easier for the user. Examples of strategies in this category are reduction (reducing complex behavior to simpler tasks) and tailoring (presenting information that is tailored to the needs and wishes of a target group). Strategies from primary task support seem to be used most in many BCSSs, from web-based interventions to mobile apps [8,9]. This emphasis on primary task support features seems logical from the perspective of the developers (i.e. most of the time the BCSS is built to support this primary task) and many individual features been shown to be effective in behavior change (e.g. the positive effects of tailoring are well known [10]. However, deciding which primary task support features to choose in which situation, is still a challenge. Moreover, primary task support is not the only category of persuasive features and research shows that other categories might even be more important for the persuasive power of BCSSs than primary task support [8,11,12].

Dialogue support, the second category of persuasive features in the PSD-model, is aimed at supporting the dialogue between the user and the system. Examples of features from this category are reminders, praise and a social role. Reminders are a feature that is well investigated and can play an important role in persuading users [13,14]. Not surprising, this feature has been used in many BCSSs (see e.g. [8,9]. Other features form this category have been used less often, although with the recent rise of gamification techniques, features as (virtual) rewards are getting more attention (see e.g. [15]). Research shows that dialogue support as a category seems to pay an important role in persuading users [8,11,12].

Credibility support, or the ways to make a system more credible and this persuasive, has been used to some extent in BCSS [9,16,17]. Credibility is an important issue in our digital community, but selecting the right way to support credibility of BCSS seems to have gotten only limited attention.

The last category of persuasive features in the PSD-model is social support, or the ways to design the system so that it motivates users by leveraging social influence. Social support through technology has received a lot research attention (see e.g. [18-20]) and seems to provide huge opportunities to persuade people in our social environment, which takes place more and more in our online world. The humanization of the web [21] plays an important role in this respect. In this light, is it even more surprising that social support features are used so little in BCSSs [8,9,16,17].

2 Advances in BCSS research

The Third International Workshop on Behavior Change Support Systems provides a place to discuss recent advances in BCSS research. The six papers presented at the workshop all cover the timely topic of how to select and evaluate effective persuasive strategies. The first session includes three papers that are about selecting persuasive strategies to increase the reach of BCSS. The second session covers three papers that show the importance of the context of the BCSS.

2.1 Persuasive strategies to increase reach

Triggers in the environment; increasing the reach of Behavior Change Support Systems by connecting to the offline world by Ludden and Offringa [22] discusses why many BCSSs have limited reach and provides an alternative approach to increase reach; design for stages of change. Through a case study, the authors show that triggers in the environment can be designed that may reach a larger group than an online BCSS. By connecting these offline triggers to the BCSS, reach may be increased.
Enhancing persuasive features of Behavior Change Support Systems: the role of U-FADE by Wiafe and Frempong [23] builds on earlier work on the three-dimensional relationships between attitude and behavior (3D-RAB) model [24] and addresses the issue of changing user needs during the use of BCSSs. When BCSSs are not ready for these changing needs, they become obsolete for a group of users, thereby diminishing its reach. The Unified Framework for Analyzing, Designing and Evaluating persuasive systems (U-FADE) provides an approach to evaluate and select persuasive features based on the (changing) needs of the targeted users. Application to an existing weight management intervention shows the possibilities of this approach.
How Persuasive are Serious Games, Social Media and mHealth Technologies for Vulnerable Young Adults? Design Factors for Health Behavior and Lifestyle Change Support: Sexual Health Case by Kulyk, Den Haas, David and Van Gemert-Pijnen [25] aims to identify effective persuasive features for a specific target group which is not reached by regular interventions. They use the case of improving the sexual health of vulnerable young adults and employ focus groups to gain insight into the needs and attitudes of these young adults towards persuasive features and design factors that contribute to the use and uptake of existing and new health technologies.

2.2 Importance of context

About the persuasion context for BCSSs: analyzing the contextual factors by Halttu, Oduor, Tikka and Oinas-Kukkonen [26] emphasizes the importance of taking the context into account for designing and evaluating BCSSs. They present the event model, which is a conceptual tool for identifying which contextual factors are important and how to take these factors into account. This event model is an extension of the persuasion context of the PSD-model and provides more concrete factors that potentially play a role in the everyday lives of end-users and should be taken into account when investigating a BCSS.

Behavior Change Support Systems for Privacy and Security by Kegel and Wieringa [27] proposes to use a BCSS for a specific domain, namely information security. For this specific context, the challenges seem to differ from areas that have received more attention in the BCSS-field like healthcare and energy consumption. Challenges that have been identified are motivation and change type, and the dynamic nature of security threats. The authors propose the Personal Information Security Assistant (PISA) as a possible solution to these challenges.
Persuasive information security: a Behavior Change Support System to help employees protect organizational information security by Busch, Patil, Regal, Hochleitner, Fröhlich and Tscheligi [28] also tackles the issue of information security, but in the context of the workplace. They present a Behavior Change Support prototype that implements persuasive features (points, quiz, challenges, statistics, personalization and risk communication) to support employees to comply with information security policies. Preliminary results of user studies show that this is a promising approach for influencing user attitudes and behaviors regarding secure work practices.

3 Discussion

The selected papers for the workshop show that research into behavior change support systems is expanding: not only by trying to reach more and other people, but also by expanding the contexts where BCSSs are employed. The workshop provides an opportunity for researchers to discuss new steps in these directions. A key point for all BCSSs, for each target group and for each context, is to select the right persuasive strategies. From the proceedings we can learn that there are several ways to select and evaluate these features, but this remains an issue that deserves continuous research attention.

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Triggers in the environment

Increasing reach of Behavior Change Support Systems by connecting to the offline world

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Abstract. Behavior Change Support Systems (BCSS) are a category of persuasive systems that can potentially help large groups of people to change their behavior. Within this category, many systems have been introduced aimed at helping people to lead a healthier lifestyle. However, many such systems do not reach all people that could benefit from using them. With reference to Stages of Change theory, this article discusses why current approaches to increase reach have been less than successful. Further, we provide an alternative approach to increase reach; design for stages of change. Following this design approach, we argue that triggers in the environment can increase reach for BCSS. A case study serves as an example of how designers can design interventions following the approach while connecting triggers in the environment to BCSS. A preliminary user study showed that connecting a BCSS to a trigger in the environment is a promising avenue to increase reach. In our discussion, we will elaborate on future avenues for research on triggers in the environment and the design of dynamic interventions.

Keywords: persuasion, stages of change, BCSS, reach, design

1 Introduction

Behavior change support systems (BCSS) have been introduced as a key construct for research on persuasive systems design, technologies, and applications (Oinas-Kukkonen, 2010). As a possible response to the severe problems that our society faces when it comes to securing health for the public at large, many of such systems have been introduced that aim to help people to adopt a healthier lifestyle. Among these are, for example, systems that aim to improve dietary behavior or to increase the amount of physical activity that people take every day (e.g., Consolvo et al., 2008). BCSS can potentially be used by large groups of people because they are easily ac-

cessible, not overly expensive and mostly convenient to use. However, BCSS often suffer from a lack of reach: most BCSS reach a limited group only, in many cases mainly highly educated women (Kelders et al., 2011), suggesting that, that in spite of their large potential, web-based interventions miss out on helping the public at large. This selective reach is not intended and in many cases it seems to strengthen the 'inverse care and information law' (i.e. people in urgent need for care are the ones who are least likely to receive care (Eysenbach, 2000; Tudor Hart, 1971).
Attempts to increase reach of BCSS have often followed the strategy of personalization. Personalization of the content or of the aesthetics of a BCSS offers opportunities to attract different target groups. The BCSS Chick clique, for example, (Toscos et al., 2006) was designed especially to be attractive (in content and system to teenage girls. Personalization can also be used to adapt the BCSS to the needs of different groups of people. Kaptein et al, (2012) for example, measured susceptibility to persuasion and studied effects of tailored, persuasive text messages to reduce snacking. Results showed that tailored messages lead to a higher decrease in snacking consumption.
Personalization of a systems functionalities and content can thus attract different target groups and improve people's satisfaction with services. In this paper, we would like to introduce an alternative design approach to increase reach: that of placing *triggers* in the environment. In his behavior model for persuasive design, BJ Fogg (2009) mentions *triggers* as one of the three principal factors that are essential for a behavior change to happen. In their work on Persuasive Systems Design, Oinas-Kukkonen & Harjuuma (2009) postulate that persuasion is often incremental and that it is easier to initiate people into doing a series of actions through incremental suggestions. We see triggers as doing just that; A trigger can be a first reason to start a series of actions leading to behavior change. Using theory on stages of change, we will show that most BCSS currently attract people who are already to some extent motivated to change, thereby failing to reach the large groups of people who are unaware of a need for change. We will argue that placing triggers in the environment can be a successful strategy to reach these groups of people. The paper will go on to show a design case study that introduces a range of products that are connected and that help people move through the different stages of change. We will report on a preliminary user evaluation of this case study that indicates that placing a triggers in the environment and connecting this trigger to a personal BCSS is a promising strategy to increase reach.

2 Design for stages of change

In their work on health behavior change, Prochaska and colleagues (Prochaska et al., 1992; 1997) identified 10 distinct processes of change. When they presented these processes to their research participants, these reported that they used different processes of change at different times, thus revealing that behavior change follows a series of stages. These findings eventually led to the development of the Transtheoretical Model of Health Behavior Change (TTM). Prochaska et al. suggest that to make a durable health change, whether it is to quit smoking, to eat a more healthy diet or to increase physical activity, people pass through five stages: precontemplation, contem-

plation, preparation, action and maintenance. In the first three stages, people built motivation to change and in the last two stages people act. Following this theory, health interventions should have different goals for people who are in different stages of change. While interventions aimed at early stages of change should aim to raise awareness, interventions in later stages should be more focused on acting out and sustaining new behavior. Based on an analysis of health interventions aimed at eating a healthier diet or at increasing physical activity, a framework was created for the design of stage-matched interventions (Ludden & Hekkert, 2014). This framework (see Figure 1) is largely based on the TTM, including processes of change and stages of change while connecting these to design strategies for stage-matched interventions. Four types of design strategies have been defined that adhere to four different (design) aims: 'raising awareness', 'enabling', 'motivating' and 'fading out'. As can be seen from Figure 1, the design strategies spread over multiple stages.

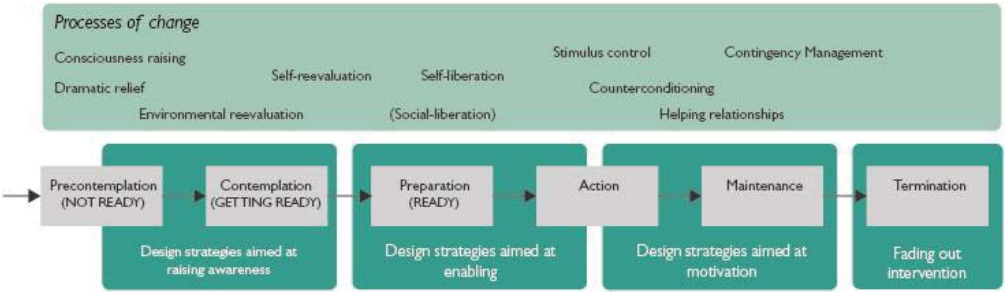

Fig. 1. The 'design for healthy behavior framework' connecting processes and stages of change to design strategies.

Most BCSS focus on particular phases in a behavior change cycle; that of action and motivation. However, when it comes to leading a healthier lifestyle, many (most) people are in earlier stages of change (Kramish Campbell et al., 1999). Most likely, these people will not feel the need to buy or use any of the numerous devices or applications on the market that support adopting a healthier lifestyle.

Therefore, placing triggers in the environment, that everyone can (and will) encounter are essential to adopt BCSS and to start a process of change. People need to become aware of the consequences of their choices and, as a second step, they need to be made aware of their possibilities for action. While presenting a design case, we will show how a trigger in the environment can serve as an enabler of changes towards a healthier lifestyle.

3 Design case: sugar to water

A design case was carried out to serve as an example of how to design an intervention that people come across in their physical environment as a trigger that is connected to another, more personal intervention that uses a BCSS that can be used in later stages of change. The topic for this design case was the lifestyle issue of drinking too many sugar containing beverages. For many people, their daily intake of sugar is too high which has a negative effect on their general health and wellbeing. Limiting the intake of sugar containing beverages can be a solution to this problem. Of course, we are not the first to address this lifestyle issue. There have been multiple attempts at creating environmental interventions to raise awareness of this issue (and thus addressing earlier stages of changes). These have often taken the form of posters or information boards that are placed in public environments such as schools or governmental buildings. Environmental interventions such as these may indeed raise awareness of the lifestyle issue. However, they do not support people in taking a next step in the behavior change process. Subsequently, in a small but promising study, Langrial & Oinas-Kukkonen (2012) have demonstrated that persuasive software using reminders may help people to reduce their intake of 'fizzy drinks'. However, the form of their intervention was especially suitable for people in the action phase. In fact, while recruiting respondents, these researchers specifically asked people if they were willing to reduce their intake of fizzy drinks. This study showed promising results but does not solve the problem of persuading people in earlier stages of change to decide to take the step to change. A sequential intervention (addressing multiple stages of change) could therefore be more effective in addressing this lifestyle issue.
Following the 'design for healthy behavior framework' three different products were designed for three different phases of behavioral change. The connected products that resulted from the design case were evaluated in a preliminary user study. Results from this study will be discussed.

3.1 Design and stages of change

The first product was designed to match the motivational state of people in early stages of behavior change. For this stage, two important issues have to be addressed. First, people in this stage do not want to change, and, therefore, they will not be willing to buy a product that supports a behavioral change. Second, the product should incorporate a design strategy aimed at *raising awareness*. During the idea generating phase, several ways of distributing information at low cost were explored such as stickers and (foldable) leaflets. Eventually, it was decided to choose a product that would be seen as a more valuable item (and that would therefore less easily be discarded). The product that was designed for this phase was a cooling sleeve that displays the amount of sugar that different types of beverages contain (see Figure 2). The cooling sleeve would be available as a free gift that could be handed out to people on the street. The print on the sleeve contains a QR code that connects to a mobile application that was designed to support a second phase of behavior change.

Fig. 2. Product designed for stages (pre)contemplation: a cooling sleeve with information about sugar in beverages.

To develop the product that should support the next stage of change, that of preparation, the designer of the intervention incorporated a design strategy aimed at *enabling.* To move through this stage people need to move from raised awareness to actually acting on a desired behavior change. During this phase, people have to come to realise that they should and that they are able to change their behavior. Therefore, it is important that an intervention can provide advice or possible actions that are relevant for a specific person to enable his or her to take action. In such a situation, a BCSS is a valuable solution because it allows organization of data and personalized feedback (cf. Oinas-Kukkonen & Harjuuma (2009)). To make the BCSS easily accessible, we chose to design a mobile application. The application supports people in tracking their daily intake of sugar containing beverages and gives them personal advice on how they can best change their daily habits, thus *enabling* them to take the next step towards the desired behavior change. Figure 3 and 4 show a sequence of screen shots that demonstrate the subsequent steps in the application; after adding some personal information, users provide information about the drinks that they drink for a week. During the week, they can gain view statistics to gain insight in precisely which beverages that they normally drink contain most sugar. After a week, the application creates personal advice and recommendations based on the provided data to support the user to take the step into an *action* phase. In this phase, people actually implement the behavior change based on the recommendations of the application.

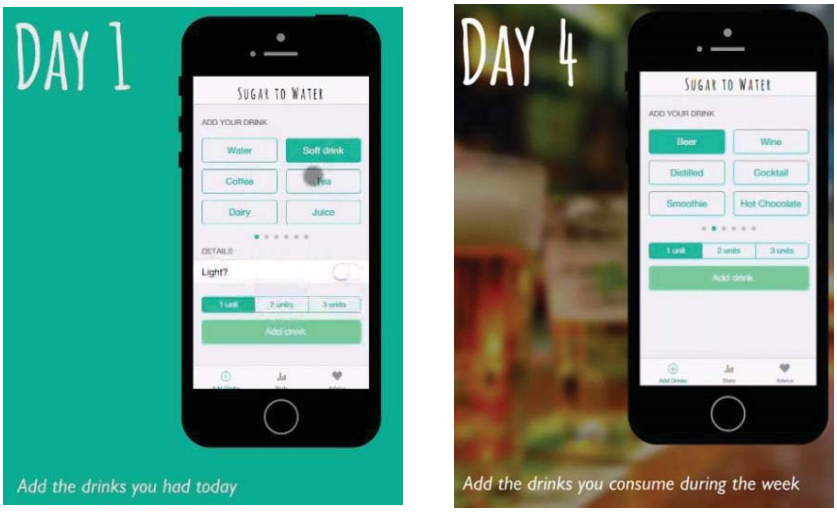

Fig. 3. The image on the left shows a screen shot of the mobile application on the first day where someone starts adding beverages from the menu to her daily intake. The image on the right shows a second screen in the same menu with different beverages.

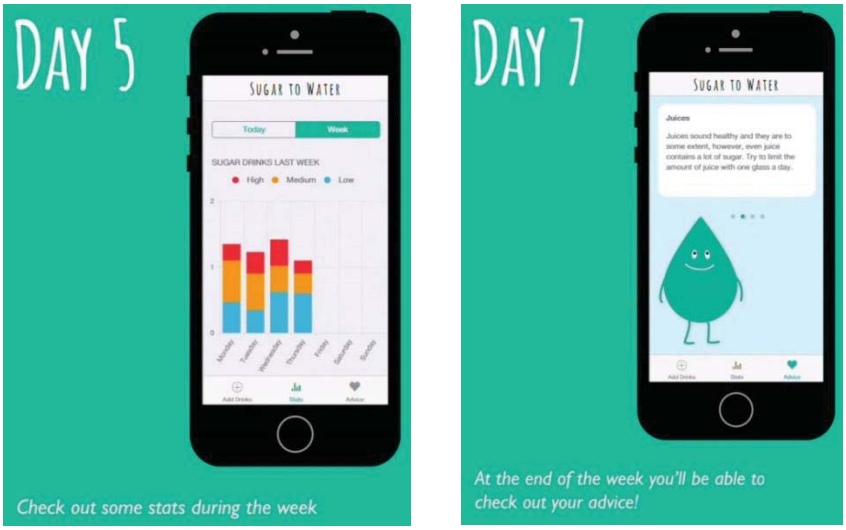

Fig. 4. Two more screenshots show the application after someone has added the daily intake of beverages for at least four days. The image on the left shows statistics that give a user insight into the types of drinks that have been consumed week. The screen shot on the right shows personal advice on how best to change behavior.

Finally, the system could recognize from the behavior pattern that the user is ready to take yet another step in the behavior change process: towards the stage of *maintenance* and recommends the product that that links to the third phase. The product that was designed for this third and last phase incorporated a design strategy aimed at *motivation.* The best alternative for drinking sugar containing beverages is drinking water. Therefore, a variety of alternatives was explored that motivate people to drink water, including light indicators and timers. Eventually, we chose a less intrusive solution because such a solution is less likely to cause irritation. The product for the designed for the third phase was a water bottle that supports the achieved behavior change by using an hour glass to remind the user to drink water (see Figure 5).

Fig. 5. Product designed for *maintenance* stage: incorporated design strategy aimed at motivation. The hour glass that is incorporated in this bottle reminds people to drink enough water.

3.2 Evaluative user study

To test whether the sequential intervention that was designed and that consisted of a set of connected products could be effective in supporting people to move through the different stages in a behavior change process we set up a preliminary user study. This user study had two main aims. The first aim was to find out if the first product in the sequence was effective for people in the early stages of behavior change and thus, if it was effective in creating awareness of the lifestyle issue of drinking too many sugar containing beverages. The second aim was to test whether the first product in the sequential intervention was effective as a trigger to connect to products in later stages of change.

Method.
The first product in the designed sequence, the cool sleeve was handed out to 18 respondents (age 25-60, m = 34.3, 9 female). Respondents were randomly selected but we tried to find respondents from multiple age groups and we tried to invite both men and women. Because the second product in the sequence, the personal application was not yet available we created a movie explaining the application and placed it on a website. Attached to the cool sleeve was a card that had a text, a URL linking to the movie and a QR code linking to the URL printed on it. The text on this card read: "KNOW YOUR BEVERAGES. Are you curious to find what you sugar intake through beverages is? Scan the QR code or visit the URL." After three days, the participants were asked to fill out a questionnaire asking questions about how they evaluated receiving the cool sleeve *("I liked receiving the sleeve"*), whether they had noticed the information on the cool sleeve and whether this information had raised their awareness of the amount of sugar in beverages *("The information on the sleeve made me more aware of sugar in drinks")*. We also asked whether they had visited the website to see the movie and (if yes,) whether the video made them think of the amount of sugar they consume through beverages and whether they would be interested in using the application that was presented in the movie. Questions were either yes/no questions or were asked on 7 point scales with end points "do not agree at all" and "agree completely". At the end of the questionnaire participants were asked to provide additional comments.

Results.
Receiving a gift like this was something positive for almost all respondents, only two people noted that they weren't certain about if they would ever use the sleeve. Responses to the question that asked whether they had seen the information on the sleeve were clearly positive (m = 6.3). Also, respondents noted that the information on the sleeve made them more aware of the amount of sugar in beverages (m = 5.3). General remarks revealed that in general respondents became more aware of sugar in drinks after reading the information on the sleeve. Some of the participants noted the fact that they already mostly drank water, tea and other drinks without sugar. However, the large amount of sugar in some beverages seemed to surprise all of them.
Out of the 18 participants, 15 eventually visited the linked web page and watched the video about the personal mobile application. Participants generally responded positively to the question about whether the video made them think about the amount of sugar they consume through beverages (n = 15, m = 5.0). Also, participants indicated that they were interested in the free application that would allow them to track the amount of sugar they consume through drinking beverages (n = 15, m = 6.6).

Discussion.
First of all, the free cool sleeve that we handed out in this preliminary user study clearly was effective in raising awareness of the lifestyle issue of drinking sugar containing beverages. People were pleased to receive the sleeve and they all noticed the information on the sleeve. The fact that all respondents took notice of the information is a very positive result: it may be easy to hand out free gifts, but raising awareness

through such a free gift is another step. Our results show that for almost all respondents their awareness of sugar in beverages was raised. Out of the 18 participants, 15 eventually watched the video, which indicated that they became interested in the subject of sugar in beverages. Again, most of the participants noted that the video in its turn raised their awareness of the issue. Moreover, the larger part of our participants, expressed their interest to actually use the application, thereby indicating that they were ready to move to the next stage of change.
The mere fact that the people in this study were part of a trial might have biased their expression of interest. However, the large group of participants that were interested in the application signals that the free cool sleeve worked well as a trigger to increase reach for this BCSS. As yet, we were unable to test the effectiveness of the application in this study. A more extensive study with a working application should be done to test whether this application is an effective intervention to support people to actually change their behavior.

4 General discussion

We have argued that to increase the large potential of BCSS to help people to adopt healthier lifestyles, the reach of such systems should be enlarged so that the people that need them most (those who are in early stages of change and are not yet aware of the need for change) will start using them.

The design case showed that placing triggers in the environment offers possibilities to connect BCSS to the offline world. In this case, the trigger was a free gift that people would receive in a public environment. Although this was not a valuable product, non-personal triggers may provide solutions that are less costly and can therefore reach even more people. For such non-personal triggers, a clear and easy to follow link to a following, more personal intervention is essential.

The case we presented here was about drinking less sugar containing beverages, however, triggering a behavior change and connecting to BCSS could be effective for a range of other behaviors that are widespread. One could think of behaviors such as eating too little fruit and vegetables, unhealthy snacking, etc. What this specific design case has shown is that analyzing the context of the intervention is important; what are people's habits concerning a specific lifestyle issue? What would be the best place to try to persuade people to try an alternative or to raise awareness of the issue? We expect that by asking these questions and adding triggers in the environment to the design of BCSS their reach could be enlarged to include people in early stages of change. Note that in the design case presented, next to the trigger and the BCSS, a third product was added aimed at helping to sustain the new behavior. Alternatively, for this stage of change (maintenance), a BCSS could be adapted to meet the goals for this stage. Such 'dynamic interventions' form an interesting research avenue and could potentially increase the effectiveness of BCSS to a large extent.

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Enhancing Persuasive Features of Behaviour Change Support Systems: The Role of U-FADE

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Abstract. The introduction of Behaviour Change Support Systems (BCSS) has enhanced the ability of utilizing computing technology and information systems for changing or altering human behaviour or attitude. Yet, some existing BCSS applications are faced with limitations that impede their effective use because they become obsolete as user needs change during it use. The Unified Framework for Analysing, Designing and Evaluating persuasive systems (U-FADE), has been introduced to address these limitations. However, the framework has not been applied in the development of any BCSS application. This research evaluates the U-FADE by applying its design principles to an existing weight management application (ObiMo Pet). Our findings support claims that U-FADE is capable of facilitating BCSS development. It was also observed that by applying the framework, extra system features are identified which may possibly enhance the persuasiveness of the application.

Keywords: Persuasive Technology, Behaviour Change Support, Captology, Unified Frameworks

1 Introduction

Behaviour change support systems (BCSS) combine properties of interpersonal interaction and mass communication to change or alter behaviour or attitude [1, 2]. It is capable of adapting to individual differences and it has a better potential for changing behaviour and/or attitude. This is because, it is capable of employing both animated and non-animated objects to persuaded its users [3].

Its effectiveness and increase use in areas of healthcare [4, 5], leisure and recreation [6], energy saving [7, 8], IS security [9], etc. has resulted in the emergence of newer challenges and research opportunities in Information Systems design. Currently, design methodologies continue to be one of the greatest challenges in BCSS research. According to Wiafe and Nakata [10] most existing BCSS applications do not follow appropriate methods during the design phase and therefore become obsolete with time. This is mainly due to the fact that existing frameworks or design approaches do not provide adequate information that can be used for analysing and designing such applications to address the changing needs of users.

Nevertheless, recently the Unified Framework for Analysing, Designing and Evaluating persuasive systems (U-FADE) [11] has been proposed to provide an

effective means of solving existing challenges associated with the design of BCSS applications. The framework incorporates key concepts from existing persuasive design models such as the Functional Triad [12], the Behaviour Wizard [13], the 3-Dimensional Relationship between Attitude and Behaviour (3D-RAB) model [14] and the Persuasive System Design (PSD) model [2] to address design challenges associated with current design methods. While it has been demonstrated conceptually that U-FADE provides a better and a more compressive approach for BCSS analysis and design [11], the framework has not been applied in developing any application to ascertain its practicality yet.

This research therefore seeks to evaluate U-FADE, using a weight management system. Precisely, the objective is to identify whether the application of U-FADE will facilitate design and also enrich the selection of persuasive features. As such, the steps in U-FADE were used to redesign an existing mobile application known as ObiMo Pet [15] and our findings are presented below as follows: a general overview of the framework is presented first, followed by the research approach used, after this the processes for redesigning, discussions and conclusions were presented.

2 Overview of the Unified Framework for Analysing, Designing and Evaluating Persuasive Systems

The Unified Framework for Analysing, Designing and Evaluating persuasive systems (U-FADE) formalizes BCSS design process by addressing changing needs of users during the design of persuasive systems [11]. It is comprised of: analysis of the Persuasion Event, selection of Persuasion Strategy, identification of System Features needed to promote persuasion, Development and Implementation of the persuasive system and the Evaluation of Behaviour Change success. Wiafe [11] explained that the main benefit of using U-FADE is its ability to provide a thinking guide for both novice and expert persuasive system developers. The framework explores the problem space by identifying variations in a user's cognitive dissonance state and the situational (or environmental) context to guide designers to select persuasive features for specific target users. The Event analysis stage consists of Use and User context analysis: a concept borrowed from the PSD model [2]. However, the framework emphasises on the need to identify internal and external factors that affect individuals to change or maintain their behaviour.

The next step in *Event* analysis is *Use* context analysis. This considers BCSS application design in relation to formal and informal behaviour change factors. It argues that, designers need to consider both formal and informal activities within their immediate environment that may interact or influence potential users to change their behaviour. Here, Natural Attitude or Behaviour Change (NABC) takes into account activities within an environment that changes an individual's behaviour or attitude naturally [11]. Issues relating to culture, social norms, beliefs, ethics, commitments and values among others are of paramount interest. Arguably, these issues are

exceptionally essential for BCSS designs since their sole objective is to alter behaviour or attitude.

Next, Planned Attitude or Behaviour Change (PABC) is considered. Wiafe [11] explained that PABC consists of existing approaches that are used on target users to change their behaviour or attitude intentionally. This may include automated and non-automated approaches. These existing activities (i.e. NABC and PABC) must be emphasised and designers may select strategies to support existing activities that are promoting target behaviour. In essence, they must reinforce the existing overt or covert persuasion. Additionally, it proposes steps that guide designers to identify system features by focusing on incremental changes as suggested by Oinas-Kukkonen and Harjumaa [2]. Transitions that involve attitude-changing states must use logical arguments (elaborated messages) to ensure a long-term change, whereas heuristics (peripheral messages) must be used for short-term behaviour change.

In U-FADE, designers are encouraged to identify a list of familiar hardware and select those that the application can be deployed on. In this process, they must pay particular attention to cost, environment and obtrusiveness of the technology they chose. As such, the introduction of a new hardware should be considered or used only when the application cannot be administered effectively on an existing familiar hardware.

The framework also provides a guide on how the 28 system features proposed by Torning and Oinas-Kukkonen [16] may support either elaboration or peripheral message routes [11]. The approach is based on findings from the *Use* and *User* analysis. It also consists of a Transition Description Card which provides a template for summarising all the activities performed to enable the designer to focus on the relevant issues relating to the targeted behaviour change. Finally, it proposed steps that can be used to evaluate the change so as to enable designers to fine-tune system features to address changing needs of users.

As already mentioned, the unified framework (U-FADE) has been proven conceptually or theoretically to facilitate BCSS development. However, it has not been empirically demonstrated. The next section is a discussion of the research approach used to assess the appropriateness and benefits of using U-FADE for designing behaviour change support systems.

3 Research Settings

In design science research, the designed artefact must map adequately to the real world, solve a problem and must be demonstrated [17]. Hence to investigate whether the framework is useful practically, it is necessary for it to be applied to develop a BCSS application. Consequently, U-FADE was applied to the development of a BCSS application that seeks to encourage its users to reduce the amount of calorie intake and manage their weight. Purposely, it was used to reassess an existing application known as ObiMo Pet. In this sense, the objectives of ObiMo Pet were used as the basis for analysis using U-FADE and the resultant design was compared to ObiMo Pet. The study focused on staff of the Accra Polytechnic which is a tertiary

institution based in Accra, Ghana. Below is a brief description of the target population and the application used for the study.

3.1 Target Population

As stated earlier, the Accra Polytechnic is a tertiary institution located in Accra the capital of Ghana. It is the first polytechnic to be established in the country in 1949 as Accra Technical School. Later, it was renamed as Accra Polytechnic and was given a tertiary status in 1993. Currently, it offers Higher National Diploma (HND) programmes in science and engineering, fashion design, social science, hotel catering and institutional management, etc. It has a staff population of over 600.

Due to her keen interest in issues relating to health of her staff, the institution has built a state of the art gymnasium that is available to the staff. In addition, seminars on healthy lifestyles are organized regularly to refresh staff on the need for maintaining good health by the Hotel Catering and Institutional Management department. The Institution also boasts of a strong staff welfare association that seeks to promote social welfare activities within the institute. Amidst all these efforts, the ratios of overweight and obese persons continue to increase.

3.2 The ObiMo Pet

Obimo Pet is a weight management system designed to manage calorie intake and physical activates of individuals who are obese. It employs persuasive strategies to motivate it users to maintain a healthy lifestyle as they cater for a virtual pet of their choice. It provides it users with healthy physical activities and diet plans that aim to support them to lose weight. As they adhere to suggestions provided by the application they earn points that can be used to decorate their virtual pets. Also, it gives recognition to users who have the healthiest and most decorated pet in the virtual community. This serves as a motivating factor to encourage users to compete as they seek to accomplish the target behaviour. The Mobile version of the application enables users to track and monitor their performance in real-time.

The application uses 6 main system features to promote behaviour change. These are; rewards, suggestions, tailoring, recommendations, competition and personalization. The designers of ObiMo Pet used the semiotic approach to information systems development as the foundation for analysis and design.

3.3 Design Objectives

The U-FADE approach for developing BCSS applications was used for requirements gathering and analysis with specific emphasis on the following objectives:

- To identify the distribution of cognitive dissonance levels of potential users so that the behaviour change support system will target specific and appropriate user needs
- To identify existing activities that may promote weight loss or impede weight gain of potential users
- To identify system features or properties that are useful for the development of such an application
- To identify appropriate hardware or device for the proposed BCSS application

Our study aimed at persuading staff of Accra Polytechnic to change their behaviour towards weight gain. Particularly, it aimed at targeting a weight loss between 3 and 5 pounds a week, and consumption of 2300 calories a day. We however acknowledge that the actual amount of calorie intake and calorie burnt is over simplified in this study; since the values normally varies according to the individual's gender, type of work or activity level, age, body weight, etc.

Additionally, we also acknowledge that although U-FADE suggests the reassessment of user behaviour to evaluate incremental behaviour change, this was not considered as part of the objectives of this study. The next section reports our findings from the analysis conducted using U-FADE.

4 Integrating U-Fade for Re-Development

4.1 Event Analysis

As proposed by U-FADE, the first stage in the analysis process is the User context analysis. Here, a questionnaire was developed to collect data and classify users into the various cognitive states as proposed by the framework. The classification was based on variations in cognitive dissonance of users' attitude and behaviour (i.e. Attitude Towards Target Behaviour, Attitude Towards Change or Maintaining Behaviour, and Current Behaviour) in relation to food menu goals (calorie intake) and exercise or workout goals (calories burnt). The target behaviour was considered as maintaining a Body Mass Index (BMI) value between 18.5 and 25.

A pilot study was first conducted to test the clarity and consistency of the questions on the questionnaire and the suggested amendments were made. Finally, the questionnaire was distributed to staff members of the target Institution. One hundred and seventeen responses were received after one month of distribution of the questionnaires. Three questions each were asked to measure respondents' Attitude Towards Target Behaviour (ATTB) and Attitude Towards Change or Maintaining Behaviour (ATCMB) in order to ensure reliable and consistent responses. Cronbach's alpha with reliability coefficient of 0.7 was used to check for reliability. Respondents were classified into positives or negative ATTB, ATCMB or Current Behaviour (CB) by computing the averages of the numerical values they assigned to each question in

the questionnaire. The distribution of cognitive dissonance states for the 117 responses received is presented in Table 1.

From Table 1, thirty-nine (33%) respondents were identified to be in state 1; meaning they are in the "ideal" state and with all things being equal they are expected to continue to maintain a BMI that is between 18.5 and 25. However majority of the respondents were found to be in states that need a change in either attitude (ATTB/ATCMB) or behaviour (CB). None of the respondents was in state 7, i.e. no staff was identified to have a BMI that is not between 18.5 and 25, and also do not believe that they should maintain a BMI value between 18.5 and 25 but would want to change.

Table 1. Distribution of cognitive dissonance state observed.

State	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Responses	39	12	0	6	42	6	0	12	117
Per cent (%)	33	10	0	5	35	5	0	10	100

Likewise, no respondent was in state 3, where Current Behaviour is positive, Attitude Towards Maintaining Current Behaviour is positive, but Attitude Towards Target Behaviour is negative. Forty-two respondents were identified to be in state 5. These are individuals who do not have BMI between 18.5 and 25, but believe that there is a need for them to change their current BMI values. According to Wiafe, et al. [14] these users experience a strong form of cognitive dissonance which serve as a motivating factor for changing their behaviour. Table 1 indicates that, the potential users of the system are experiencing different forms of cognitive dissonance levels. This therefore suggests that it will require different persuasive system features or properties to persuade them [11]. Although U-FADE argues that persuasive systems or technologies should ensure that they provide specific persuasive features for all states, for the purpose of this study only users in state 5 were considered.

As suggested by the framework, the next stage of the analysis is to collect information regarding the Use context (i.e. Planned Attitude or Behaviour Change and Natural Attitude or Behaviour Change). Informal interactions, interviews and discussions were used to gather relevant information pertaining to this. Eight observations were identified to impact staff attitude and behaviour in relation to maintaining a healthy BMI. The observations and associated suggested persuasive features identified to be appropriate for users in state 5 are summarised in Table 2.

Societal norms and culture, availability and access to technology, the existence of staff association, among others were identified to be some of the key things that can be used to inform the design of the BCSS application.

Table 2. Selected system features identified to promote weight management for the target population.

Observation	Description	System feature		Implementation
		Elaboration	***Peripheral***	
Societal norms	Ghanaians perceive overweight people as wealthier and rich: this serves as a negative impact on the target behaviour	Cooperation	Social facilitation	The system should provide a platform for discussion to counter the notion associated with being overweight
Hotel Catering and Institutional Management department	There is a nutrition and home science unit at the institute with scholars in nutrition	Authority		The system should display endorsement of the department for the weight management app
		Suggestion	Social role	An avatar of one of the renowned scholars in the unit should be used to suggest healthier menus
Intellectual and competitive environment	This is an educational institution made up of intellectuals who prefer to demonstrate that they can march their peers		Social comparison Competition	The system should provide a means for peers to compete
Staff association	There is an association for staff of Accra polytechnic employees: they meet regularly to discuss their welfare		Normative influence	The system should provide a means to make users know that the target behaviour is a collective goal
Expensive and Poor Healthcare facilities	Healthcare cost is becoming expensive and in addition there are few healthcare facilities in the country		Reminders	The system should provide a means of reminding users of the increasing cost of healthcare and poor medical facilities
Rising cost of food prices	The cost of food prices continuous to increase due to high inflation		Suggestion	Suggest alternative cheaper and healthier menus
Gymnasium	The availability of a state of the art gym serves as a positive impact to the target behaviour Some staff also believe that they are taxed indirectly to maintain the gym		Reminder	Prompt staff to use the gym regularly since they believe they are paying for its maintenance
		Social Role	Suggestion	An avatar of the gym instructor should be used to suggest exercise schedules

4.2 Persuasive Strategy

The selection of technology must aim at identifying the most convenient hardware that is readily available, affordable and also familiar to potential users of the system. Hence a mobile device was considered to be appropriate since all staff owns mobile devices. This was realised during the Use analysis.

According to U-FADE , users with a positive ATTB and ATCMB who perform negative behaviour (not maintaining a between 18.5 and 25) are more likely to change if peripheral messages are used [11]. Thus, the peripheral route was considered to be the most appropriate channel for persuading.

4.3 Selection of System Features

In Table 2, some system features were identified to supports elaborated messages. However these features were not considered appropriate for the study. This is because we limited our design to users with the right attitude; hence there is no need to change their attitude. Rather, emphasise is to be given to peripheral messages that promotes behaviour change. Social role, competition, normative influence, suggestions and reminders were identified to be appropriate for promoting behaviour change in this situation. Social role was identified based on the fact that there is a nutrition and home science unit within the Hotel Catering and Institutional Management department at the Institute. This unit employs scholars in nutrition. Since the staff are familiar with their colleagues who are experts in areas of nutrition and wellbeing, they are more likely to accept persuasive messages from an avatar (a virtual nutrition scholar) of one of their colleagues who is an experts in the field.

<table>
<tr><td colspan="2">Transition: 5 → 1</td></tr>
<tr><td colspan="2">Target Behaviour: Users are to have a BMI value between 18.5 and 25</td></tr>
<tr><td>Type of Change: Behaviour</td><td>Type of Message: Peripheral</td></tr>
<tr><td colspan="2">Assumptions: All users at this state did not migrate from any previous state</td></tr>
<tr><td colspan="2">Constraints: None</td></tr>
<tr><td rowspan="2">List of possible paths: 5 → 1</td><td>Selected path: 5 → 1</td></tr>
<tr><td>Previous state: None</td></tr>
<tr><td colspan="2">Description of Previous state: Not Applicable</td></tr>
<tr><td>Selected system features:
Social Role, Normative Influence, Competition
Suggestion, Reminders, Social Facilitation
Social Comparison</td><td>Selected technology:
Mobile Device</td></tr>
<tr><td colspan="2">Comments: None</td></tr>
</table>

Figure 1. Transition Description Card for Transition 5 → 1

Likewise, the existence of a staff welfare association at the Institute promotes normative influence; consequently, normative influence was considered as an appropriate system feature. Refer to Table 2 for the list of system features identified and its associated justification for the selection of these features.

As required by the framework, a Transition Description Card (TDC) was completed for transition 5 → 1 (i.e. changing users with the right attitude but a negative behaviour). The assumptions, the type of change, the type of message, constraints, etc. are highlighted on the TDC for the specific transition. Figure 1 is the TDC for transition 5 → 1 that was realised during analysis.

5 Findings And Discussions

The analysis facilitated the selection of a specific target group which is well defined as compared to the original application. In ObiMo Pet the system was not designed for any particular target group. Precisely, in ObiMo Pet it was assumed that the issue of weight management is generic and thus the designers did not deem it necessary to identify target specific issues. The framework facilitated the identification of a particular group of users (those in state 5) as the majority. Consequently, it focused its persuasive activities and system features on this type of users. Although one can argue that the other groups of users also need attention, this characteristic of the U-FADE enables the designer to plan or target majority of the population.

Again, even though the analysis focused on users in state 5, it identified seven system features. However five of them were not the same as the ones used in ObiMo Pet. The seven features observed were social role, normative influence, competition, suggestion, social facilitation, social comparison and reminders as compared to tailoring, competition, rewards, suggestions, recommendation and reminders. Out of these, suggestions, competition, reminders were common to both, whereas Social facilitation, Social comparison, Social role and Normative influence were not present in ObiMo Pet.

One may therefore argue that ObiMo Pet's failure to identify these features may be due to the fact that it did not adopt an appropriate approach to analyse the design of the BCSS application. Rather, the designers used a generic analysis and design methodology (the semiotic approach) that is used for Information Systems development. More importantly, the approach used for analysing and designing of ObiMo Pet failed to identify these features although the application targeted a larger population as compared to the target users for this analysis. This therefore suggests that using generic Information Systems design methods should not be encouraged in BCSS development.

Also, all the suggested system features seek to promote an existing condition that favours the target behaviour or refute an existing believe or perception that impedes the performance of the target behaviour. This was not the same in the case of ObiMo Pet. This is to say that, the selection and use of system features was aimed at targeting only behaviour change. Although some features were identified, they were not

considered to be appropriate since Table 2 explained that they are more appropriate for attitude change (elaboration) rather than behaviour change (peripheral). ObiMo Pet did not provide any substantive justification for the selection and use of the persuasive features. It appears that the designers used an arbitrary approach in the selection process: a practice that is common to some of the existing BCSS applications.

Apart from the selection of system features, one crucial issue appears to be largely ignored in BCSS designs. This relates to how system features are implemented. It was observed that although some system features used in ObiMo Pet were also identified during the analysis, they were implemented differently. For example, In ObiMo Pet, reminders were used to remind users of their daily activities whereas in the analysis it was observed that reminders should be used to make staff to use the gym regularly since they pay for the service indirectly. Hence in ObiMo Pet, reminder is used for elaborated messages (targeting attitude change) whereas it is used for peripheral messages (targeting behaviour change) in the proposed system. Similarly, suggestion and competition are implemented differently.

With respect to hardware selection, the analysis advocated for the use of a mobile devices, however in ObiMo Pet both mobile and PC were used to implement the application. Again, there was no justification for the need of a PC interface for a weight management system. As observed from the analysis, majority of the users would be comfortable using an app on a mobile device. It is however important to state that ObiMo Pet considered a larger audience as compared to what was used for the study. Hence, there is the possibility that the use of a PC may be relevant for other target groups that were not considered in this study.

6 Conclusion

In this paper we have demonstrated the practicality of the Unified Framework for Analysing and Designing persuasive systems. The design principles of the framework were tested on the objectives of a persuasive weight management system (ObiMo Pet) which works on both mobile and static devices. This system motivates overweight and obese users to follow a weight management plan.

After comparing the system features realised from our analysis, our observations supported the claim that there are variations in cognitive dissonance of users. Users were found in six out of the 8 listed states proposed by Wiafe, et al. [18]. It was also observed that by applying the U-FADE, new system features were identified.

However, our findings indicate that the framework fails to provide the exact messages that should be used for persuasion, rather it provides specification for the message: suggesting instance in which peripheral messages would be appropriate and those that will require elaboration. That not withstanding, it can be inferred that the U-FADE approach to BCSS development helps to identify system features that can be used to enhance applications. However, the study cannot conclude that the introduction of additional system features to ObiMo Pet will make it more effective, since there is no empirical evidence to support such a claim. It is therefore

recommended that, future research should investigate the relationship between the number of persuasive features and the persuasiveness of an application. This is to say that, the proposed system must be implemented and evaluated in terms of its effectiveness in changing user behaviour.

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How Persuasive are Serious Games, Social Media and mHealth Technologies for Vulnerable Young Adults?

Design Factors for Health Behavior and Lifestyle Change Support: Sexual Health Case.

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Abstract. Modern eHealth technologies, such as serious games, social media and mobile applications addressing health behavior support are evolving rapidly. High-risk young adults with low educational background and of foreign origin could especially benefit from personalized health technologies, designed for their special needs. Sexual health is a delicate subject and well-designed and tailored health technologies are needed to meet the needs of the target group and enhance uptake. The aim of this exploratory user study is to identify the persuasive features and design factors that contribute to the use and uptake of existing and new health technologies. Four focus groups were conducted with 37 young adults to gain insights into their needs and attitudes, with sexual health case used in the study. Qualitative data analysis was performed based on Persuasive Design model to identify stimulating, blocking and neutral persuasive features, specific for high-risk young adults, as well as generic design factors. Five generic design factors are formulated based on our findings: (1) *anonymity*, (2) *interactivity*, (3) *portability* (4) *source* and (5) *comprehensibility*. These findings aim at informing the design of health technologies for lifestyle and sexual health behavior change support of high-risk young adults, and could be applicable for young adults in general and other health topics.

Keywords: young adults, eHealth, Persuasive Systems Design model, social media, mHealth, serious gaming, focus groups

1 Introduction

Young adults, especially young adults who are poorly educated, are at higher risk for leading an unhealthy lifestyle on different aspects that have an effect on health behavior, including nutrition, physical activity and sexual health. Among other health topics, there is growing importance of addressing the sexual and reproductive health needs of adolescents (10-19 years) and young people (10-24 years) [1]. The World Health Organisation [2] defines *sexual health* as: *'a state of physical, emotional, men-*

tal and social well-being related to sexuality; not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination and violence.' Based on surveillance data of sexually transmitted infections (STI) and HIV collected by STI-clinics run by municipal health services, young adults of foreign origin are at increased risk regarding undesired sexual health outcomes [3-5]. The pattern of increased vulnerability for undesired sexual health outcomes is also present among the largest four immigrant groups in the Netherlands who originate from the following countries: Turkey, Surinam, Morocco and The Netherlands Antilles [6].

In the context of sexual health, 'classic' face-to-face consultations are poorly known among vulnerable young adults [7]. Public health surveillance data also show the underrepresentation of (male) young adults of foreign origin [5] at the free sexuality consultations at the municipal health services. They could especially benefit from personalized health technologies, designed for their special needs. Existing online interventions mainly reach highly educated native women, even if they are not the initially intended target group [8-9]. One of the reasons for the limited reach could be the lack of participation of the target group in the development of the health applications. It is well known in (public) health research that the amount of influence people have on their own well-being contributes to actual health and well-being [10]. Participation, therefore, is a powerful means to increase the impact and uptake of health technology.

Efforts within public health and epidemiology research directed towards reaching young adults of foreign origin in the context of sexual health are limited to informative websites and community-based approaches [11-12]. Current public health activities include for instance the provision or distribution of condoms, free anonymous counseling sessions, or specific campaigns (e.g., aimed at raising awareness of the available public health services). Such interventions focus mainly on STI and HIV prevention, lack of evidence on their effectiveness and often do not match the specific needs of low-educated young adults or young adults of foreign origin [13-15].

With the emerging new technologies, such as serious games, social media and mHealth, new opportunities arise for persuasive and personalized health to support behavior change [16-18]. *Behavior Change Support System (BCSS)* can be defined as: "*a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying using coercion or deception*" [19]. Persuasion is being used to improve adherence and thus the effects of eHealth [20]. Persuasive System Design (PSD) model [21] offers various persuasive techniques that are widely used in design and evaluation of persuasive health technology [22-23]. Among the four categories of persuasive design features, recent research shows that *dialog support* features play a significant role in relation to adherence to web-based health interventions [22]. Persuasive features, from social support category are important in BCSS [24]. Specific user groups such as high-risk young adults have special personal needs and preferences when it comes to design. Therefore, it is essential to identify specific persuasive features and design factors that influence their attitudes and/or behavior, when it comes to the use and uptake of

health technology for behavior change support. For instance, *social support* features seem to play a more important role for young adults than for other age groups, since young adults tend to be influences by their peers [25]. Despite the fact that social media are often treated as the golden standard for young adults, its suitability for high-risk young adults for health support remains unclear [26-27].

Previous research on the design of persuasive health technologies involving high-risk young adults is lacking. Young adults of foreign origin are a hard to reach target group. There is also little known about their needs for the design of health applications [7, 26]. Interestingly, young adults between 12 and 21 are the most critical users of online technologies, who are inpatient with slow unreliable applications [17, 28].

In this study, we investigate how technologies for health behavior support of vulnerable young adults should be designed to meet their needs. This paper presents the results of the exploratory focus groups study on the specific user requirements and conditions for the design and implementation of health technologies for behavior change support of young adults. The primary focus in this study is on social media [29], serious games [30], and mobile applications [31] that are commonly used by young adults [26, 32], with sexual health as a health topic. The ultimate goal of this study is to gain insights into the special needs of this user group, persuasive features and design factors influencing the use and uptake of applications for sexuality, well-being and health behavior support of young adults.

2 Methods

2.1 Participants and procedure

In total, four focus groups were conducted with 37 young adults (51, % male and 48,6% female) with low socio-economical status and from various ethnical backgrounds with average age between 12 and 24 years (M=17.4, SD=3.1). The birth country of the mother or father determined their ethnic background, where the country of the mother was leading when both parents are from foreign decent. Participants' ethnicity was related to a variety of geographical regions: Turkey, Surinam, Morocco, The Netherlands Antilles, Iraq, and Afghanistan. Sixty percent of the participants were from the first four regions, which represent the four biggest immigrant groups in the Netherlands. Participants were recruited via the municipal health services and the social workers at the local youth centers in three different cities and regions across the Netherlands. All participants signed a consent form prior to the study. Additional consent from parents was collected for participants younger than 16 years. Participants received a cinema gift voucher of €15, goodies (ballpoints and condoms), and refreshments as an incentive. Groups were composed of all male or all female participants to ensure comfort discussing sexually related topics.

2.2 Study setting

The focus groups were held at the local youth community centers as a follow-up of the educational weekly activities organized by the social workers, and lasted between 70 to 75 minutes. Trained moderator and an assistant led the focus groups. The moderators used a discussion guide, during the focus groups important points from the guide were also presented to participants in a PowerPoint presentation. The assistant took notes and answered questions during the subgroups activities. The final version of the guide was developed based on a pilot test group and was used for all four focus groups. Questions were posed in an open-ended manner followed by more specific prompts.

The focus groups discussions were divided into five components. First, moderator gave a short introduction, explaining the purpose of the focus group and the role of the participants. To promote confidentiality, participants were given a choice to use either a first name or an imaginary nickname for the name boards to address each other during the discussion. Participants were asked to fill in a questionnaire on demographics such as age, gender, level of education, ethnical origin of parents and how open the young adults feel about discussing health topics such as sexual health. In the second component, the participants were split in two subgroups (4 - 6 participants per group) to explore two different application types: serious online game 'Can You Fix It?' and mobile application 'Dance4Life' providing information on sexuality and sexual health (see Fig. 1 and Fig. 2). After a free exploration, each subgroup was asked to discuss the usefulness and suitability of the application for them, positive and negative experiences and suggestions for improvement. In the third component, a plenary discussion on opinions and experiences of young adults followed in subgroups.

Next, in the fourth component, the moderator showed and discussed an example of a social media application: a Facebook (FB) page of the regional municipal health services and a YouTube movie on how STI test is done. In the fifth part, examples of possible new applications for health behavior support were discussed. These concerned two concepts: a serious game via Facebook and a Virtual Coach [17] providing anonymous free health consultation. Participants were asked to give their opinion on these alternative concepts and to express their own ideas on technologies for health behavior and lifestyle change support.

2.3 Analysis

Focus group sessions were audio recorded with a digital voice recorder with participants' permission. During the data analysis, audio files were transcribed verbatim, analyzed, coded and categorized. An analysis of the influence of various persuasive features on the response of young adults towards various types of health technology was done (Braun 2006). Persuasive features were coded according to the Persuasive System Design model [21]. In order to validate the coding and avoid bias, a second investigator coded a transcription of a randomly selected focus group session. Discrepancies between coders were discussed and resolved between the investigators.

Overall, the coding was similar with minor differences. Coding scheme was then adjusted accordingly to facilitate cross-case analysis. Prior to the focus groups, experts analyzed all examples of applications to be presented to the participants, in order to identify the present persuasive features and the missing ones, expected to be missing by the users.

Fig. 1. 'Can You Fix It' Sense Love game.

Fig. 2. Screenshot of the Dance4Life app (AppStore, 2014)

3 Results

Persuasive features derived from the focus groups were first categorized into: (a) stimulating, (b) blocking and (c) neutral features, based on the coding scheme used for the data analysis. The identified features are described below with relevant quotes from the focus groups' participants, followed by the generic guidelines to inform the design of public health technologies for behavior change support of young adults.

3.1 Persuasive features

***Stimulating* features.** Stimulating features are perceived as having positive influence on motivating the user, perceived usefulness and/or adherence. Table 1 illustrates the identified stimulating persuasive features, PSD category and quotes, namely: *trustworthiness, expertise, real-world feel, verifiability, liking, simulation* and *tunneling*.

Table 1. *Stimulating* persuasive features

Persuasive feature	PSD category	Quote
Trustworthiness	System credibility	*"The information has to be reliable." (Coach)*

Expertise	System credibility	*"I want it to be made by someone who has the experience." (FB page)*
Real-world feel	System credibility	*"If you know that it is from Public Health Services (GGD), than yes. Then people would be more inclined to use it." (FB page)*
Verifiability	System credibility	*"I want to know who the designer is." (General)*
Liking	Dialogue support	*"The (virtual) character has to look attractive, then I would like it." (Coach)*
Simulation	Primary task support	*"I liked that you can choose what you can and cannot do, what should happen and what is wrong" (Game)*
Tunneling	Primary task support	*"I liked that I could directly see where to navigate and how to search. You get everything just in place" (Mobile app)*

***Blocking* features.** Blocking features are perceived as having negative influence on motivating the user. Table 2 illustrates the identified blocking persuasive features with quotes.

Table 2. *Blocking* persuasive features

Persuasive feature	PSD category	Quote
Recognition	Social support	*"I really don't want anyone to know that I have been using this app." (Personal coach on FB)*

***Neutral* features.** Neutral features are the ones perceived as having no effect on motivating the user, perceived usefulness and/or adherence. Table 1 illustrates the identified neutral persuasive features with quotes.

Table 3. *Neutral* persuasive features

Persuasive feature	PSD category	Quote
Social learning	Social support	*"People who don't go outside often can play this and learn how it is in the outside world." (Game)*
Rewards	Dialogue support	*"The fact that I could win condoms would not influence me" (FB page)*

3.2 General design factors

Five general design factors were formulated based on the analysis of the focus group data and the identified persuasive features presented above, namely: (1) *anonymity*, which has implications for the use of social networks, (2) *interactivity*, as it facilitates engagement and ensures better uptake of interventions; (3) *portability* of the technologies, as it ensures privacy and effortless use; (4) *source* of the information within the application has to be visible and reliable to be perceived as trustworthy and (5) *comprehensibility*, meaning more visually aided and easily worded information.

These generic factors aim at informing the design of health technologies for lifestyle and sexual health behavior support of young adults. Incorporating these factors and persuasive features into the design of health technologies for young adults for behavior change support should increase their usefulness and uptake by the target group. Each factor is described below with relevant quotes from the participants.

Anonymity. The participants all agreed that anonymity is a crucial factor for health support: *'If you look it up on a computer your parents can see it on your screen.'* (Mobile app); *'I would go to a friend to use the Internet. Otherwise your mom can come inside or something...'* (Serious game).

Besides the perceived risk of 'being caught in the act', online and mobile applications sometimes also register visit, a feature that was not appreciated by young adults of foreign origin. They are not inclined to look for information on sexual health via social networks such as Facebook or Twitter, as their friends and family can see their activity right away: *'I think it is inappropriate that my family can see that I visit this page.'* (FB page); *'If you 'like' something, friends know right away what you are doing!'* (FB page). Thus, this factor has important implications for the use of social networks for sexual health promotion.

Interactivity. Participants often mentioned interactivity as a missing feature or a feature that is not fully available. For instance, after playing with a serious game during the focus group discussion participants stated that they would have liked to intervene more often during the game than it was actually possible. This is illustrated in the following reaction expressing frustration: *"I find it strange that I couldn't click that often, because I wanted to 'Fix' more often but that was not possible!"* (Serious game).

It is not just the presence of interactivity that is important, but the level of the interactivity seems to be crucial in order to facilitate better engagement. For instance, in the serious game interactivity was incorporated, but could have been expanded further. The mobile application, on the other hand, only allowed navigating through various menu items at all times and yet participants missed an interactivity feature allowing to contact a sexual health care professional: *'I also want to be able to ask questions myself, and get an answers.'* (Mobile app).

Interactivity seems to have a positive effect on the perceived usefulness of the health technology which could especially contribute to a richer and better user experience.

Portability. Portability of the platform on which the health technology is realized plays a crucial role for young adults. Participants had a clear preference for a mobile-based type of platform, as opposed to the web-based platform as it insures privacy and effortless use for this specific target group: *'You always have your mobile phone with you. It is faster.'* Another participant mentioned: *'If you just search for these things (information on sexual health) on the internet, ... you get everything (on your desktop), with a mobile app it's easier.'*

Young adults would rather use the search functions directly on their mobile phone, without a link with social networks: *'If you really need this (search function) you just download it (on your mobile phone) and you know that it is not visible anywhere else.'* (FB page). Participants also preferred to be able to use certain location features of the mobile application offline: '*I want to look up things online but also offline, without WIFI for instance, like these things nearby (location of the free consultation).'* (Mobile app). In the last quote, the participant refers to a location tracking

service on a mobile application that allows a user to find an office of a nearest free sexual health consultation by typing a zip code.

Source. The participants mentioned that the source of the information, independent of the type of platform, is also important for them to be able to evaluate the quality of the information. The source of information has to be explicitly stated, clearly visible and trustworthy: *'It looks attractive, but you want to know what (source) is behind it.'* (Serious game); *'I want it to be made by someone who has experience with it…'*(Personal coach); *'There should not be a name (of the public health care provider), but a logo or something.'* (FB page).

Participants indicated that they would trust the provided health information more when it is clearly stated that the familiar public health organization, such as Municipal Health Services is behind it: *'...If you know it's (information on a page) is from the Municipal Health Services, then yes. Then the people will be willing to use it...'* (Facebook). And another participant said: *'The Municipal Health Services are famous (familiar), that is good.'* (Facebook).

Comprehensibility. Comprehensibility of the health technologies is another important factor, which was divided by two sub-themes specific for young adults with foreign origin: visually aided information and availability of applications in different languages. Overall, the participants appreciated the visual aesthetic of the applications: *'Mostly you would play (use) it more if it looks attractive.'* (General). Several participants described the importance of visually aided information: *'There are so many pictures here, I like that.'* (FB page). Other participants mentioned that not only the design with images was important, but also the colors of those images: *'I would play it if there is a nice image, with different colors'* (Serious game).

Another sub-theme that emerged was the language used in the applications. One of key characteristic of young adults of foreign origin is that they often speak different languages with their families at home. The availability of the applications for lifestyle and health behavior support in other languages (than Dutch) would benefit their use: *'I also want to have an English version of the app.'* (Mobile app). To conclude, persuasive health technology for lifestyle support and health behavior change have to be more visually aided and easily worded, if possible in different languages and the vocabulary of the low-educated young adults as a specific target group.

Next, we discuss the findings and implications for the design and implementation of persuasive health technologies and online interventions for behavior change support.

4 Discussion

This study employed focus groups to get insights into persuasive features and design factors that influence the use and adoption of various forms of modern health technologies for lifestyle and behavior change support among vulnerable young adults, such as low-educated young adults and young adults of foreign origin. Even though this study primarily focused on the sexual health behavior, identified persuasive fea-

tures and design factors might also be applicable for other lifestyle and health topics like physical activity support [17] and interventions targeted towards broader user groups, including young adults in general.

Sexual health is a delicate and sensitive subject independent from ethnic background, however we believe that having a certain ethnical background can increase the sensitivity of this information, for instance due to stigma. This point is also confirmed by the other recent studies, suggesting that stigma around sexual health could affect the use of social media among young adults [11, 26]. In this study, we have not compared young adults of foreign origin with native young adults. However, we believe cultural beliefs, norms and customs, together with the well-known aspects from the STI and HIV prevention, can stress the importance of the persuasive features and design factors that emerged from the focus groups.

Our findings show that even though persuasive health technologies offer unique opportunities for young adults of foreign origin, designers have to take into account the specific needs of this group. Our results indicate that *anonymity* is an important factor, which has major implications for the use of online technology for enhancement of sexual health. This is especially an issue for the social networking websites, such as Facebook, as these media are meant to share information with peers. Despite the expectations from other research on the important role of *social support* features for young adults [25], Facebook and other social networks might be less suitable for deploying applications for sexual health support among vulnerable young adults. However, they are useful as a link to promote other reliable online platforms and BCSS aimed at improving sexual health. In other words, young adults of foreign origin should not be expected to join a group about sexual health or 'like' a Facebook page of the municipal health services on this topic. Several recent studies focusing on social networks use for sexual health promotion confirm this finding [26, 33]. The banner advertisements, which often can be found on the periphery of Facebook pages, could be useful to provide links to other applications for sexual health though.

Additionally, the participants in our focus groups highly appreciated *interactivity*. The presence of interactivity was experienced is less important. The level of the interactivity, on the other hand, seems to be a crucial factor in order to facilitate better engagement. Higher interactivity can be also associated with more challenging and engaging user experience. Rich engaging interaction imbedded in the interfaces of social media applications, mobile apps and serious games may contribute to a better uptake of the intervention, as identified in another study with young adults [26].

Portability was another important factor, as it insures both privacy and effortless use wherever participants are [26]. Persuasive eHealth technology can easily accommodate these needs [17-18]. Our groups of young adults of foreign origin prefer a portable media as platforms. This conclusion coincides with findings of related studies [26, 31]. Young adults search information mostly via (smart-)phones, and prefer also online help with questions on sexuality [26]. Portability, also called mobilization of social media in recent studies [26, 34], stresses the need for accessibly of online health services from anywhere and mobile applications are able to facilitate that need.

Furthermore, independent of what kind of technology is offered, the *source* of information has to be visible and to be perceived as trustworthy. Trust to the provided

source of information can be identified by the recognition and familiarity with the logo of the health organization. Recent research also identifies trustworthiness of the information as a crucial factor for the successful application of the modern technology in sexual health care for young adults [26, 35].

The design factors we mention above could apply to adults of foreign origin, as well as young adults in general. The fifth factor, which is especially connected to young adults of foreign origin, is the *comprehensibility* of the information offered by persuasive health technologies. Specifically, health technologies for behavior change support have to be more visually aided and easily worded, possibly in different languages and the vocabulary of the low-educated target group. Although this seems an obvious conclusion, many public health interventions have not been properly evaluated in cooperation with the specific target groups, such as adults of foreign origin before and after going 'live'. Furthermore, it is essential to involve the target user group in the design of persuasive health technologies for behavior change support.

Additionally, one of the participants said that it would be good if the health applications were designed separately for men and women, or at least tailored towards the specific needs of both genders. Additionally, it seemed that men and women found different design esthetically attractive. Gender specificity did not emerge as a factor, but does give some insights into the reason why existing health interventions might mostly reach women [8-9]. Possibly the design of the currently available interventions is tailored more towards women and more attention should go into the needs of men, specifically young men of foreign origin.

In our study, we focused on identifying the persuasive features and design factors for health behavior change support through persuasive technologies, to meet the specific needs of vulnerable young adults. There is, however, another factor that can be attributed to the success of applications for sexual health support, namely the reach of these applications. The design maybe perfectly tailored towards young adults, but if they do not find and use these applications the effort to improve them is moot. The current practice is to create more demand by more supply. Moreover, there are many online interventions available to promote sexual health in the hopes of reaching their target groups. It remains a challenge to guide the users towards the 'reliable' applications. Trustworthiness of the source and one central platform that combines several high quality health interventions are needed [7, 26].

Our research on sexual health does not include sexual health in all it facets. We have focused on sexual health as in the absence of infections and information about infections. However, sexual health also entails sexual pleasure and the ability to enjoy your sex life [36]. The other side of the coin, sexual pleasure is something that is becoming more and more stressed in sexuality research. This aspect of sexual health might also be an important factor to investigate when designing health applications for young adults. Online technologies, have already taken steps to improve sexual health focusing on sexual pleasure [36]. These technologies could be applied in the future research towards enhancing positive sexual experiences of young adults of foreign origin.

Focus groups are an ideal method to investigate a delicate and sensitive subject as sexual health. On the one hand, focus groups are usually kept small, to facilitate par-

ticipation and profound discussions. On the other hand, keeping the focus groups small also induces some limitations. They can only yield qualitative data. Not all adults of foreign origin that can be found in the Netherlands were part of the current focus groups. However, the four largest immigrant groups were well represented in our study. Furthermore, the various ethnic backgrounds were mixed in the focus groups, possibly making it difficult to express some culturally specific opinions.

The second limitation of our study is that foreign origin and low education are confounded in our study. The young adults who participated also had low educational background. Therefore, it is possible that the factors that emerged were contributable to level of education instead of ethnic background. This is a potential bias, but also a strength, as it gives more insight into the special needs of the vulnerable target group who could potentially benefit from persuasive technologies for sexual health behavior support most. Finally, one focus group had a different moderator but was assisted by the same assistant for taking notes. Both moderators used the same instructions and discussion guide and the audio recordings of all focus groups were transcribed and analyzed by the same investigator using the same coding scheme, as well as cross-checked by the second investigator to avoid bias.

The current results can contribute to future developments of persuasive health technologies, specifically aimed at enhancing healthy lifestyles and health behavior of high-risk young adults. We suggest, for instance, a mobile application as a type of platform, that would optimally assist anonymity and would be accessible from anywhere [31, 37]. Personalized mobile application could provide a low-threshold service to enable contact a health care specialist after the face-to-face consultation. Such service, in combination with playful engaging tasks to raise awareness on own sexual health behavior, could prevent high-risk young adults to fall into the same risky sexual behavior pattern, and ultimately facilitate better continuity and self-management in public sexual health. Of course there are could be other suitable options, such as imbedding the serious gaming elements into a mobile application to raise awareness on the lifestyle and health behavior [30].

5 Conclusion

In conclusion, several stimulating, blocking and neutral persuasive features specific for high-risk young adults were identified in this exploratory study, as well as five generic design factors. Namely, health technologies for young adults should be anonymous, interactive, portable, from a reliable source, and easily comprehensible for the user. These findings aim at informing the design of health technologies for lifestyle and sexual health behavior change support of high-risk young adults, and could be applicable for young adults in general. Incorporating these factors and persuasive features into the design of health technologies for behavior change support, for sexual health and also over health topics, suggest to increase their usefulness and uptake by the target group. As part of the future work, we are currently designing the new personalized health application for self-management support of high-risk young adults, incorporating the identified persuasive features and design factors and involv-

ing the potential users and sexual healthcare professionals in the holistic iterative design approach.

Involvement of the target group throughout the whole development process is crucial, as well as iterative evaluation of the design with them to increase uptake and ensure successful implementation and ultimately better sexual health. Moreover, future research should also focus on the specific evaluation methods to measure the effects of persuasive technologies on the health behavior and lifestyle of young adults. This important topic is highlighted in detail in other studies [22], focusing on the validation of the Perceived Persuasiveness Questionnaire (PPQ) [38-39] and the relation to the PSD model [40]. Further research is required to validate these finding, preferably combining qualitative and quantitative approach. For instance, it would be interesting to compare these results with the additional user evaluation using the existing persuasiveness measures like PPQ.

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About the Persuasion Context for BCSSs: Analyzing the Contextual Factors

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Abstract. Accumulation of contextual data offers new opportunities to improve the preventative health and wellbeing interventions. In this paper, we discuss the importance of understanding the context elements of Behavior Change Support Systems (BCSSs) and present an Event model illustrating the Use, User and Technology Context factors of the Persuasion Context. The model is a conceptual tool for identifying potential meaningful context factors and serves as basis for future research activities.

Keywords: behavior change support systems, persuasive technology, persuasive systems design, context modeling

1 Introduction

Personalized technology interventions have been listed among the top research questions related to big data in computer science and information systems [1]. While personalization possibilities give rise to numerous commercial applications, it is somewhat unclear how actual personalization is implemented and which pieces of information are actually useful. In addition, more emphasis should be given for creating value for individual end-users, the ones actually creating the mass of information. A very potential carrier for preventative health and wellbeing services is persuasive technology [2]: a research field that studies how people are persuaded while interacting with computer technology. While big data provides possibilities for both prediction and explanation, persuasive systems will take that information into action.

Operationalization of the information provided by big data depends on understanding context and improving persuasive (or information) systems' awareness and access to contextual data – which, in turn, increases the richness of communication [3] and can be a predictor to overall adherence. In terms of persuasive systems, Oinas-Kukkonen and Harjumaa's [4] persuasive systems design (PSD) model, which is a framework for developing and evaluating persuasive systems, states that the development process for persuasive systems is multi-phased. The PSD model consists of: 1) seven underlying

postulates defining basic principles of successful persuasive systems, 2) the persuasion context analysis which defines the desired behavior or attitude change type, studies the persuasion event and the effectiveness of different strategies to achieve the desired outcome, and 3) the actual design of systems qualities with four (primary, human-computer dialogue, credibility, social) support categories to be designed, evaluated or implemented at the feature level.

In this paper, the persuasion context analysis of PSD model is deepened by studying contextual factors of the persuasion Event. The following sections of the paper provide a review of literature on contextual information, an outline of the Event context model and discussion of the model and its implications.

2 Background

2.1 Persuasion context in PSD model

In this section we focus on the second phase of the PSD model [4], the Persuasion Context. The Persuasion Context phase is crucial for understanding the user, use case, application domain and technological environment of the system. Context analysis refers to the overall persuasion situation, and involves the study and identification of contextually relevant elements in a user's life situation in order to deliver successful support systems for behavior change. It is divided into three categories, namely Use Context, User Context and Technology Context [4]. *Use Context* covers the factors that arise from the problem domain i.e. the specific features of the application area in question, and also factors of situational relevance. The *User Context* focuses on factors, which create individual differences and may therefore influence the effectiveness of the system. These include, for example, goals, interests, motivations, attitudes, and all kinds of situational and personality elements. *Technology Context* refers to factors which stem from the technological features of the system, such as selected platform type, available devices and application software [4]. All these elements have both their strengths and weaknesses and in accordance with all other context factors they create the overall persuasion context of the system.

Regardless of its crucial nature, Persuasion Context is often not taken properly into account in scientific literature describing persuasive designs [5], mainly because of insufficient system descriptions. The PSD model has also been criticized for being too general and not providing explicit guidance for practical design work [6, 7]. One of the previous works contributing to the Persuasion Context knowledge created a 3D model for analyzing the system users' relation to target change [8] and later the same model was applied to the analysis of Persuasion Context in the PSD model [6]. Another Persuasion Context contribution comes from the field of Green IS [7], where behavior change in organizational settings was studied. The results confirm that the selection of design principles is dependent on the contextual factors of the organizations and the application domain and urge that information systems should be studied in their actual

contexts. Additionally, one of the two core principles identified in the study, tailoring, is inherently rooted to understanding of user groups [7].

2.2 Context modeling

Context itself is such a multidimensional and wide concept that unambiguous definitions are infeasible; instead of trying to grasp the whole entity, it is more practical to find a proper viewpoint and construct the definitions accordingly. While the significance of context has been identified also in information systems research, lately its role in theorizing is also becoming more prominent [9]; most of the work in the field is focused on organizational level and deal with business applications. Therefore the present study draws from the multidisciplinary field of human-computer interaction (HCI) and also from the engineering field of contextual computing. The most common definition of context is by Dey [3] who stated:

> *"Context is any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."*

The definition is operational by nature and aims to gather factors which help designing context-aware applications. This definition was further extended in Zimmermann et al. [10] to include both formal (categories of context information) and operational (the use of context) definitions. In the field on mobile HCI, Jumisko-Pyykkö and Vainio [11] presented a descriptive model for context of use. The model is based on a broad literature review and contains five contextual components: physical, temporal, task, social and technical-information components. Also some additional properties and level of magnitude, dynamism, pattern and typical combinations are visible in the model. Despite the dynamic nature of the model, the initial literature review of the study reports that context of use is seen as being rather static. Yet mobile contexts are inherently dynamic and heterogeneous and consist of transitions from one context to another [11]. Thanks to recent development of sensor technologies, true contextual awareness is becoming more sensible target for mobile applications.

The challenge for this paper, however, is more practical: how to separate the essential context factors from everything else that is present in our everyday life. This same question was addressed in a longitudinal study of mobile internet [12]. The study developed a conceptual framework for contextual elements which likely influence human behavior when using the service. In addition to a very practice-oriented context model, the study revealed that the services were actually used in a very limited set of contexts despite the ubiquitous availability of the mobile internet. Some context factors also had different effects on utilitarian vs. hedonic and active vs. passive services, giving clear implications that identifying the key context factors for each service might be enough for delivering specialized (tailored or personalized) services. Context also plays a crucial role in the value customers perceive in services, especially in mobile services [13]. The conditional value of the service is created, when contextual elements interacting with the service user and the service enhance the service's value in-use. The study found four contextual elements (time, location, lack of alternatives, and uncertain conditions)

which act as filters for the service value offered by the service provider; depending on the context, the user either perceives those values or not [13]. While this study is from the economics field, it highlights an important issue also for the BCSSs field: the system needs to fit to the use and user context in order to deliver the intended service.

2.3 Context in user experience

In the field of user experience (UX), the role of context in constructing the subjective experiences of the users is acknowledged. In their well-known definition of user experience, Hassenzahl and Tractinsky [14, p.95] specify context as one of the three parts of UX:

> *"UX is about technology that fulfils more than just instrumental needs in a way that acknowledges its use as a subjective, situated, complex and dynamic encounter. UX is a consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)"*

In the context of BCSSs the target is more than just good user experience, but also to change behavior with support of the system. It is acknowledged that design is an influential factor and even though there is increased knowledge on effective mechanisms, this area lacks the detailed understanding of contextual factors. In fact, it is argued that persuasive strategies are means which could be applied to basically any "end", referring to the application domains [15]. Also design patterns contribute [16] to the vision that persuasive strategies are not context-dependent and are therefore posing an interesting challenge to context sensitive literature. Regarding user experience, BCSSs have a very specific goal: the achievement of intended user experience by influencing the users [17] and ensuring the experience is meaningful.

3 Modeling the Persuasion Event

In this paper, the focus is on deepening the understanding of Persuasion Event of the PSD model [3], namely the elements of Use Context, User Context and Technology Context. In broad sense this means understanding the user of the system, both situational factors and more enduring issues of their life situation as well as the technology platform supporting the system. The PSD model itself is generic and applicable to both evaluation and design of the BCSSs, and likewise the proposed Event model aims at both evaluating and studying the existing system and guiding the design of future systems. In the long run, understanding the users in their real Use Contexts will aid the designing of new systems. For now, it is constructed for identifying meaningful contextual factors. It is a conceptual tool that helps identify potential concrete elements in

the everyday lives of end-users and should not be considered as a new context modelling theory.

Regardless of the viewpoint, most of the contextual factors have both situational and more enduring effects. While both types of factors are important and necessary for adaptive and well-tailored systems, it is relatively difficult to determine which type would dominate in any given persuasion situation. Therefore the original categories of the Event are divided into situational and more long-lasting factors: Use Context refers to situational factors and User Context to elements, which relate to individual differences of the user. Technology Context is kept as separate category but it mainly assess sustainable elements of selected technology (Figure 1).

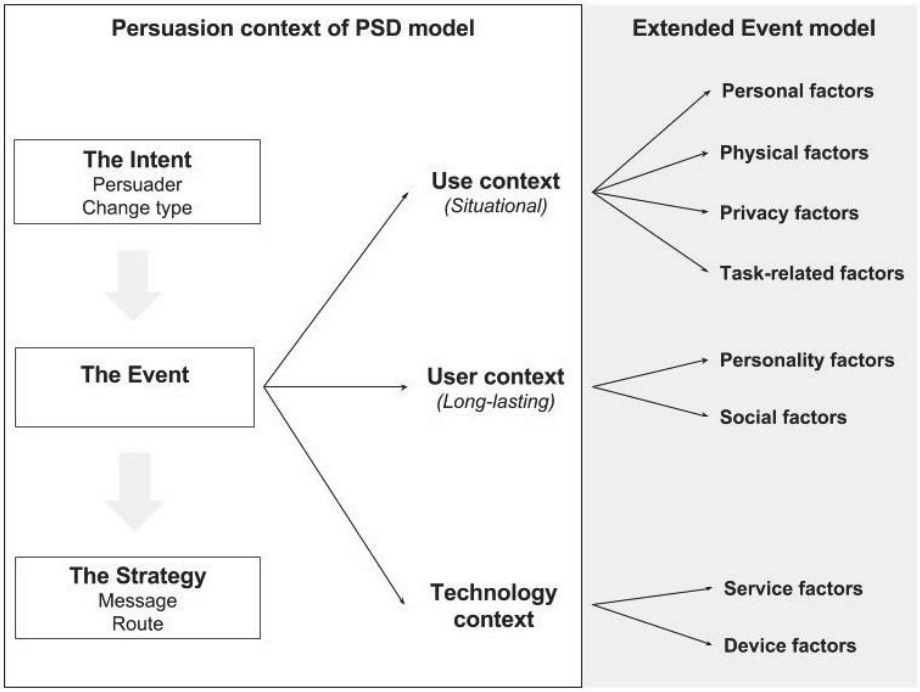

Fig. 1. Persuasion context of the PSD model with extended Use, User and Technology context elements of the Event.

In addition to the PSD model, the Event model is strongly influenced by Lee et al. [11], who studied the use of mobile services in a longitudinal research setting. The study focuses on real-life situations and identifies ten sources of situational variation in the use contexts. They suggest two main categories: personal and environmental. Environmental factors are further divided into physical and social factors. Personal and physical factors are integrated also into the Event model. Examples of personal factors include emotions evoked in the use situations and subjective nature of time; physical factors refer to, for example, a location element. Social context of Lee et al. [11] is re-defined

as privacy factors, concerning the private or public nature of use situations and the level of interaction with other people around. Additionally, the situational Use Context has the task-related factors category, which refers to characteristics of user tasks. Overall, the situational factors are selected based on their measurability in end-user surveys: some additional factors could be introduced to the model should automatic sensing parameters be accessible (for example in a field study where tracking with sensors is utilized).

The User Context in the PSD model focuses on user-dependent issues, such as needs, goals, motivation, abilities, and attitudes, taking a more holistic approach to the life situation of the user. The same applies to Event model, but the nature of factors is long-lasting, e.g. mood is not part of User Context, but it is grouped as situational factors and is therefore part of Use Context. The main difference between the Use and User Contexts is therefore how time-sensitive the factors are. The User Context is divided into personality and social factors, which aim to group this challenging mix of features into smaller entities. Social factors are predominantly social elements such as social influence and subjective norm and personality covers factors like attitude, persuadability, goal-directedness and habits.

The significance of User Context is observable in the interplay between the other Event contexts: the User Context is in a key position when considering tailoring a persuasive system so that it can best serve each individual user. Tailoring, in turn, is a way of leveling Use Context and Technology Context so that these remain more predictable at least to some degree. Various psychological processes are included in the processing of persuasive messages, and tailoring the persuasive messages to an individual user increases the opportunity of gaining a positive outcome [18].

The Technology Context deals with the features of the selected technology and technological aspects of the service. All levels of inquiry are encouraged, such as the platform of choice, the application features, and the specific implementation details, in order to assess both the strengths and weaknesses of the Technology Context. This group aims to cover elements, which have enduring, general level impact on the service, while situational elements are handled in Use Context, in the task-related factors section.

4 Conclusion and discussion

The presented Event model is built on the PSD model and has the intention of serving as an evaluation and design tool. The ultimate goal of the model might be that some links from context factors to end-user groups, application domains or some other factors could be identified and those could be used as design guidelines for future systems. This would further contribute to our understanding of persuasive mechanisms. In the meantime, the model is first validated with empirical methods, to verify the factors and basic items for each factor and later used as research model for analyzing the relevance of different BCSS features.

Compared to conceptual model of Lee et al., [11], this model has both situational and more enduring aspects of the context. Behavior change process takes time so it will not be feasible to focus only on situational factors. On the other hand, situational factors

contribute to the overall user experience of the service or application and therefore cannot be overlooked either. As the model is primarily developed for health BCSSs, this might limit its application and is therefore a limitation of our study. Also the practical nature of the model might decrease its applicability.

When studying these different types of contextual elements, one should keep in mind that there might be elements that override all other elements in some or most situations. This dominant or recessive nature of context elements might be the key for identifying, if not the most opportune moments for persuasion, at least avoiding some of the worst ones. The interplay between "situational and dispositional variables" [19] and effect of situational factors on goal prioritization [20] also pose interesting viewpoints for evaluating and developing new BCSSs. Goal-setting considerations are another interesting aspect for context modelling: behavior change applications typically have both short and long-term goals and both should be supported by the design. If the service fails to support the user in difficult moments which require situationally sensitive functions, the overall long-term goal support might soon become useless.

The context also plays a crucial role in habit formation. Stable context functions as trigger to habitual actions and according to some studies [21], strong habits can also outweigh goals. Understanding the contextual elements triggering the habit might enable us to find tailored or even personalized solutions which attack the key habit trigger by creating new context cues to suppress it.

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Behavior Change Support Systems for Privacy and Security

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Abstract. This article proposes to use Behavior Change Support Systems (BCSSs) to improve the security of IT applications and the privacy of its users. We discuss challenges specific to BCSSs applied to information security, list research questions to be answered in order to meet these challenges, and propose an architecture for the Personal Information Security Assistant (PISA), a software framework designed to improve the privacy-related behaviors of end-users.

1 Introduction

Research into BCSSs has mostly been applied in the context of healthcare: persuading users to adopt a healthier lifestyle, or to comply with medical advice. However, another potentially fruitful area of application is information security: digital systems and services are becoming more complex and connected, and thereby become more vulnerable. After technical risk mitigations have been implemented, the human element often turns out to be the weakest link in the information security chain. Risk perceptions in information security are strongly influenced by incidents [1, 2]. A BCSS can help improve the alignment between risk perceptions and reality in the absence of recent incidents. However, BCSSs in information security differ from healthcare in that positive feedback is the absence of consequences (no security breaches), and in security there may be a long delay between action and consequence (the security breach can happen months after the behavior that caused it). This means that any BCSS for information security will need to address several domain-specific challenges. There are few publications on the application of BCSS to security. One of these is by Johnston, listing 10 general requirements for security interfaces[3]. In the Personal Information Security Assistant (PISA) project[1], we aim to reduce security risks and enhance the privacy of users by persuading them to change their attitudes and behaviors in this area. We do this by offering a personalised security operations center for the individual: the PISA.

2 Challenges in the Application of BCSS to Security and Privacy

Based on previous discussions with experts in Risk Assessment, as well as established end-user security literature such as [3], we define two challenges in the

[1] http://scs.ewi.utwente.nl/projects/pisa/

field of end-user security. We then associate these challenges with corresponding goals that we think have the potential to meet them.

Challenge: Motivation and change type The Elaboration Likelihood Model (ELM)[6] defines the constructs *user ability* and *motivation*, which influence what type of communication will be effective. We assume that both ability and motivation to improve IT security and privacy are low among the general public, and so a BCSS for security and privacy needs to employ persuasive techniques that require little intervention or thought from the user. Such a communication strategy relies on the ELM's *peripheral route*, where users use heuristics and peripheral cues to make their decisions. However, directly conflicting with this strategy is the type of change that PISA needs to achieve: sustained behavioral and attitudinal change is needed to raise security awareness[1]. This type of change is best realised through education and intervention. Such a strategy corresponds to the ELM's *central route*, relying on careful thought and consideration from the user. This conflict in route choice leads us to define the following goal:

Goal: Personalisation A BCSS for security and privacy needs to personalise the interaction with its users, allowing for the maximum of education and interaction that users are comfortable with, based on their motivation and ability. Personalisation also allows dialogue to evolve over time as user's attitudes and abilities change. A BCSS can do this by observing the user's actions and behavior when interacting with digital systems and services. Based on this information, the BCSS should be able to estimate the user's risk appetite and security preferences.

Challenge: Dynamic threats Security and privacy can be compromised by a vast range of threats. Most of these threats require sophisticated technology and expertise to address. In addition, these threats are dynamic and change over time, which means countermeasures will need constant maintenance. A be-all-end-all system for security, then, is not feasible. This leads to the second goal for a security- and privacy-enhancing BCSS:

Goal: An extensible software framework Since privacy cannot be protected by a single system, a different approach is needed. Using a software framework that can integrate multiple extensions to protect against different threats can be an answer to this problem. Using different extensions for different threat categories, education and motivation regarding privacy can still be achieved using a single system. This way, a BCSS can offer a robust platform for sharing system information, user activity and a single channel for communicating with a user. This allows for a better user experience, minimizing redundant communciation between protective systems and the user. Additionally, such a framework can form the basis for an ecosystem of protective measures developed by different parties, distributing the development and maintenance cost of a comprehensive security solution.

3 Research Questions

The goals defined in the previous section lead us to the following research questions specific to a BCSS as applied to information security and privacy:

Q1: How can user ability and motivation regarding information security be measured by observing human computer interactions? The answer to this question is needed to address the personalisation goal: to structure the message in a clear and persuasive manner, both constructs need to be taken into account.
Q2: What user-characterising factors can and should influence how a BCSS takes action and informs the user? The answer to this question is also needed for the personalisation goal: beyond motivation and ability, many factors can influence how a person responds to information presented by the BCSS. Identifying and incorporating them will enhance the system's persuasive ability.
Q3: How can enterprise risk assessment methodologies be adapted for and applied by end-users to enhance the security of the IT systems they use, and/or their own privacy? The answer to this question well help us structure educational content for effecting behavioral change in security and privacy: a wealth of risk assessment methodologies exist for an enterprise context. If a way can be found to adapt this to an end-user context, the message itself can be improved, heightening effectiveness as well as credibility of the BCSS.
Q4: How can a user's personal and system security status be visualised? Implementing the answer to this question will improve the persuasive power of the BCSS: without an effective way to communicate a user's status, it becomes hard to motivate users to change their behavior.
Q5: What techniques can be used to maintain the privacy of a user's data while allowing cross-extension communication? This question needs to be answered in order to prevent a security and privacy BCSS from becoming a risk of its own: consolidating a wealth of intelligence on a person risks making the BCSS a single point of failure in security.

4 PISA Architecture

The goal of the PISA is to enhance user privacy by persuading the user to change their behavior in accordance with their privacy risk appetite. Previously, we have used the Persuasive Systems Design (PSD) model by Oinas-Kukkonen[5] to identify requirements and persuasive elements of the second PISA prototype [4]. After developing two prototypes, we have converged on the architecture shown in Figure 1.

The PISA Client: A program running on a user's device. Interacts with the user and uses information gathered from sensors in PISA extensions to keep a user profile up to date. Based on this user profile and a database of rules, PISA protects the user when an event takes place. It does this through advice to the user and by using actuators in PISA extensions.

PISA Extensions: Plugins that can integrate with PISA, protecting the user based on a set of event-response rules associated with the PISA Extension. Sensors are programs that can monitor aspects of the user's system (such as browsing activity or typing speed) while Actuators are programs that can take specific actions within a user's system (such as starting a virus scanner). The Logic component is a program that communicates between different parts of the extension and the PISA client.
The PISA Update Server: A centralized database of plugins and event-response rules that the PISA Client can use to update itself.

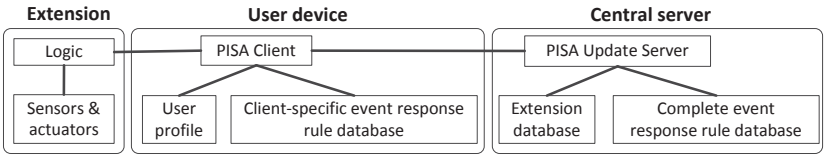

Fig. 1. The architecture of the PISA

As a proof of concept, our second prototype used a browser plugin as a PISA extension to detect when a user was entering his password on a non-HTTPS protected site. It then informed the user and prevented him from entering his password on what could potentially be a phishing site.

5 Planned Work

This architecture will be used as a guideline for implementing a series of prototypes that we will test in laboratory conditions (using students and researchers as subjects), using feedback from each iteration to improve the next. The immediate research question that these prototypes will aim to answer is how to assess a user's skill and motivation based on observation (Q1 and Q2). When personalisation is possible, advice and educative content and human-computer dialogue will be structured using enterprise risk assessment methods (Q3). Once sufficient extensions exist, a test involving a tiered reporting structure, aggregating sensor data into categories, will be used to visualise the observed risk appetite of the user (Q4). Existing literature on privacy preserving techniques will be consulted throughout the development of the extension API (Q5). Finally, a test of the efficacy and persuasive elements of the prototype will be carried out in a real world context with our project partners, which include an internet service provider and a telecom service provider.

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Persuasive Information Security

A Behavior Change Support System to Help Employees Protect Organizational Information Security

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Abstract. Digital information is an important asset in the corporate world. Organizations typically devise policies and guidelines to help employees protect the security of such information. Complying with these policies can often be confusing and difficult and may obstruct the task at hand, thus potentially leading employees to circumvent or ignore these policies. Commercial technology and training programs to mitigate this issue suffer from various shortcomings. To overcome these limitations, we present a Behavior Change Support prototype that implements six persuasive features: Security Points, Security Quiz, Challenges, Statistics, Personalization, and Risk Communication. Evaluation of the prototype established persuasive security as a promising approach for influencing user attitudes and behaviors regarding secure work practices. We apply the findings to offer suggestions for how the six persuasive features could be further enhanced.

1 Introduction

Breaches in organizational information security can have severe consequences. Loss or theft of sensitive digital information can cost millions and damage the organization's reputation. Organizations therefore have a strong incentive to protect their digital information. Sources of threats to information security are not limited to external entities. Studies show that a sizable proportion of information security breaches are caused inadvertently in the course of routine work of employees, despite absence of malicious intent.

One of the mechanisms used by organizations to deal with the protection of information is an information security policy, i.e., the rules and guidelines defining permitted and forbidden actions related to information assets. Naturally, organizations want and expect employees to adhere to the prescribed policy. However, employees may find it challenging to comply with their employer's information security policy. Factors that underlie these difficulties include perceived self-efficacy and subjective norms toward information security in the organization [1,15].

Enforcement of security policies via purely technical means (e.g., cutting access off when the network connection is insecure) takes away perceived behavioral control from employees, thus creating frustration and annoyance. We present a Behavior Change Support System that uses persuasive features aimed at promoting compliance with organizational information security policies without compromising perceived behavioral control.

We believe that the key to the effectiveness of such a system is educating employees regarding the risks and rationale that underlie the policy at hand [14]. Toward this end, we designed six features aimed at increasing employee awareness and knowledge of organizational information security policies and changing attitudes and behavior toward greater compliance with the policy while supporting engagement with the issue of organizational information security.

Specifically, we formulated the following research question: which persuasive system features are most likely to affect attitudinal and behavioral change regarding organizational information security?

To tackle the above question, we conducted a user study of a prototype implementation of our designs. We found that persuasive strategies could be beneficial for promoting secure user practices, albeit to varying extents. At a high level, our contribution consists of demonstrating the value of persuasive strategies as a means for promoting secure user practices.

We first describe the theoretical background of our work. Next, we describe the prototype design of the persuasive features followed by the details of the user study conducted to evaluate the features. We report the findings regarding the persuasiveness of the prototype Behavior Change Support System and conclude by reflecting on the findings.

2 Related Work

Technological approaches for increasing compliance with security policies include commercial applications that manage endpoint security (e.g., IBM Unified Endpoint Management). These applications often enforce information security policies without helping end users understand the importance of the policy and the consequences of violations. While training and awareness programs [10] empower employees regarding secure work practices, such programs are expensive and time-consuming and need periodic repetition.

A Behavior Change Support System [13] is an effective and popular approach for changing human attitudes and behavior. Based on principles of persuasion, we designed such a system in order to foster positive employee attitudes toward organizational information security, empower employees to make informed security decisions, and promote secure work practices as the subjective norm in the organization.

Technology that utilizes persuasive strategies has been applied to promote a variety of target behaviors in diverse domains, such as education, health, sustainability, etc. For example, Gamberini et al. [7] noted the effectiveness of personal statistics and tailored suggestions and advice for affecting power consumption, and Munson and

Consolvo [11] found that setting personal weekly goals and monitoring progress were useful in promoting greater physical activity. Research further shows that the effectiveness of persuasive technologies could be improved by taking into account individual differences in receptiveness to the underlying persuasive strategy [8]. For instance, Zuckerman and Gal-Oz [18] propose personalizing persuasive technologies based on an individual's receptiveness for self-quantification, virtual rewards, and social comparison.

However, some of the above studies report contradictory results. For instance, Zuckerman and Gal-Oz [18] found that virtual rewards led to increased physical activity, yet most of their study participants did not find the rewards meaningful. Similarly, Gabrielli et al. [6] received mixed reactions toward the strategies of challenges, statistics, rewards, social comparison, and suggestions (via text messages); some participants described them as motivating while others did not find them useful. These contradictions point to the need for further investigation that could help reconcile these discrepancies.

3 Prototype of Persuasive Features

Only a few studies [3,5,17] have so far applied persuasive technology for usable security. However, these studies utilized relatively small student samples, not our target population of knowledge workers. Moreover, these explorations were limited to specific practices, such as choosing passwords, rather than considering all work practices that impact the security of the organization's information resources. To address this gap, we built a prototype that utilized 8 of the 28 persuasive strategies from the comprehensive framework outlined by Oinas-Kukkonen and Harjumaa [12]. The prototype was an interactive front-end interface for an information security application. This application is intended to be installed on the work devices of employees. As an initial exploration of the front-end interface, our prototype was implemented to function within a Web browser. The prototype system covered the following eight persuasive strategies described by Oinas-Kukkonen and Harjumaa [12]:

Rewards: The system rewards the target behavior, in our case with Security Points and Security Badges.
Tailoring: The system is personalized to a user’s interests and personality, here through a questionnaire that determines features of potential interest to each user.
Competition: The system promotes competition with others, in our application through Challenges.
Simulation: The system provides a means for understanding the connection between behavior and its consequences, in our case by communicating potential risks.
Social comparison: The system allows comparing one’s performance with others, in our prototype via statistics of past security behavior.
Suggestions: The system recommends appropriate behavior at opportune moments, in our application by suggesting interesting features determined using questionnaire responses.

(Social) learning: The system facilitates learning about target behavior, in our prototype by a Security Quiz with questions about the information security policy.
Self monitoring: The system provides a means to track one's performance and status, in our implementation via Statistics of past security behavior.

We term an operational system *implementation* of one or more persuasive strategies as a persuasive *feature*. Our prototype incorporated the above eight persuasive strategies in the form of six persuasive features, viz., Security Points, Security Quiz, Challenges, Statistics, Personalization, and Risk Communication. We chose strategies and features based on the promising techniques identified in the literature, e.g. Gamberini et al. [7]. We limited the exploration to six persuasive features in order to maintain a number manageable within one study.

Table 1. Mapping between prototype features and persuasive strategies.

Prototype Feature	Primary Persuasive Strategy	Secondary Persuasive Strategy
Security Points	Rewards	-
Security Quiz	(Social) learning	Rewards
Challenges	Competition	Rewards
Statistics	Self monitoring	Social comparison
Personalization	Tailoring	Suggestion
Risk Communication	Simulation	Rewards

Table 1 shows the mapping between the persuasive strategies we employed and the corresponding persuasive features within our prototype. It can be noted that each feature operationalized a primary and a secondary strategy. The exception was Security Points, which did not incorporate a secondary strategy. We summarize each of these features below. Busch et al. [2] provide further details.

Security Points. Users could collect virtual rewards in the form of Security Points. As described below, Security Points could be earned by taking a Security Quiz, completing Challenges, or answering a Personalization questionnaire. Users were awarded Security Badges corresponding with the progressive accumulation of Security Points, viz., Beginner, Intermediate, Expert, Professional, and Master. Security Points could be used to "buy" perks, such as time to use social media and colors to change the look-and-feel of the prototype. Points were deducted if the user's actions were deemed insecure for organizational information security. As mentioned below, the Risk Communication feature of the prototype warned users about the loss of Security Points resulting from insecure behavior.

Security Quiz. In order to facilitate learning, users were presented with quizzes on practices and scenarios related to the information security policy. Each question offered multiple answer choices, only one of which could be chosen as the answer. Although one of the answer options was the best choice, the other options could also be appropriate choices. Users were rewarded with Security Points corresponding to the appropriateness ranking of the chosen answer.

Challenges. Motivation through competition among employees was promoted by this feature. Users could accept Challenges that were either competitive (e.g., "Behave more securely than your colleagues for one week.") or individual (e.g., "Comply with all security policies for one week."). Users were rewarded with Security Points upon successful completion of the assigned Challenges.

Statistics. The Statistics feature showed the number of information security policy violations per week committed by the user as well as the average number of violations for other employees across the organization. The user was presented with visualizations of various Statistics regarding security compliance, enabling comparison of his or her practices with those of co-workers and promoting the persuasive strategies of self-monitoring and social comparison.

Personalization. By answering a questionnaire that determined persuadability for each of the six persuasive features, a user had the possibility to choose features that could be especially fitting for him or her. The Personalization questionnaire consisted of statements related to the persuasive features (e.g., "I like to compete against others" related to the Challenges feature) rated on a Likert-type scale. For each persuasive feature, the individual obtained a persuadability score which determined his or her individual receptiveness to that feature. Based on questionnaire responses, the system made personalized suggestions for helping the user follow secure information practices. For example, if questionnaire responses indicated that the user is greatly influenced by social comparison, the prototype encouraged the user to consult the Statistics (see above) to compare his or her practices with those of co-workers. To incentivize personalization, users were awarded Security Points for completing the questionnaire.

Risk Communication. The prototype integrated with the underlying operating system to detect when a user might be engaging in risky information security practices. In such cases, the prototype warned the user of the risk for the organization as well as personal consequences for the user (simulation). For example, if the user attempted to transfer a sensitive document using an insecure connection, a popup window warned the user that the practice violated organizational security policy and he or she would lose Security Points. For documents with low sensitivity, the user could choose to heed or ignore the warning. For highly sensitive documents, access was blocked.

4 Method

We employed the prototype to conduct a user study evaluating the perceived persuasiveness of the implemented features. The user study was carried out online via the Web. Participants read the following scenario: *You are waiting at the airport to embark on a business trip. While waiting, you wish to prepare a business document. In order to work on the document, you need sensitive information from a file stored on the company's servers. The security policy of your employer states that you should access sensitive company information only from encrypted (secure) network connections. The wireless Internet connection at the airport is unencrypted.*

The scenario served as the background for framing the study. However, our questions to the participants about the persuasive features were independent of the scenario. Participants were asked to imagine themselves in the scenario and open our Web based prototype and explore and interact with each feature one at a time by clicking the corresponding prototype tab. The Security Points tab described how the user's behavior could lead to earning or losing points and badges. Participants were also shown the current point balance along with an explanation of how it could be redeemed for rewards. The Security Quiz tab included one example question: "How can I best protect the information in my office?" Participants were awarded 1 Security Point for answering correctly or provided feedback if their answer was incorrect. The Challenges tab provided the opportunity to earn Security Points by committing to two example challenges, one competitive ("Behave more securely than your colleagues for one week." – 10 Security Points) and one individual ("Comply with all security policies for one week." – 20 Security Points). The Statistics tab showed a temporal graph of security policy violations committed by the user along with the average number of violations across all employees of the organization. The Personalization feature presented the participant with a questionnaire regarding his or her attitudes and behaviors. The prototype was not connected to a back-end system. Therefore, upon completing the questionnaire, participants received an explanation regarding how the responses would have been utilized for personalized suggestions when connected to the back-end security system. To evaluate the sixth feature, viz., Risk Communication, participants were asked to open another application called "File Explorer." Within this application, participants were instructed to (try to) open 'Low-Sensitive Document.pdf,' 'Medium-Sensitive Document.pdf,' and 'High-Sensitive Document.pdf.' Clicking on the 'Low-Sensitive Document.pdf' brought up a warning regarding a security policy violation. Given the low sensitivity of the file, the warning allowed the user to proceed if he or she desired. The warning popup for the other two files blocked opening the file with no user override.

With the exception of Risk Communication, all features were presented in random order by randomizing the tab sequence in the prototype. In the case of Risk Communication, we felt that the effort of starting a new application and then returning to the prototype might lead to attrition. We therefore excluded the Risk Communication feature from randomization; it was always the final task.

After encountering each persuasive feature, participants were asked to rate items regarding usefulness, enjoyment, increase in awareness, attitude and behavior change (adapted from Drozd et al. [4] and Venkatesh and Bala [16]) on a 7-point Likert-type scale from Strongly disagree (1) to Strongly agree (7). These items were inspired by a persuasiveness model [9] and the Technology Acceptance Model 3 [16].

The participants were recruited from a database of voluntary study participants from Austria. We screened potential participants such that only those who were employed full- or part-time were eligible. Participants worked at various organizations in and around Vienna, Austria.

5 Initial Findings

Of the 81 participants, we retained the 64 who indicated the presence of explicit information security policies at their organizations. Gender distribution was roughly equal (33 females and 31 males) with ages ranging from 21 to 60 (median = 32). As the five items for measuring the persuasiveness of the single features were adapted from several different scales [4,16], we checked the dimensionality of these items with an exploratory factor analysis. The corresponding scree plots for each feature pointed to a single underlying latent factor based on the eigenvalue criterion (eigenvalue > 1). We interpreted and labeled this factor as the *persuasiveness* of the feature, leading to a single overall persuasiveness score for each prototype feature.

Shapiro-Wilk normality tests revealed that some of the scores violated the assumption of normality. Therefore, we used non-parametric statistical tests in subsequent analyses. Consequently, we report the medians of these scores, instead of means.

Figure 1 shows notched box plots of the persuasiveness scores for each feature, with higher values indicating greater persuasiveness. The notches in the boxes indicate the 95 percent confidence interval of the median. The line at 4 on the y-axis marks the neutral mid-point of the 7-point Likert-type scale. Based on the medians, Risk Communication, Statistics, and Security Quiz were rated as more persuasive, while Security Points, Challenges, and Personalization were found less persuasive.

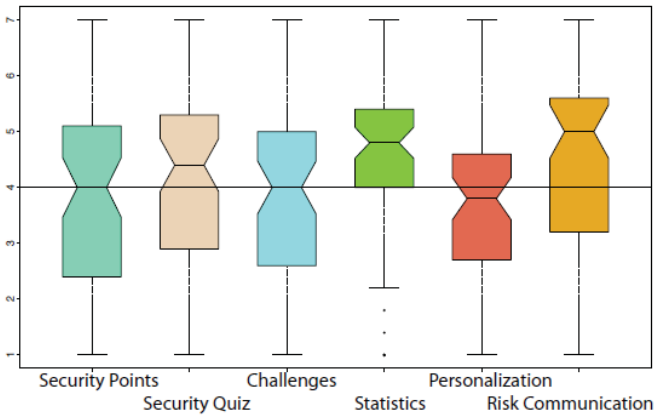

Figure 1. Persuasiveness scores for each prototype feature with 1= Strongly Disagree to 7= Strongly Agree.

We employed one-sample Wilcoxon tests to examine if each feature was rated significantly better or worse than the neutral mid-point (4) of the 7-point Likert-type scale. We found that Statistics ($V = 1380.5$, $p < 0.001$) and Risk Communication ($V = 1225$, $p < 0.05$) were rated significantly better than the mid-point. The ratings for Security Quiz ($V = 1062$, $p = 0.40$) were not significantly better than the mid-point, while those for Personalization ($V = 704.5$, p-value = 0.33) were not significantly worse. Finally, Security Points ($V = 658.5$, $p = 0.26$) and Challenges ($V = 729.5$, $p = 0.44$) were neither significantly better nor worse than the mid-point.

6 Discussion

By its nature, security is secondary to an ongoing task, often obstructing the task at hand. Therefore, even neutral ratings of security features can be seen as a success. Our results thus indicate the promise of persuasive security for helping employees understand and follow secure work practices compliant with the organizational security policy.

At the same time, the variance within each feature suggests that individuals could react to a particular feature in differing ways. Ensuring coverage across such diversity of views may require a combination of several features and strategies, instead of relying on a single aspect. Our preliminary findings (see Figure 1) indicate that Statistics, Risk Communication, and Security Quiz are especially promising persuasive strategies in the information security context.

Open-ended participant responses pointed to further improvement in each of the persuasive features in the prototype:

Security Points. Features such as Security Points and Badges introduced playful and game-like aspects to the interaction. Participant responses indicated that it is important to consider the presentation of such elements for an organizational context, where professionalism and seriousness are important and run counter to playfulness.

Security Quiz. Despite including only a single question, participant reactions to the Security Quiz feature provided useful design insight. In particular, we found that it is essential not only to reveal the correct answer but also to explain the rationale behind how the answer was derived.

Challenges. Our implementation of Challenges included a group task that asked users to compete with fellow employees. Participants cautioned that such competition could run counter to the organization’s culture and risk alienating colleagues.

Statistics. The Statistics feature was well-liked. We believe that the appeal stems from the usefulness of the information for comparing one's practices with the larger picture as well as its visual presentation that made it easy to comprehend.

Personalization. Participants found it difficult to understand the Personalization feature and its connection with information security. These difficulties appeared to be driven largely by the one-time nature of the study and the non-functioning nature of this feature in the Prototype.

Risk Communication. While participants appreciated the contextual nature of Risk Communication, they complained about its disruption and obtrusiveness. Moreover, participants were frustrated because the dialog did not offer concrete guidance on achieving the task in a secure manner. These reactions reveal that effective Risk Communication needs to balance a variety of tensions, such as whether to interrupt the user or provide feedback in the background and whether to block user actions completely or allow users to proceed with a policy violation.

These observations could serve as useful guidelines for improving the studied persuasive features and applying them in systems. For instance, Statistics could benefit from the addition of a larger set of security-related behaviors and enabling an understanding of security that considers nuance, such as severity and risk. Similarly, Risk

Communication needs to minimize disruption and guide the user toward the secure alternative, instead of serving a purely informational and/or access control function.

7 Limitations

We must also point out several important limitations. There were interdependencies among the persuasive features. For instance, Security Points were incorporated in the Security Quiz, Challenges, Personalization, and Risk Communication. These interdependencies might have led to overlapping effects among the features. Additionally, the application of randomization in order to avoid order effects may have created somewhat unnatural sequencing, thus hampering a full understanding of a feature. For example, successful completion of a Challenge was rewarded with Security Points. However, due to random feature ordering, it was possible to encounter Challenges prior to being introduced to the concept of Security Points. At the same time, it is also likely that the potential errors of such peculiarities were canceled out owing to the random ordering. As explained in the Method section, Risk Communication was placed at the end, which may have introduced an order effect for this feature.

Our study examined a single usage instance using an interface prototype lacking back-end functionality. Moreover, study participants had no prior exposure to the prototype. A longitudinal study with a functioning system is needed to study how these findings are affected by usage experience and learning.

8 Conclusion

Our research goal was to investigate if a Behavior Change Support System with persuasive features could be a promising mechanism for raising employee awareness of an organization's information security policy and helping prevent work practices that violate the policy. To achieve this objective, we applied eight persuasive strategies to design and implement six persuasive features in an interactive prototype. A user evaluation of the features via an online study suggests that the features hold promise but their persuasive power could be enhanced by design refinements. A functioning deployment in a real-life setting is needed to study the longitudinal impact of the persuasive features. We hope these findings spur further exploration that investigates how additional persuasive strategies could be employed to develop persuasive system features.

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