Designing, Modeling and Evaluating Influence Strategies for Behavior Change Support Systems

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Abstract. Behavior change support systems (BCSS) research is an evolving area. While the systems have been demonstrated to work to the effect, there is still a lot of work to be done to better understand the influence mechanisms of behavior change, and work out their influence on the systems architecture. The papers of the second BCSS workshop aim at filling this gap. They test existing influence strategies and suggest new ones, develop evaluation methods of influence strategies, and introduce systems architectures that support novel influence strategies.

1 Introduction

An emphasis of research in Behavior Change Support Systems or BCSS (Oinas-Kukkonen 2010a, 2010b, 2013) is that technology, information, and people involved in behavior change interventions shouldn't be studied in isolation. The three components of a BCSS combine into an entity that should be studied as a whole to produce meaningful insight as the interaction of the components is the gist of the behavior change support phenomenon. This also implies that should one component change, the others will have to adjust. We are currently living through such a major re-adjustment: Ongoing technological advances and fundamental recent changes in the scientific picture of man, his motivations, and behavior control mechanisms, call for continuing adjustments in the theory behind and application of behavior change support systems.

Technological advances that reduce the size of information and communication technology (ICT) and make it globally interconnected both challenge and open up opportunities for researchers of behavior change support systems. ICT is becoming increasingly ubiquitous and embedded in objects of the everyday life, contributing towards humanizing those technologies (Oinas-Kukkonen & Oinas-Kukkonen 2013). We can carry ICT with us and can even wear it. Mobile services, in particular, are designed to be consumed instantly, anytime, and anywhere (Chae and Kim 2003). Technology is also becoming increasingly aware of the context of its use (see e.g. Wang, Huang et al. 2011), which opens up unprecedented opportunities to identify opportune situations to help people change their adverse behaviors or maintain desired behaviors. In particular,

mobile technologies can, increasingly, connect to personal devices monitoring the individual's physical states. Hence, it is not surprising that there is a growing interest in applying behavior change support systems for a variety of interventions. This also means that there is growing demand for academic knowledge instructing how to apply high-tech instruments for behavior changing interventions ranging from health and security to climate change, and more.

Effective persuasion is based on deep understanding of *human information processing*, and that understanding is currently undergoing profound changes. Recent research in cognitive psychology suggests that automatic and largely autonomous processes that interpret and select information play a leading role in most behaviors: Perception, evaluation, and even choice have non-conscious roots (for a recent review, see e.g. Custers and Aarts 2010). Interestingly, this means that consciousness plays perhaps a relatively minor role in controlling behaviors. These insights promote a shift in application of persuasive strategy: In persuasive systems design more attention should thus be given to support more directly behavior change rather than only attempting to influence a person's beliefs, attitudes, and intentions. Relative importance of information content in persuasion is in the decline while more direct influences to behavior are in the rise. Development of new influence strategies is badly needed. Both the theory and practice of identifying and assessing the effectiveness of persuasion and behavior change is in need of re-development to make them embrace the emerging view of human information processing: In particular, measurement techniques and instruments that rely less on personal judgment of persuasiveness are needed.

The aforementioned trends put increasing pressure on BCSS researchers. Growing need for behavior change support systems means that the researchers should start consolidating their research efforts to be able to offer easy to apply instructions to their growing audience with limited background in BCSS. To meet the demand, several theoretical areas should be targeted. First, the recent developments in relevant consumer technologies (i.e. ICT, personal health technology) and in cognitive psychology should be better integrated in the BCSS paradigm in the form of strategies of influence. Second, BCSS design methods and tools should be advanced to a level at which BCSS people with limited background in the field could apply the BCSS paradigm in designing effective behavior change support systems. Finally, evaluation tools for the BCS systems need to be validated to ensure the performance of the systems in real-life applications.

2 Advances in BCSS research

The papers of the BCSS2014 workshop address three timely issues in design and development of effective behavior change support systems: identification of effective influence strategies of BCSS, evaluation methods for BCSSs, and new tools to define and construct BCSS architectures. We will next highlight, in brief, the key ideas behind the papers included to the Proceedings of the workshop.

2.1 Evaluation of BCSS

In their paper, de Jong and associates (2014) evaluate constructs developed for measuring perceived persuasiveness in technology. They find that, in general, the different measures line up with the data obtained with Perceived Persuasiveness Questionnaire (PPQ). However, the relationship between perceived persuasiveness (cf. Oinas-Kukkonen 2010b) and actual use rates of the persuasive technology, obtained by analyzing log-data, appears to be much more problematic. In sum, the authors conclude that their analysis demonstrate that the PSD model (Oinas-Kukkonen and Harjumaa 2009) generates consistent results, when measured using different methods.

Caon and co-authors (2014) describe at conceptual level the Virtual Individual Model that will be integrated to the PEGASO system through an ontology-based virtualization. The aim of the project is to develop a system that is sensitive to characteristics of the individual and the interaction context and capable of using this information to dynamically select opportune tailored interventions. The PEGASO model is integrated to the system through an ontology-based virtualization.

Rao (2014) reports about her work on developing evaluation tools to assist the design of persuasive game systems. The paper argues for applying persuasive design principles to games design when behavior change is the fundamental end of the game. The paper suggests that it is important to include gamification in a discussion about persuasion through games, because persuasive strategies play a central part in gamification design. Rao suggests that the Persuasive Systems Design (PSD) model (Oinas-Kukkonen and Harjumaa 2009) can be used in game design to identify specific characteristics of game systems that affect categories of persuasive structures such as credibility and personal involvement.

2.2 Influence Strategies of BCSS

Unal and colleagues (2014) examine users' compliance to persuasive messages in mobile application recommendation domain and explore how persuadability of users affects their compliance. The authors motivate their research by noting that the rapid growth in mobile application market means a significant challenge to find interesting and relevant applications for users. They find that subtle methods of persuasion are more effective than obvious persuasive messages at creating compliance. Also, persuadability is an important determinant on individual's compliance to recommendations.

Orji (2014) explores gender effects on the strategies for persuasiveness of BCSSs. They identify that there is a need to adapt persuasive approaches to various user characteristics and go on to test if gender is among the characteristics that should be taken into account when designing individualized persuasive strategies. The author concludes that gender-dependent approaches would generally be more appropriate for designing BCSSs that will effectively promote health behavior changes than the one-size fits all approach.

Gkika and Lekakos (2014) test whether certain persuasive strategies, especially in the form of recommendation explanations, can affect user's adoption of recommendations. The authors argue that explanation is an important aspect of

recommendation that may make targeted people more open to accept a recommendation. They find that an individual's intention to consume a recommendation good is increased if the item is accompanied with a persuasive explanation.

2.3 BCSS Design

Alahäivälä and his co-authors (2014) aim at breaking out the black-box thinking in persuasive systems design. They present a software design pattern for giving rewards as a way of persuasive human-computer dialogue in BCSS. They argue that by developing software architectures and software design patterns, BCSS research can be enhanced from proof-of-concepts to concrete software development guidelines. The paper provides BCSS research with an intricate implementation level view of the software development aspects of BCSSs.

Wartena and company (2014) discuss the issue of bridging the healthcare and designer point of views to intervention. They argue that social systems development around the BCSS would benefit from better understanding of the interaction between the user, mediator, social system and the socio-technical system involved. They present a game-architecture inspired design approach for BCSSs, and go on to demonstrate the benefits in the design process of combining four archetypal modes of use: trigger, intervention, assessment, and participation.

Burrows and her colleagues (2014) discuss BCSS design in the domain of climate change and using social and digital media technologies to influence users to change their energy consumption behavior. They seek to understand how information about users may be utilized within the development of persuasive technologies and BCSSs. The authors identify how values, lifestyle aspects, and energy consumption behaviors may be modelled to BCSS to deliver relevant and personalized information and knowledge that can influence behavior change.

3 Discussion

All in all the outlook of the BCSS field is promising. Persuasive technology and behavior change support systems research are in the position of giving back to practitioners and other fields of academic inquiry rather than just consume ideas sourced from the important reference disciplines. To make this happen, though, the field will have to amalgamate the recent findings in cognitive and other psychology and the technological advancements in ICT in its existing body of knowledge on how to apply information systems to persuade people change their behaviors.

Acknowledgements. We wish to thank the many people who have made the BCSS2014 workshop possible: Bernd Ploderer for helping with the web site; Sitwat Langrial, Bernd Ploderer and Wolfgang Reitberger for acting in the steering committee; Liisa Kuonanoja for helping to put the proceedings together; and the reviewers for reading through and commenting on the submissions.

References

1. Alahäivälä, T., Oduor, M., Oinas-Kukkonen, H.: A Reward Design Pattern in BCSS, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
2. Burrows, R., Johnson, P., Johnson, H.: Influencing Behaviour by Modelling User Values: Energy Consumption, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
3. Caon, M., Carrino, S., Guarnieri, R., Andreoni, G., Lafortuna, C. L., Abou Khaled, O., Mugellini, E.: A Persuasive System for Obesity Prevention in Teenagers: a Concept, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
4. Chae, M., Kim, J.: What's So Different About the Mobile Internet? Communications of the ACM, 46 (12), 240-247 (2003).
5. Custers, R., Aarts, H.: The unconscious will: How the pursuit of goals operates outside of conscious awareness, Science, 329(47), 47-50 (2010)
6. de Jong, N., Wentzel, J., Kelders, S., Oinas-Kukkonen, H., van Gemert-Pijnen, L.: Evaluation of Perceived Persuasiveness Constructs by Combining User Tests and Expert Assessments, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
7. Gkika, S., Lekakos, G.: The persuasive role of Explanations in Recommender Systems, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
8. Lehto T., Oinas-Kukkonen H., Drozd, F.: Factors Affecting Perceived Persuasiveness of a Behavior Change Support System. *International Conference on Information Systems (ICIS 2012)*, Orlando, Florida, December 16-19 (2012)
9. Oinas-Kukkonen Harri (2010) Behavior Change Support Systems: The Next Frontier for Web Science. *Proceedings of the Second International Web Science Conference (WebSci 10)*, Raleigh, NC, US, April 26-27, 2010.
10. Oinas-Kukkonen Harri (2010) Behavior Change Support Systems: A Research Model and Agenda. *Lecture Notes in Computer Science*, Persuasive, Vol. 6137, pp. 4-14, 2010, Springer-Verlag, Keynote Paper.

11. Oinas-Kukkonen Harri (2013) A foundation for the study of behavior change support systems. *Personal and ubiquitous computing*, Vol. 17, No. 6, August 2013, pp. 1223-1235.
12. Oinas-Kukkonen Harri & Harjumaa Marja (2009) Persuasive Systems Design: Key Issues, Process Model, and System Features. *Communications of the Association for Information Systems*, Vol. 24, Article 28, pp. 485-500, March 2009.
13. Oinas-Kukkonen Harri & Oinas-Kukkonen Henry (2013) *Humanizing the Web: Change and Social Innovation*. Palgrave Macmillan, Basingstoke, UK, 248 pages.
14. Orji, R.: Exploring the Persuasiveness of Behavior Change Support Strategies and Possible Gender Differences, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
15. Rao, V.: Heuristic Evaluation of Persuasive Game Systems in a Behavior Change Support Systems Perspective: Elements for Discussion, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
16. Unal, P., Taskaya Temizel, T., Eren, P.E.: An Exploratory Study on the Outcomes of Influence Strategies in Mobile Application Recommendations, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)
17. Wang, C.-Y., Huang, H.-Y. Hwang, R.-H.: Mobility management in ubiquitous environments. Personal and Ubiquitous Computing, 15 (3), 235-251 (2011)
18. Wartena, B., Kuipers, D., van Dijk, H.W.: Ludens Modi Varietas; A Game-architecture inspired design approach for BCSS, Proceedings of the Second International Workshop on Behavior Change Support Systems (BCSS2014), Padova, Italy, May 22 (2014)

Evaluation of Perceived Persuasiveness Constructs by Combining User Tests and Expert Assessments

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Abstract. To develop effective behaviour change support systems, persuasive technology can be used. The persuasive systems design model offers a framework to identify and operationalize such elements. In this pilot study, we evaluate the questionnaire developed to measure perceived persuasiveness of information technology. We analyzed verbatim user-test transcripts, and performed expert-assessments of the Nurse Antibiotic Information App (NAIA). These data were compared to questionnaire results on this app.

Expert-assessment identified task support, perceived persuasiveness, unobtrusiveness, credibility, perceived effort and perceived effectiveness (as defined in the Persuasive Systems Design model) as being present within the NAIA. These constructs also scored satisfactory in the questionnaire. User-test transcripts are in line with questionnaire results.

Given the consistent results in this pilot study, our approach seems promising for evaluating the questionnaire and will be applied to other settings and websites/applications.

Keywords: eHealth, Perceived Persuasiveness, User-tests, Expert-Assessment

1 Introduction

Any interactive computing system, designed to change users' attitudes and/or behaviour, is called persuasive technology [1]. Oinas-Kukkonen and Harjumaa [2] state that the changing of users' attitudes and/or behaviour should be achieved without using coercion or deception.

For the development and design of such technology, the Persuasive Systems Design model (PSD) can be used [3]. However, using this model during develop-

ment and design of a Behaviour Change Support System (BCSS), does not necessarily mean that users feel more motivated for behaviour change. Therefore, Lehto et al. developed the Perceived Persuasiveness Questionnaire (PPQ) to predict the perceived persuasiveness of a BCSS [4]. However, thus far, the PPQ has not been fully validated yet. It is of importance that this is done, to be able to reliably compare different eHealth technologies, or their application within different settings, with each other.

In this study, the University of Twente and the University of Oulu cooperate, to evaluate the PPQ, with the ultimate goal to have a validated tool to measure perceived persuasiveness available. This is important, since the PPQ offers eHealth developers an opportunity to measure the perceived persuasiveness of their technology and to test the assumptions of the PSD-model. For the validation, we evaluate the results of the PPQ in different settings, aimed at civilians, patients and professionals [4-8]. We will perform expert-assessments to determine which elements of the PSD model are actually incorporated in the ICT system under investigation.

In this paper, we describe an explorative pilot study in which a questionnaire, usability tests, and expert-evaluations are combined to evaluate PPQ constructs, applied to the Nurse Antibiotic Information App (NAIA) [5]. Research questions are:

- Does the users' perceived persuasiveness relate to expert evaluations of the presence of categories for persuasive system principles?
- Does the users' perceived persuasiveness relate to verbalised user-experiences during user-tests?

1.1 The Nurse Antibiotic Information App

Nurses need easily accessible, centralized information support at the point of care, especially regarding medication safety [9, 10]. As part of an antimicrobial stewardship program (promoting prudent use of antimicrobials), the web-based NAIA [11] was developed. A more detailed description of the NAIA and it's participatory development process is given elsewhere [5, 12]. The NAIA includes information on the preparation and administration, but also optionally provides additional background information.

2 Methods

2.1 Study Setting

The NAIA was implemented in two lung wards of a local 1000-bed teaching hospital. A total of 62 nurses (45 FTE) worked at these wards during the pilot phase. The app was incorporated within the nurses' personal hospital start-page, which allowed for easy access [12]. At the time of the study, the app had been

available for >6 months at the ward, offering nurses many occasions to use it and get familiar with it.

2.2 The Perceived Persuasiveness Questionnaire

The Perceived Persuasiveness Questionnaire (as it was available at the time of study) was aimed at evaluating a weight loss application. The questionnaire was used as part of a larger study for summative evaluation of the NAIA, including other measures for behavior change specifically relevant for antimicrobial stewardship [5]. The PPQ was adapted, to fit the research goals of the evaluation study [5]. This means that some constructs of the PPQ were omitted (i.e. dialogue support and social support). Thus, these are also not included in the current study.

Perceived task support, perceived persuasiveness, unobtrusiveness and credibility were included. Two of the credibility items were merged, since no distinguishing Dutch translations could be formulated. We only incorporated one task support item, addressing the overall aim of the behaviour change (appropriate antimicrobial use), since the behaviour itself (e.g. correct administration, preparation, recognition of side effects) is too diverse to address with one item. The questionnaire was translated into Dutch and back-translated into English. Negative items were conversed and construct scores were calculated as the average score of its items.

2.3 Expert-Assessment of Persuasive Elements Within the Nurse Antibiotic Information App

The expert-assessment was executed by two native Dutch speaking researchers, who were both familiar with the app and its purpose. They also had several years of experience with working with the PSD model. Experts independently scored the presence of PSD constructs in a demo-version of the app. Only those constructs that can (as a persuasive strategy) be built into the technology itself, as features or characteristics of the system, were scored. This means that use continuance (the users' intention to continue working with the system [8]) was omitted as this is more an outcome of persuasive strategies than a strategy in itself. Scoring was performed on a 5-point Likert scale, differences were discussed to reach consensus.

2.4 User-Test Analysis for Reported Persuasiveness

Analysis of the scenario-based user-tests of the NAIA is currently work-in-progress, whereas here we report on preliminary results of the summative evaluation via user-tests. It should be emphasized that, in this part of the study, nurses were not specifically asked to comment on persuasiveness elements. Rather the user-tests were aimed at the more general evaluation of the user friendliness of the NAIA. Two independent researchers analyzed the verbatim transcripts of 16 of the 34 user-tests that have been performed. This is done by scanning for any

remarks, made by the nurse, about constructs of the PSD model. First, the researchers checked whether they identified the same text fragments for coding (thus, text excerpts that exemplify a persuasiveness construct). Second, they checked whether the same code was applied to the fragment. If researchers disagreed, consensus was reached via discussion about the relevance and content of particular comments. The definitions of PPQ constructs and the PSD model were used to guide the discussions. Based on the discussion, the constructs primary task support and perceived effectiveness were merged, since they overlapped greatly. For example, when users indicated that they think the app supports them in their information-search tasks, this indicates primary task support (the complex task of searching for information is made easier by using the app), but also perceived effectiveness (working with the app is beneficial for nurses in quickly and easily finding relevant information).

3 Results

3.1 Use of the Nurse Antibiotic Information App

To gain insight in actual use of the App, log-data were recorded for eight months, between pre- and post-intervention measurement. In that period, the app was visited a 1251 times. It was used an average of 5.11 (SD 3.14) times per day. Most visitors did not only log-in but explored the App further (10.71% of the visits consisted of viewing one page only; the entry page). On average, 5.03 pages were seen per visit, and a visit lasted on average 2 minutes and 26 seconds.

3.2 Perceived Persuasiveness

A total of 34 nurses were invited to complete the questionnaire, of these, 30 nurses actually participated (88.24%). The participants' mean age was 30.8 (SD 9.06), 26 of them were female. On average, they had 8.45 years (min 0.5, max 38, SD 8.52) of work experience as a nurse. They used the internet for work and private, for an average of 2.54 hours (SD 1.86) per day. Table 1 shows the accumulated, average scores of the measured constructs.

Table 1. Results of expert-assessment and PPQ questionnaire.

PSD construct	Presence	PPQ Score*
Primary task support	5	4.25
Dialogue support	1	-
Credibility	4	4.13
Social support	1	-
Unobtrusiveness	4	4.11
Perceived persuasiveness	4	4.11

Perceived effort	4	#
Perceived effectiveness	5	#
Use continuance	-	#

Items were scored on a 5-point Likert scale, ranging from 1 (totally disagree), 2 (disagree), 3 (don't agree, don't disagree), 4 (agree), to 5 (totally agree); *: Negative items are conversed; #: At the time of study, this construct was not part of the PPQ yet.

3.3 Presence of PSD Constructs in the App

Participating experts reached high consensus about the presence of the PSD constructs in the app. Primary task support, credibility, unobtrusiveness, perceived persuasiveness, perceived effort and perceived effectiveness were present in the app. Consensus ratings (reached after discussion) are displayed in Table 1.

3.4 Remarks About PSD Constructs During User-Tests

From the verbatim user test transcripts, remarks on perceived persuasiveness were identified. The results of the analysis (including exemplary quotes) are shown in Table 2. Overall, more positive than negative remarks were made. Most remarks concerned primary task support. Perceived persuasiveness, unobtrusiveness, perceived effort and use continuance were also (positively and negatively) commented on.

Table 2. Overview of user-test analysis results

PPQ	N (*)	Quote
Primary task support		
Pos.	32(14)	"[…] *that it clearly shows: dose, preparation and administration. That is what I want to know. That's why I use the App."*
Neg.	11(7)	"*I don't think it always says how long administration of an antibiotic may take."*
Perceived persuasiveness		
Pos.	8(5)	"*[…] And it's very convenient that it is so easy to search. That's much like our good old 'yellow booklet' [paper-based antibiotic information, ed.]."*
Neg.	4(3)	"*That's difficult to read, so it is less interesting, because you'll soon feel like you don't understand and I would then just leave it to the physician."*
Credibility		
Pos.	1(1)	"*[…] Information that you find on the internet is not specifically written for our hospital. This is."*
Neg.	0(0)	n.a.
Social Support		
Pos.	6(6)	*"Or just for your own information. […] Because you want to be as well informed as possible when you call the physician."*
Neg.	0(0)	n.a.

Dialogue support		
Pos.	3(2)	"*As soon as you type in 'am', that Amoxicilline and Augmentin are already suggested to you. I personally find that really convenient."*
Neg.	0(0)	n.a.
Unobtrusiveness		
Pos.	7(4)	*"This is really easy to find… just type it in and there it is! For the old systems, we had to go through many steps before you find the information you need. That's much easier here."*
Neg.	5(4)	"*[…] It might be convenient, that if you have a EPS**, you can select the drug and are automatically brought to the information and don't have to open the App separately."*
Perceived effort		
Pos.	6(4)	"*This nicely describes how to prepare the antibiotic, while that [prior information source, ed.] requires you to read through the whole story, before you find the 'preparation' heading."*
Neg.	6(3)	"*I notice that I am using it [the app] increasingly often, but I still have to search for a little while."*
Use Continuance		
Pos.	7(7)	*"Well, as far as antibiotics are concerned, I check the app. At least I do, and I think my colleagues do too."*
Neg.	3(2)	"*Augmentin [an antibiotic, ed.] is something we use very often, so I don't really check the app for that."*

*number of unique participants making one or more remarks in this category
** EPS: Electronic Prescribing System

4 Discussion

This study combined user-tests, and expert-assessment to evaluate constructs of the Perceived Persuasiveness Questionnaire. Log-data show that, over the eight months between pre- and post-intervention measurement, the Nurse Antibiotic Information App (NAIA) is structurally being used relatively frequently, repeatedly motivating nurses to look-up information. This indicates that the NAIA was incorporated in daily clinical practice, and fulfils a need for easily accessible and well-structured information about antimicrobials. This was also found in prior research [5].

Agreement between experts about the presence of different constructs of PSD was high. Primary task support, credibility, unobtrusiveness, perceived persuasiveness, perceived effort and perceived effectiveness were found in the app.

The constructs perceived effort, perceived effectiveness and use continuance were added to the PPQ after the evaluation study of the NAIA. They are therefore omitted in the questionnaire, but they all are included in the user-tests and perceived effort and perceived effectiveness are included in the expert-evaluation.

All four constructs, that experts rated as being present in the NAIA, and that were included in the PPQ at the time, were also positively perceived by the nurses in the questionnaire study (score >4).

The user-tests analysis showed similar results: positive remarks are made concerning primary task support, perceived persuasiveness and unobtrusiveness. Credibility did not get as many remarks; it appears to play a relatively smaller role in the practical use of the app. However, even though nurses did not proactively mention the credibility of the app, when asked (with the questionnaire), the app is considered to be credible. So, the mere fact that it was not mentioned, does not necessarily mean it is absent in the app.

A remarkable finding, based on the discussions during the user-tests analysis, was that primary task support and perceived effectiveness had to be merged. Researchers were unable to structurally distinguish these constructs within the users' comments (the comments simultaneously fitted-in with both constructs). This might be due to the nature and purpose of the app (which is directly aimed at influencing the task performance of nurses), but it might also be an indication of the importance of having a validated Perceived Persuasiveness Questionnaire available, to be able to distinguish between constructs. This pilot study only included a single system, it is therefore impossible to determine which of the two (the system or the questionnaire) caused the problem mentioned above. To avoid such bias (caused by including a single system), we will include multiple apps in the validation study. The currently studied app mainly focusses on primary task support. For the validation study, it is necessary to cover the full range of constructs of the PSD model. Therefore, other apps are included, that might aim at different constructs (e.g. Facebook, Twitter, Prevalence app, Ned i Vekt and Virtual Health Check).

These have different aims (e.g. social interaction, weight loss, infection control) and different target audiences (e.g. professionals, civilians). The PPQ has, in more or lesser extent, been applied to all of these apps, which allows for comparisons to be made.

With this pilot study, we have shown that the PSD model generates consistent results, when measured using different methods. However, results of this study should be interpreted with care, due to some limitations. As this was a pilot study, it had a relatively low number of participants (users and experts). Also, not all constructs of the PPQ were included in the questionnaire study. Finally, its results may have been influenced by other questionnaires that were simultaneously used (concerning e.g. usability and empowerment).

In future research, we will do more in-depth log-file analyses, focussing on which parts of the NAIA are mainly used and at what moments, as prior research has shown that log-files may be used to study the effect of persuasive elements in eHealth technology [13, 14]. Additional user-tests will be analysed, to allow for conclusions in the field of effectiveness of the NAIA. The study will, as mentioned before, additionally be applied to other apps and other settings, and will be

complemented with thorough evaluation of a Dutch PPQ. These are all important steps to be taken to enable valid PSD evaluations in summative research.

The current pilot study gave us a framework, based on which we will work towards validating the PPQ. We created a protocol for expert-assessment of a behaviour change and its support system, we showed how this evaluation enables a PSD focus, and provided an example of validation via user-tests.

References

1. Fogg, B.J., Persuasive Technology: Using Computers to Change what We Think and Do. 2003: Morgan Kaufmann Publishers.
2. Oinas-Kukkonen, H. and Harjumaa, M. (2008) Towards Deeper Understanding of Persuasion in Software and Information Systems. The First International Conference on Advances in Human-Computer Interaction (ACHI '2008), Sainte Luce, Martinique, February 10-15, 2008, ISBN 978-0-7695-3086-4, pp. 200-205.
3. Oinas-Kukkonen, H. and M. Harjumaa, Persuasive Systems Design: Key Issues, Process Model, and System Features. Communications of the Association for Information Systems, 2009. **24**: p. 485-500.
4. Lehto, T., Oinas-Kukkonen, H., and Drozd, F. (2012) Factors Affecting Perceived Persuasiveness of a Behavior Change Support System. International Conference on Information Systems (ICIS 2012), Orlando, Florida, December 16-19.
5. Wentzel, J. and J.E.W.C. van Gemert-Pijnen. Antibiotic Information App for nurses. in The Sixth International Conference on eHealth, Telemedicine, and Social Medicine. in press. Barcelona, Spain.
6. Jong de, N, A. Eikelenboom-Boskamp, A. Voss, J.E.W.C. van Gemert-Pijnen, User-centered and persuasive design of a web-based registration and monitoring system for healthcare-associated infections in nursing homes. in The Sixth International Conference on eHealth, Telemedicine, and Social Medicine. in press. Barcelona, Spain.
7. Lehto, T., Oinas-Kukkonen, H., Pätiälä, T. and Saarelma, O. (2012) Consumers' Perceptions of a Virtual Health Check: An Empirical Investigation. In: 20th *European Conference on Information Systems*, ECIS 2012 Proceedings, Paper 154. http://aisel.aisnet.org/ecis2012/154.
8. Lehto, T. and Oinas-Kukkonen, H. (2014). Explaining and Predicting Perceived Effectiveness and Use Continuance Intention of a Behavior Change Support System. Behaviour and Information Technology, online first. doi:10.1080/0144929X.2013.866162..
9. Koch, S.H., C. Weir, M. Haar, N. Staggers, J. Agutter, M. Görges and D. Westenskow, Intensive care unit nurses' information needs and

recommendations for integrated displays to improve nurses' situation awareness. Journal of American Medical Informatics Association, 2012. **19**(4): p. 583–590.

10. Ndosi, M. and R. Newell, Medicine information sources used by nurses at the point of care. Journal of Clinical Nursing, 2010. **19**(17-18): p. 2659-2661.
11. Demo Information Application for nurses. In Dutch. [cited 2014 03-10]; Available from: http://abnurseapp.infectionmanager.com.
12. Wentzel, J., L, van Velsen, A.H.M. van Limburg, N. de Jong, J. Karreman, R. Hendrix, and J.E.W.C. van Gemert-Pijnen, Participatory eHealth Development to support Nurses in antimicrobial Stewardship. BMC Medical Informatics and Decision Making, in review.
13. Gemert-Pijnen van, J.E.W.C., M.S. Kelders, and T.E. Bohlmeijer, Understanding the Usage of Content in a Mental Health Intervention for Depression: An Analysis of Log Data. Journal of Medical Internet Research, 2014. **16**(1): p. e27.
14. Kelders, S. and J.E.W.C. Gemert-Pijnen, Using Log-Data as a Starting Point to Make eHealth More Persuasive, in Persuasive Technology, S. Berkovsky and J. Freyne, Editors. 2013, Springer Berlin Heidelberg. p. 99-109.

A Persuasive System for Obesity Prevention in Teenagers: a Concept

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Abstract. In the frame of the PEGASO European project, we aim at creating an ecosystem that enables teenagers to easily adopt a healthy lifestyle. In this ecosystem, the persuasive ICT system plays a key role in motivating users to build healthy habits. The persuasive system is based on mobile technologies and provides tailored motivational mechanisms based on the information provided by the virtual individual model.

Keywords: persuasive technology, obesity prevention, computer-tailored intervention.

1 Introduction

Lifestyle has been identified as the main preventive methods for several health risks. Among the main emerging problems overweight at all ages ranks probably at first place. But if for adults this could be a result of a joint pathology, in teenager counter fighting overweight with proper strategies could be a win-win model for a real prevention of future pathologies. Overweight could also easily become Obesity, which is now epidemic in many countries so that a general alarm has been issued worldwide. Obesity is due to several factors as genetic contributors, metabolic conditions (e.g. diabetes and hypertension), psychological and behavioral issues. Concerning the last two factors, an important role is played by an inadequate education [1], in particular about health literacy. We faced the promotion of healthier lifestyles in an ongoing European project (PEGASO) aiming at developing a complete services ecosystem that would be able to motivate teenagers to learn and to apply a healthy life-style effortlessly. This ecosystem comprehends many actors as the school system, the teenagers' family, the social community, the medical experts and other stakeholders. The creation of this ecosystem aims at enabling the teenagers, who are not fully independent in their life to facilitate the adoption of a healthy life-style.

2 Virtual Individual Model

The ICT system plays a key-role in the PEGASO ecosystem. The influence that technology can exercise on people is recognized by the scientific community and currently a new domain in the computer science, known as Persuasive Technology [2], focuses on formalizing the design and development of computing products that can change the way users act and think. In the persuasive technology field, the Behavior Change Support Systems became an important object of studies since this name describes the persuasive systems that integrate additional software features as continuous accessibility and social support, unobtrusiveness, ease of use, and improved dialogue between the users and the system [3]. The PEGASO project aims at pushing this concept further introducing the feature of dynamically selecting the opportune tailored interventions based on the user's individual characteristics and interaction context. Tailoring the intervention involves modeling the user's characteristics and for this purpose it has been developed the Virtual Individual Model, which comes from the concept of the Virtual Physiological Human. The latter is a methodological and technological framework for integrated modeling of a living human body that describes the interaction of all the physiological components of individuals from molecular to apparatus level [4]. The Virtual Individual Model aims to include individual's characterization composed of physiological, physical, and psychological determinants. This allows integrating biological aspects of human functioning with lifestyle behaviors and psychosocial externalities that are crucial for the determination of the adoption of a certain life-style. This model is integrated in the system through an ontology-based virtualization. This process allows turning the information contained in the Virtual Individual Model into a structured knowledge that can be dynamically updated and elaborated by the computer to select the best interventions for each individual. Tailored interventions make the information personally relevant and researches demonstrated that computer-tailored health education is more effective in motivating people to make dietary changes [5] and that it could be also a good practice to promote physical activity [6].

3 Tailored Intervention Forms

The Virtual Individual Model characterizes the user's nutritional habits, physical status, and psychological status to provide personalized intervention to foster the adoption of a healthy life-style. Obviously, the interaction between the system and the user plays a crucial role in the tailoring process and to facilitate the effectiveness of the intervention. Since the teenagers are the targets of the PEGASO project, the smartphone has been chosen as the mediator of the interaction. Indeed, the smartphones are already perceived as a companion and it is most likely that this relationship between user and smartphone will strengthen in the future [7]. The smartphone is the perfect companion because it is personal and it is ubiquitous. It will provide the possibility of interacting directly with the user asking to enter some information or in a discreet and implicit manner allowing monitoring the user activity. The sensed data referring to the parameters that con-

cern the selected characteristics modeled for the tailoring will be updated constantly in the Virtual Individual Model. Moreover, with the many connection possibilities, the smartphone can allow accessing the information stored in the cloud and can connect to other devices, such as wearable accessories that can improve the physical activity monitoring. Since it is ubiquitous, it can always provide the appropriate trigger, as tailored messages, to influence the user's behavior. This is very important, since Fogg observed that "without an appropriate trigger, behavior will not occur even if both motivation and ability are high" [8]. Moreover, the many sensors integrated in the smartphone allow capturing the contextual information, which can help to generate the trigger at the opportune moment maximizing its effectiveness. Moreover, the smartphone allows installing many applications as media services and games that will motivate the teenagers to interact with the system. The mobile game will be designed to promote physical exercise. The integration with social networks will add the social aspect of the users' life to the parameters for the tailoring of the interventions and, most importantly, the social factor represents a very effective motivator. Another mobile application will be a sort of personal food diary, where the user will be able to note his/her alimentary behavior. This diary will help to understand the alimentary behavior of the user in order to provide the right feedback. For example, some data suggest that breakfast consumption is associated with higher intakes of micronutrients, fruit and vegetables and less frequent use of soft drink [9]. This means that the breakfast consumption habit can help to adopt a healthy dietary behavior. The diary allows following this behavior and to intervene through an alarm in order to remind to the teenager to have breakfast. The eating behavior is not only related to homeostatic reasons. In fact, an important factor that influences people's need and choice of food is represented by the emotional state [10]. The diary will allow noting also the mood in order to include the emotional state in the recognition of behavioral patterns. In fact, this information can be used to find some specific behavioral pattern related to emotional eating in order to generate the best intervention.

4 Conclusion

Currently, the PEGASO project is in the design phase, where all the experts from the different domains are working to create the cross-disciplinary Virtual Individual Model with the related ontology for the digitalization. At the same time, some participants coming from the Psychology, the Industrial Design and the Computer Science domains are conducting focus groups and participatory design events in schools in three different countries (Italy, Spain and United Kingdom) for the design of the system. In a later stage when the system will be developed, three pilots in different countries will take place (Italy, Spain and United Kingdom). These pilots will allow validating the effectiveness of this approach and examining the cultural differences that may impact on teenagers' life-style. The discussion of the future development of this system with the experts that will attend the workshop will provide the possibility of generating an interesting debate and to receive important feedback from different points of view.

References

1. C. Weinert, S. Cudney, and E. Kinion, "Development of My Health Companion to enhance self-care management of chronic health conditions in rural dwellers.," Public Health Nurs., vol. 27, no. 3, pp. 263–9, 2001.
2. Fogg, B. J. (2002). Persuasive technology: using computers to change what we think and do. Ubiquity, 2002(December), 5.
3. Oinas-Kukkonen, H. (2013). A foundation for the study of behavior change support systems. Personal and ubiquitous computing, 17(6), 1223-1235.
4. Fenner, J. W., et al. (2008). "The EuroPhysiome, STEP and a roadmap for the virtual physiological human", Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 366(1878), 2979-2999.
5. J. Brug, A. Oenema, and M. Campbell, "Past, present, and future of computer-tailored nutrition education.," Am. J. Clin. Nutr., vol. 77, no. 4 Suppl, p. 1028S–1034S, Apr. 2003.
6. H. O. den Akker, L. S. Moualed, V. M. Jones, and H. J. Hermens, "A self-learning personalized feedback agent for motivating physical activity," Proc. 4th Int. Symp. Appl. Sci. Biomed. Commun. Technol. - ISABEL '11, pp. 1–5, 2011.
7. Carrino, S., Caon, M., Abou Khaled, O., Andreoni, G., Mugellini, E. (2014) "PEGASO: Towards a Life Companion", in the Proceedings of the 16th International Conference on Human-Computer Interaction, in press.
8. Fogg, B. J. (2009). "A behavior model for persuasive design", In Proceedings of the 4th international conference on persuasive technology (p. 40). ACM.
9. Merten MJ, Williams AL, Shriver LH. Breakfast consumption in adolescence and young adulthood: parental presence, community context, and obesity. Journal of the American Dietetic Association, 2009, 109(8):1384-1391
10. C. Science, A. Kapoor, P. Johns, K. Rowan, E. A. Carroll, M. Czerwinski, and A. Roseway, "Food and Mood : Just-in-Time Support for Emotional Eating," ACII2013, pp. 252–257, 2013.

Heuristic Evaluation of Persuasive Game Systems in a Behavior Change Support Systems Perspective: Elements for Discussion

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Abstract. This text reports the work-in-progress of a PhD project about the development of evaluation tools to assist the design of persuasive game systems. The theoretical framework provided by BCSSs can be used in the context of games through a redefinition of games as "systems" in order to highlight their persuasive intent, and to focus on their core quality of interactive systems. The PSD model can be used successfully in game design if integrated with knowledge about game elements that affect persuasion.

1 Introducing game systems

As the number of products and systems using the interaction modalities of games to affect attitude and behavior change increases, the need grows for appropriate evaluation tools to insure the effectiveness and ethical soundness of their persuasive strategies. Current design strategies for persuasive games rely heavily on the designer's intuitive skills and can refer to precious few theoretical frameworks, the most popular being the one considering persuasive games as argumentation instruments that persuade rhetorically by offering meaning experientially rather than literally, through the rhetorical tool called procedural rhetoric [1]. Even the definition of "persuasive games" is center of debate as different terms are used to describe similar artifacts in different practice contexts (serious games, games for change, games for health, procedural games, games with an agenda etc) [2]. These terms can refer to vastly different disciplinary and theoretical frameworks, ranging from information debriefing in educational games to media effects theories (for example Klimmt or Ennemoser in [3]). In addition to this, reflection on the evaluation of efficacy is usually conducted without reference to design issues [3], which doesn't help to focus on the pragmatic problem of understanding the persuasion dynamics enacted during game interaction. A newcomer to such debate is gamification, a design method that employs game elements and dynamics in non-game contexts usually with the goal of increasing engagement and often for behavior change, that does not offer a separated experience like most games do. While it is still not clear what is the rightful place of gamification in game research [4], it seems important to include it in a discussion about persuasion through games, because of the central part that persuasive strategies play in gamification design.

The notion of game systems, inspired by that of Behavior Change Support Systems [5], is here suggested as a way to concentrate on the persuasive qualities of interaction that happens when a situation is framed at some level as "game", following the root interpretation of games as human-computer interaction [6] and as systems of rules [7], in the attempt to avoid the debate about terminology and methods. A definition of persuasive games by their *intent* instead of their methods (such as procedural rhetoric) allows a larger view on the strategies employed for behavior change. The analogy with BCSS theory, that considers both systems using computer mediated communication and human computer interaction [8], enables us to look beyond the disciplinary divide that scatters reflection on persuasive strategies in different disciplinary fields, disciplinary jargons and methodologies [9] and to concentrate on the strategies employed and their effectiveness from a truly interdisciplinary angle.

2 PSD Model, Game Design and Game Effectiveness

There is no specific framework to assist the design of persuasive game systems except for the above-mentioned procedural rhetoric framework, which supports suggestions about composition and expressive effectiveness rather than persuasive effectiveness [10]. Aside from that, game design strategies in general lack methodologies, and the distance between industry methods of design and (mostly individual) academic frameworks is barely filled by scientific methods that are also employed within the industry, such as Design Patterns [11], the Mechanics Dynamics Aesthetics (MDA) framework [12] and the Machinations method [13].

Another issue is at which level of the design process can the evaluation of the persuasive structures be more useful. The Persuasive Systems Design model offers categories for the heuristic evaluation of different stages in the life of a product, and can consider together persuasive goals (intent), the design (strategy), and the user experience and context (event) [14]. In game research there is a strong separation between design methodologies and evaluation tools, which are usually employed in later stages to evaluate usability and playability [15] [16] and are scarcely present in the design process. Although a plethora of heuristic tools to assist the design can be found both in academic reflection and industry practice (for an overview, see for example [17]), there is little systematic effort in that direction, and very little existing methods employed to connect design practices with persuasive strategies (a theoretical effort in that direction can be found in [18] and a few others).

The challenges in developing such a method are several: the above-mentioned issues in the definition of what makes a game persuasive and a lack of general framework that includes different approaches to persuasion through games, at the moment scattered among different disciplinary fields; the difficulty in isolating specific elements in game design and in looking for correlations with persuasive strategies in other media or in interpersonal communication.

The work-in-progress reported here chooses as a foundation the Machinations model [13], because it offers a comprehensive overview of game mechanics and the possibility to combine them to categorizations of persuasive strategies.

3 Persuasive Game Elements versus Game Frame

What makes a game a game is the existence of rules and goals, and the shared acknowledgement that that situation is in some sense fictional (suspension of disbelief), and separate from daily activities; this is at least the original definition, that has been reviewed several times since for digital games [19]. The solidity of this definition is what creates a difficulty in understanding games for behavior change: if the game activity takes place in a separate moment, this leaves opportunities for attitude change in the way that any other mediated message would do (for instance a TV program) would do. The situation is different in the case of game elements disseminated during the performance of an action (gamification, although some products classified as games present the same characteristics): the (eventual) effects of game activity are directly influencing the performance or non performance of the primary task, and the situation is not different from most examples of persuasive technology. One first step in the adaptation of the PSD model to game systems is to understand which elements of game systems are inherently persuasive and which others can be persuasive when employed correctly.

At the moment three main areas of persuasive aspects of the game environment have been identified (which doesn't include the whole spectrum of game mechanics and dynamics but rather general elements):

a) *perceived elements*, which depend on an attribution of value by the user, such as

what Huizinga called *'the magic circle'*, that is, the socially shared mental and physical space of the game, and the level of *fun*, which can depend on personal qualities of the user just as on the initial attribution (expectations);

b) *structural elements:* elements that relate to the structure of game systems and determine how the interaction with the system works, such as *rules, goals* and *agency;*

c) perceptual elements: elements that relate to the physical apprehension of the game system, such as physical arousal during activity, and elements related to cognitive immersion and transportation, such as in narrative persuasion.

The next step in the agenda will be how these elements typical of a game experience relate to the categories of primary task support, social support, dialogue support and credibility support exemplified in the PSD model.

4 Conclusions

By considering games and gamification as game-based information systems, and persuasive games as one particular kind of Behavior Change Support System it is possible to open new perspectives in the analysis of what makes a game persuasive and differentiate between different persuasive strategies. This document wants to assert the desirability and feasibility of adapting the PSD model to the necessities of persuasive game design, and propose a temporary plan of action in that direction.

References

1. Bogost, I.: Persuasive Games: The Expressive Power of Videogames. The MIT Press, Cambridge, MA, USA, (2007).
2. Djaouti, D., Alvarez, J., Jessel, J-P: Classifying serious games: the G/P/S model. In Felicia P. (ed) Handbook of Research on Improving learning and motivation through educational games: multidisciplinary approaches. IGI global, Hershey, Pennsylvania, USA (2011)
3. Ritterfeld, U., Cody, M. and Vorderer, P. (eds.) (2009) Serious Games: Mechanisms and Effects. New York/London: Routledge.
4. Deterding et al: CHI 2011 Workshop Gamification: Using Game Design Elements in Non- Game Contexts, in CHI 2011 Proceedings, May 7–12, Vancouver, BC, Canada (2011)
5. Oinas Kukkonen H.: A foundation for the study of behavior change support systems. Pers Ubiquit Comput DOI 10.1007/s00779-012-0591-5 Springer-Verlag, London (2012)
6. Barr, P., Noble, J., and Biddle, R.: Video game values: Human-computer interaction and games. Interacting with Computers 19, 2 (2007), 180-195.
7. Salen, K. Zimmerman, E.: Rules of Play, Game Design Fundamentals, MIT Press (2004)
8. Oinas-Kukkonen, H. and Harjumaa, M. Towards deeper understanding of persuasion in software and information systems. Proceedings of The First International Conference on Ad- vances in Human-Computer Interaction (ACHI 2008), 200-205.
9. Bogost I. Fine Processing in H. Oinas-Kukkonen et al. (Eds.) PERSUASIVE 2008, LNCS 5033, pp. 13–22, 2008
10. Treanor, M., Mateas, M., and Wardrip-Fruin, N.: Kaboom! is a Many-Splendored Thing: An interpretation and design methodology for message- driven games using graphical logics. Proceedings of the Fifth International Conference on the Foundation of Digital Games, (2010).
11. Holopainen, J., Björk, S. (2008) "Gameplay Design Patterns for Motivation". Proceedings of ISAGA 2008, July 2008, Kaunas, Lithuania.

12. Hunicke, R., LeBlanc, M, and Zubek, R., MDA, A Formal Approach to Game Design and Game Research. In Proceedings of the Challenges in Game AI Workshop, Nineteenth National Conference on Artificial Intelligence (AAAI '04) (San Jose, California) AAAI Press, 2004.
13. Dormans, J. Engineering emergence: applied theory for game design. Amsterdam (2012) 32.
14. Raisanen T., Lehto T., Oinas Kukkonen H., Practical Findings from applying the PSD model for evaluating software design specifications in Ploug T., Hasle P., Oinas Kukkonen H, (Eds) Persuasive 2010, Springer Verlag, Berlin Heidelberg, Germany, 2010.
15. Isbister, Game Usability, Elsevier, Burlington, MA, USA, (2008).
16. Bernhaupt R. (ed) Evaluating User Experience in Games Concepts and Methods Springer Verlag, London, UK, (2010).
17. Paavillainen J. Critical review on video game evaluation heuristics: social games perspective FuturePlay 10 Proceedings of International Academic Conference on the Future of game design and technology (2010) pages 56-65
18. Svahn M.: Processing Play: Perceptions of Persuasion. Digra Conference Proceedings (2009)
19. Huizinga, J. (1955, originally published in 1938). Homo Ludens: A Study of the Play Element in Culture. Beacon Press, Boston.

An Exploratory Study on the Outcomes of Influence Strategies in Mobile Application Recommendations

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Abstract. The rapid growth in the mobile application market presents a significant challenge to find interesting and relevant applications for users. Recommendation systems deal with ends such as movies and consumer goods that are consumed by users where similarity between consumer tastes is generally taken into account. On the other hand, recommendation systems for mobile applications differ from traditional systems in terms of the characteristics of the ends they recommend. They present applications that are not just the ends for consumption but also means to reach various ends. In almost all application stores mobile applications are grouped under headings that employ consensus or authority influence strategies such as the most popular, most downloaded, editor's choice or applications of the day. However in the literature, there is limited information about the users' perception of such influence strategies and underlying factors that lie beyond the users' preferences. The traditional persuasion literature suggests that people are more likely to accept recommendations when the sources display persuasive messages during the interaction. However the effect of visibility modality in the display has not been extensively studied. The effects of visible and semi-visible persuasive messages are analyzed and compared in this study. The users' compliance with persuasive messages in the mobile application recommendation domain is examined. The question of how the persuadability of users affects their compliance is further explored.

Keywords. Persuasion, mobile application recommendations, recommender systems

1 Introduction

Technology that is intentionally designed to change a person's attitude or behavior is called persuasive technology [1]. Persuasive technology of today is based on attitude and behavior change theories and uses information technology as a tool to change users' attitudes or behaviors. Persuasive technology can be used in software and information systems as well as welfare, commerce, education and health [2]. Persuasive systems have recently become popular in many domains such as energy saving, health, mobile and ubiquitous commerce.

Persuasive Technologies employ influence strategies to attain their goal. Fogg [1] describes 40 strategies, Cialdini [3] describes 6 strategies and Torning and Oinas-Kukkonen [4] describes 28 strategies. Among them the most extensively studied grouping by Cialdini [3] identifies the reciprocity, commitment and consistency,

liking, scarcity, authority and social proof principles of persuasion. These six principles are described as the means of influence that can affect the tendency of people to comply with a request.

Reciprocity refers to the fact that people feel obligated to the future repayment of any favor, gift or like they receive. The obligation to repay is easily triggered by obligation to receive. Although not requested or chosen, a favor or gift makes a person feel indebted and obliged to return the favor. Consistency is a central motivator for human behavior that is highly valued in society whereas inconsistency is perceived as an undesirable personality trait. The commitment and consistency principle refers to the fact that individuals tend to be consistent with their prior choices, statements and actions. When an individual makes a commitment such as taking a stand or going on record to do something, compliance will be attained through the pressures of consistency. Liking refers to the principle that people are more likely to accept requests from people that they know and like. It is known that people respond favorably to requests from people they like than those they dislike. The physical attractiveness of people, their physical, mental or personal similarities with the self, familiarity and positive associations increase the tendency for liking. Scarcity indicates the fact that the opportunities are more valuable when their availability is limited. When there is limited supply of a good or limited time left to purchase an item or service, people are more inclined to buy and own it.

The authority principle means that individuals are influenced by those that they perceive to be in authorized positions and tend to accept the requests coming from them. Authority may be symbolized by titles and signatures, style of dress or uniforms or by credentials certifying their expertise. However there are controversial issues related to the influence of authority figures in regard to the relevance of their expertise and trustworthiness. People's perception of a threat for their freedom to choose can also lead to resistance for compliance [5]. Lack of social interaction and cues such as eye contact, voice tone and wearing a uniform may also affect the power of authority figures in online interactions. Guadagno and Cialdini [6] point out that the authority principle is successful when used as a decision heuristic in cyberspace, but is far less influential when used in an online interactive discussion.

The social proof principle, also known as the consensus principle, covers the idea that when many people are doing something, it becomes socially acceptable to do the same thing. The perception that other people find an alternative as appropriate and desirable offers others a shortcut to the choice of that alternative. The claim that a product is the bestselling or the most liked one gives enough evidence for most people to buy that product. However, the opposite can also be true in that, people also have a desire to consider themselves to be unique and different from the majority, thus this strategy should be handled carefully and subtly applied [7].

The effectiveness of social influence strategies in persuasive systems has been studied by examining how an individual's attitudes can be affected by verbal messages presented by others. According to Chaiken [8] there are two primary decision making strategies available to individuals; a heuristic approach as using rules of thumb and shortcuts to make decisions or a systematic approach which involves the rational and careful scrutinizing of the facts. Another model develo-

ped for persuasive communications is Elaboration Likelihood Model (ELM). There are two routes to persuasion in ELM. An individual may be persuaded either by the central route as carefully evaluating the content of the persuasive messages, or through the peripheral route where the individual uses simple cues or rule of thumb [9]. Elaboration on the persuasive messages means that the individual scrutinizes the message and underlying influence strategies according to his motivation and ability. When the persuasive message is presented obviously and visibly, it is likely that elaboration likelihood will be high. High elaboration likelihood can trigger argumentation and cause resistance to persuasion. To avoid resistance to persuasion, influence strategies may be embedded in a semi-visible modality in persuasive messages. This refers to the subtleness of the persuasive messages under evaluation.

Persuasion profiles are defined as the expected effects of different influence strategies for a specific individual. These profiles are supposed to be based on user profiles such as demographics, personality traits, persuadability and behavioral data [10]. Persuadability is an important scale in identifying persuasion profiles. To measure persuadability, the need for cognition [11] is widely used as a scale for a person's compliance with persuasive requests. Kaptein et al. [12] created a 12 item questionnaire to measure an individual's susceptibility to the six persuasion principles of Cialdini [3]. They showed that their scale is more powerful than the need for cognition scale defined by Cacioppo [11] . Later, Kaptein et al elaborated on the items of the questionnaire and developed a new scale called Susceptibility to Persuasive Strategies Scale (STPS) [13]. The questionnaire that is used in this study to determine persuadability levels of participants is adopted from Kaptein et al. [13][14]. Rather than using the full scale, only the items presented under the consensus and authority principles are used due to their relevance to the focus of the study. In the mobile application recommendation domain, implementations of consensus and authority influence strategies are predominantly used on the basis of the most popular ones, most downloaded ones, editor's choice, applications of the day.

Persuasive technology has promising features to foster mobile persuasion. Mobile users predominantly prefer to use mobile applications rather than browsers to access internet services. Application markets have grown rapidly as a result of vesting user interest in mobile applications. Mobile application recommendation websites and services fulfill the growing need to filter, rank and recommend the best applications from the hundreds of thousands available. Some of these sites operate in the official application marketplaces like the Genius of iTunes App Store and the recommendations in Google Play. Other marketplaces like Amazon Appstore, Yandex, Opera App Store also display recommendations for the users.

Recommender systems often aim to persuade people and thus they may be accepted as adaptive persuasive technologies [10]. These systems have been successfully employed in recommending goods or information and enjoyed by many users especially in the e-commerce field. They may suggest items to the users according to their needs and preferences which help users to prune the huge information bulk that is mostly useless. To prune information, there are two well-known methods [15]: The first method, content-based recommendation, is based on recommending items similar to the items the user has preferred in the past.

The second method, collaborative recommendation, suggests items that other customers with similar tastes and preferences liked in the past. In addition to the underlying methods, user profiles and persuasion profiles may be processed and added on the recommendation systems which can then be used to build personalized relevant outputs.

Little is known about the recommendation mechanism of Genius of iTunes App Store or Google Play. Commercial mobile application recommendation systems such as AppBrain, AppJoy and AppsFire are also developed to offer recommendations to users. Among these systems, AppsFire allows users to form friendships and share the applications they like. AppJoy [16] automatically measures application usage patterns and recommends applications based on a collaborative filtering method. AppBrain monitors the installation history and provides recommendations in the same category.

Recommender systems that are used for applications, may make use of persuasive technologies and user persuasion profiles. Although they offer a promising field of study, none of the previous research has studied the influence strategies employed or that can be employed in the context of mobile application recommendations. The main contribution of this paper is that the effects of influence strategies are explored and then a comparison is undertaken with no influence strategies for the first time in this domain. Furthermore the effects of visible and semi-visible influence strategies are compared and examined in terms of user compliance in an experimental context.

The remainder of this paper is organized as follows. In section 2 methodology is described. The design of the experiment and methodology is given in section 3. The results and discussion are provided in section 4 followed by conclusion and future work in section 5.

2 Experiment Design and Methodology

There are two phases in this research; first employing a questionnaire to learn about the user context and behavior in mobile environment, second conducting experimental surveys in the field with visible and semi-visible persuasive messages.

2.1 Measuring Persuadability

In the first part of the research, the participants were invited to complete a persuadability questionnaire. The following 8-item persuadability scale which was adopted from Susceptibility to Persuasive Strategies Scale (STPS) [8] was used to assess a participant's persuadability score. The items were scored on a 7-point Likert scale ranging from totally disagree (1) to totally agree (7). The items were as follows:

Authority

– I always follow advice from my general practitioner.

– I am very inclined to listen to authority figures.
– I always obey directions from my superiors.
– I am more inclined to listen to an authority figure than to a peer.

Consensus
– If someone from my social network notifies me about a book, I tend to read it.
– When I am in a new situation I look at others to see what I should do.
– I often rely on other people to decide what I should do.
– It is important for me to fit in.

The scale reliability is considered to be sufficient since the Cronbach Alpha value was 0.819 for authority and 0.752 for consensus constructs. We computed the persuadability scores for each of the authority and consensus strategy dimensions. The overall persuadability score was calculated as the average of the 2 dimensions. This score was used to discriminate users as high, low and moderate persuadables. The lowest quartile was addressed as low persuadables and the highest quartile as high persuadables. The participants with scores in between were considered to be moderate persuadables.

2.2 Experimental Design

In the second phase of the study, an experimental design was conducted to test the impact of influence strategies. The participants were assigned to two groups based on their overall persuadability scores obtained in the first phase of the study. The high and low persuadables were assigned to two groups with equal proportion. One group was used as the control group with no treatment and the other group was given treatments with persuasive messages employing authority and consensus influence strategies. After the first experimental study with visible persuasive messages, a second study was conducted which presents semi-visible persuasive messages to the same persuasion group. The control group received no influence strategies in either phase of the study

Prior to the experiments, the participants were informed that the purpose of the study was to measure their involvement or interest in mobile applications. The participants were asked to judge a total of 8 mobile application introductions against a series of descriptive scales according to how they perceive the introduction. The mobile applications were evaluated online in two sessions each covering 4 applications. The participants were also informed that the names of the applications had been changed in order to eliminate any bias and/or commercial conflict.

Applications from major application categories, which may be of interest to the participants, such as productivity, shopping, tools, personal life and messaging were chosen. A pre-test was conducted to establish content validity in terms of product involvement and to improve the questions, format and scales. A total of 10 people tested the applications and instruments in the field and their feedback was incorporated into the final revision.

The participants were presented with mobile application introductions on separate screens and were expected to proceed one by one. The control group was given the application introduction in 3 or 4 sentences as presented in the summaries of application introductions in application markets like iTunes App Store or Google Play. The persuasion group was presented with introductions that employ persuasive messages such as the examples given below. The arguments contained in the messages were selected by carrying out a preliminary study on mobile application recommendation systems and mobile application advertisements. For each application introduction, one of the persuasive messages was utilized. In the visible version, the persuasive messages were given separately at the end of the introduction and in semi-visible version the persuasive messages were embedded in the introduction text. An example of one of the applications, a voice recorder, with authority influence strategy is given below as an example. In visible presentation the authority figure, namely IT News Magazine, was highlighted as the recommender of the application. In semi-visible presentation, the persuasive message was given in the body of the introduction subtly embedded in the sentence.

Voice Recorder (Visible version)

Voice Recorder is a mobile application to record voices. You can use this application to record your classes, memos, greeting messages or other events. With 14 distinct sound effects you can add special effects, alter the tempo and convert your recordings to different formats. You can upload your recordings to Dropbox or Google Drive and send/share them whenever you want.

This voice recording application is recommended by IT News.

Voice Recorder (Semi-visible version)

Voice Recorder is a mobile application to record voices that is recommended by IT News magazine. You can use this application to record your classes, memos, greeting messages or other events. With 14 distinct sound effects you can add special effects, alter the tempo and convert your recordings to different formats. You can upload your recordings to Dropbox or Google Drive and send/share them whenever you want.

The persuasive messages used for other applications in the visible versions were as follows:

- This application is recommended by authorities of the field
- This application is the editor's choice in Google Play.
- This application is a trending popular application.
- This application is downloaded more than N times.
- This application is most popular in its category in 2013.

The participants were invited to evaluate each mobile application introduction. The relevance of the mobile application to the participant, the attitude towards the mobile application introduction and the purchase intention were used as const-

ructs for evaluation purposes. The constructs that are measured by 7 item Likert scale given below were adapted from prior research to ensure that the scales were reliable.

- Product Involvement (Importance); from unimportant to important [17]
- Product Involvement (Relevance); from of no concern to me to of concern to me [17]
- Attitude towards; from disliked to liked a lot [18]
- Purchase intention; definitely would not purchase to definitely would purchase [18]

2.3 Participants

The empirical data was collected in December of 2013, using a questionnaire which is e-mailed to the undergraduate and graduate university student lists of a well-known university in Turkey. Of the 381 people who completed the questionnaire, only 283 provided a contact e-mail. Therefore the invitation to participate in the experiment was sent to these 283 participants based on their overall persuadability index. The participants were offered a choice of two gifts for their participation (either a 8 $ cinema ticket as a gratis or donation for a sapling on their behalf). Among them, 180 participants completed the experiments, 80 of them from persuasion group and 100 from control group. The overall persuadability of the participants was distributed as 40 high persuadables, 45 low persuadables and 95 moderate persuadables. The average age of participants was 21.7 and just under half of the participants (47 %) were female.

2.4 Hypotheses

Prior to the experiments we formulated the following hypotheses:

H1: Evaluation of mobile applications does not differ between high, moderate and low persuadables.

H2: Evaluation of mobile applications does not differ according to gender.

H3: Evaluation of mobile applications does not differ with operating systems used.

H4: Evaluation of mobile applications does not differ between a user group subject to persuasive messages and a user group not subject to persuasive messages.

H5: Users who are subject to authority persuasive messages will comply equally with those users who are subject to consensus persuasive messages.

H6: Users who are subject to consensus persuasive messages will comply equally with those users who are not subject to any persuasive messages.

H7: Low persuadable users who are subject to authority persuasive messages will comply equally with consensus persuasive messages.

H8: High persuadable users who are subject to authority persuasive messages will comply equally with consensus persuasive messages.

H9: Users who are subject to visible persuasive messages will comply equally with users who are subject to semi-visible persuasive messages.

3 Results and discussion

The normality of data is checked for all test variables with the Kolmogorov-Smirnov Test and Shapiro-Wilk Test using SPSS. The results obtained from these tests show that the data is normally distributed hence t-test, paired sample t-test and ANOVA test are used for hypothesis testing.

3.1 Persuadability

Figure 1 shows the mean scores of persuadability measurements in terms of three different levels of persuadability. Oneway ANOVA is used to evaluate the impact of the overall persuadability index on user perception (H1). The ANOVA results indicate significant differences in the participants' perceived importance ($F(2, 177) = 4{,}027$, $p = 0.019$), perceived relevance ($F(2, 177) = 4.292$, $p = 0.015$) and Likeness ($F(2, 177) = 3.642$, $p = 0.028$). However, purchase intention ($F(2, 177) = 51.866$, $p = 0.128$) does not significantly differ between the high, moderate and low persuadables at the 0.05 alpha value.

To determine which persuadability levels are different from others, Bonferroni post hoc test is employed. For the perceived importance and perceived relevance, the high persuadables and low persuadables are significantly different with $p= 0.018$ and $p = 0.012$ respectively. For Likeness, the high persuadables and moderate persuadables' evaluation differ significantly with $p = 0.04$ whereas for Purchase Intention there is no significant difference in participants' perception.

In Figure 2 the average scores of the users' responses to the persuasive messages by gender distinction (H2) are shown. According to t-test results, females score significantly higher on perceived importance ($t = 2.341$, $p = 0.02$), relevance ($t = 2.437$, $p = 0.016$), likeness ($t = 2.929$, $p = 0.004$) and purchase intention ($t = 3.179$, $p = 0.002$). Similarly, the effects of operating system (OS) being used (H3) is given in Figure 3. The response from Android and iOS device users is significantly different for relevance ($t = -2.625$, $p = 0.010$) and purchase intention ($t = -2.701$, $p = 0.008$) whereas the difference between perception on importance and purchase intention is not significant for importance ($t = -2.625$, $p = 0.010$) and for purchase intention ($t = -2.625$, $p = 0.010$).

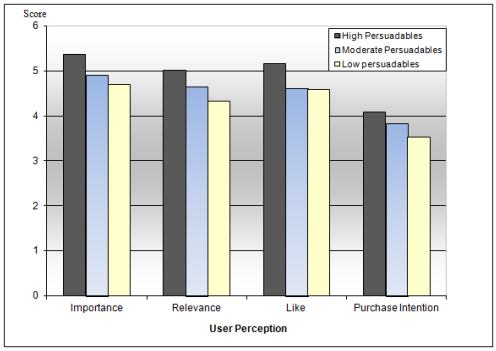

Fig. 1. Effects of Persuasion Profiles on User Perception

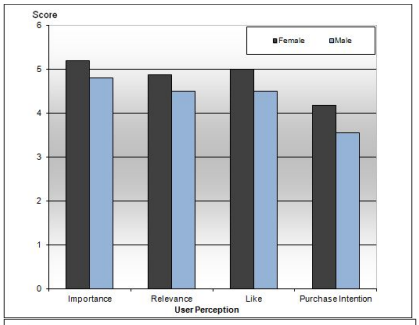

Fig. 2. Effects of Gender on User Perception

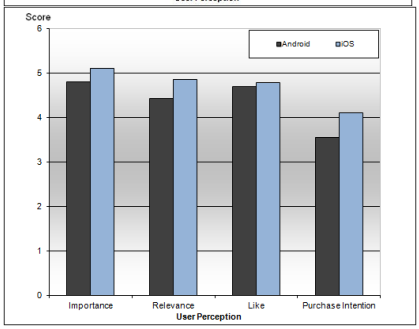

Fig. 3. Effects of OS on User Perception

3.2 Authority and Consensus Influence Strategies

The mean scores in user perception for authority, consensus and no influence strategies are given in Figure 4.

The hypothesis for evaluation of mobile applications does not differ between the user groups that are subject to persuasive messages and those that are not subject to persuasive messages. (H4) is rejected at 0.05 alpha value for purchase intention (t=-2.037 p=0.043), importance (t = -2.78, p = 0.006), relevance (t = -2951, p = 0.004) and likeness (t = -3.336, p = 0.001).

The users who are subject to authority persuasive messages will comply equally with the users who are subject to consensus persuasive messages (H5) is rejected at 0.05 alpha value for importance (t = -9.316, $p < 0.001$), relevance (t = -8.211, $p < 0.001$), likeness (t = -6.079, $p < 0.001$) and purchase intention (t=-8.225 $p < 0.001$).

The users who are subject to the consensus persuasive messages will comply equally with the users who are not subject to any persuasive messages (H6) is rejected for importance (t = 3.071, p = 0.002) and relevance (t = 2.133, p = 0.034) but cannot be rejected for likeness (t = 0.533, p = 0.595) and for purchase intention (t=-1.305, p=0.193) at 0.05 alpha value.

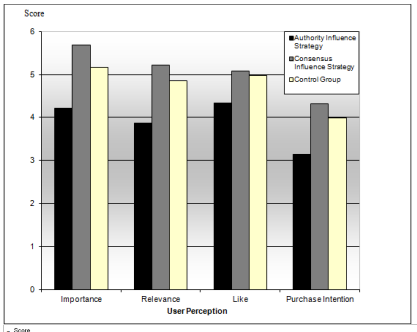

Fig. 4. Effects of Authority and Consensus Influence Strategies on User Perception

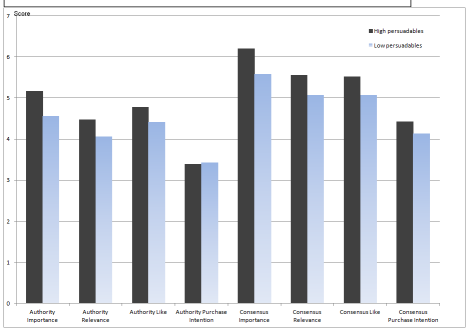

Fig. 5. Effects of Authority and Consensus Influence Strategies for High and Low Persuadables

The mean scores in user perception for authority and consensus influence strategies for the high and low persuadables are given in Figure 5. For each of the persuadability group whether there is a significant difference in users' perception of consensus and influence strategies is further tested.

The hypothesis (H7) that low persuadable users who are subject to authority and consensus persuasive messages will comply equally is rejected at 0.05 alpha value for importance (t=-2. 477 p=0.018) and relevance (t = -2.62, p = 0.013). However for likeness (t = -1.621, p = 0.114) and purchase intention (t = -1.952, p = 0.059) null hypothesis cannot be rejected.

Similarly, hypothesis (H8) that high persuadable users who are subject to authority and consensus persuasive messages will comply equally is rejected at 0.05 alpha value for importance (t=-2. 916 p=0.006) and relevance (t = -2.648, p = 0.012). For likeness (t = -1.819, p = 0.078) and purchase intention (t = -1.878, p = 0.069) null hypothesis cannot be rejected as in the case of low persuadables.

3.3 Visible and Semi-Visible Persuasive Messages

Figure 6 shows the pairwise comparison results which revealed that perception of semi-visible persuasive messages scored significantly higher than the visible messages. The fifth hypothesis (H5) that the users who are subject to visible persuasive messages will comply as equally as those users who are subject to semi-

visible persuasive messages is rejected at 0.05 alpha value for four of the evaluation factors. The null hypothesis (H9) is rejected for importance ($t = -3.38$, $p = 0.001$), relevance ($t = -3.56$, $p = 0.001$), likeness ($t = -3.775$, $p < 0.001$) and purchase intention ($t=-3.052$ $p=0.003$).

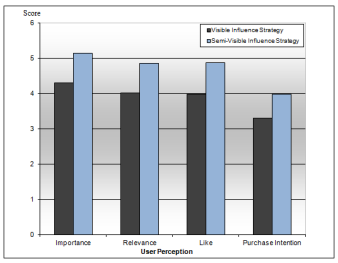

Fig. 6. The effects of the visibility of the influence strategies on user perception

3.4 Discussion

The findings of this study provide an insight into the mechanisms of user perception in the context of mobile application recommendations. Multiple conclusions can be drawn from this research. First, the overall persuadability index provides a viable instrument for user profiling through its influence on user perceptions. More persuadable individuals who are generally more likely to accept recommendations and who have a tendency to align with authority expressed higher compliance with persuasive messages as expected. In other words, high persuadable individuals are more likely to develop a positive attitude towards persuasive messages whereas low persuadable individuals are more inclined to develop distrust.

Gender and operating system being used are other instruments that exhibit significant differences on user perception. It is shown that females scored significantly higher on perceived importance, relevance, likeness and purchase intention with remarkably low significance levels. We can assume that females are high persuadables compared to males. A similar comparison on the effects of operating system being used indicate that iOS device owners score significantly higher on purchase intention and relevance whereas there is not a significant difference in terms of importance and likeness dimensions.

The second conclusion we reach is that persuasive messages may result in a concern about the frankness and smartness of the system and may lead to a decline in the users' perception of the system's trustability and hence the users' compliance with persuasive messages. However, the influence strategy deployed in persuasive messages is distinctive in this context. The consensus influence strategy leads to higher compliance levels than the authority influence strategy whereas the authority influence strategy actually worsens the compliance level of the members of the control group that is not subject to any persuasive messages. Additionally, when the persuadability levels are considered, it is demonstrated that the consensus influence strategy leads significantly higher scores for perceived importance and relevance for both high and low persuadables.

The third conclusion is that the compliance level is lower when the persuasive messages are visible to the users compared with the semi-visible persuasive messages. This result is consistent with previous research that noted the users' resistance to persuasion when the persuasion intent is disclosed [5].

4 Conclusion and Future Work

This study is important for its contribution to a recently developing field. There are not many empirical studies conducted in this field especially in mobile application recommendations. This study has provided results that can be used for future research about consumer behavior and the persuasion profiles affecting it. The model and findings may provide a useful framework for business model developers and actors in the mobile application market.

Based on the results reported in this paper, it appears that the use of persuasive messages should be tackled cautiously. On average persuasive messages may decrease the overall user compliance. In our framework, the consensus influence strategy yielded a higher compliance in the persuasion group than the control group that received no treatment. On the contrary, utilizing authority influence strategy decreased user compliance. For user compliance, it does matter how the persuasive messages are presented to the user. Semi-visible persuasive messages effects are higher than the visible persuasive messages. Furthermore, the persuadability of the users is an important determinant on users' compliance with recommendations. When designing recommendation systems for users these findings can be used to increase the efficiency of the system.

References

1. Fogg, B. J. Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann (2003)
2. Oinas-Kukkonen, H., Harjumaa, M.: Towards Deeper Understanding of Persuasion in Software and Information Systems. First International Conference on Advances in Computer-Human Interaction, pp. 200–205 (2008) doi:10.1109/ACHI.2008.31
3. Cialdini, R.B.: Harnessing the Science of Persuasion. Harvard Business School Publishing (2001)
4. Torning, K., Oinas-Kukkonen, H.: Persuasive System Design: State of the Art and Future Directions. In: Proceedings of the 4th International Conference on Persuasive Technology (Persuasive '09), Article 30, pp. 1-8. ACM, New York, NY, USA (2009)
5. Fuegen, K. and Brehm, J. W.: The intensity of affect and resistance to social influence, pp. 39–64. Lawrence Erlbaum (2004)
6. Guadagno, R. and Cialdini, R.: Online persuasion and compliance: social influence on the Internet and beyond. The Social Net: Understanding human behavior in cyberspace. Y. Amichai- Hamburger, ed., University Press, Oxford (2005)
7. Snyder C.R, Fromkin H.C.: Uniqueness: the human pursuit of difference. New York: Plenum (1980)
8. Chaiken, S.: Heuristic versus Systematic Information Processing and the Use of Source versus Message Cues in Persuasion. Journal of Personality and Social Psychology, 39, pp. 752-66 (1980)
9. Petty, R.E., Cacioppo, J.T.: Communication and Persuasion: Central and Peripheral Routes to Attitude Change. Springer-Verlag New York Inc, New York (1986)
10. Kaptein, M. C. and Eckles, D. Selecting Effective Means to Any End: Futures and Ethics of Persuasion Profiling. In Ploug, T., Hasle, P., and Oinas-Kukkonen, H., (eds), Persuasive Technology, pp. 82–93. Springer Berlin / Heidelberg (2010)
11. Cacioppo, J. T. and Petty, R. E.: The need for Cognition. Journal of Personality and Social Psychology, vol. 42 (1), pp. 116 (1982)
12. Kaptein, M., Markopoulos, P., de Ruyter, B., Aarts, E.: Can You Be Persuaded? Individual Differences in Susceptibility to Persuasion. In: Gross, T., Gulliksen, J., Kotzé, P., Oestreicher L., Palanque, P., Prates, R.O., Winckler, M. (eds.) INTERACT 2009. LNCS,vol. 5726, pp. 115–118. Springer, Heidelberg (2009)
13. Kaptein, M., de Ruyter, B., Markopoulos, P., Aarts, E.: Adaptive Persuasive Systems: AStudy of Tailored Persuasive Text Messages to Reduce Snacking. ACM Transactions on Interactive Intelligent Systems, vol. 2 (2), pp. 10-1/25 (2012)

14. Kaptein, M., Lacroix, J., Saini, P.: Individual differences in persuadability in the health promotion domain. Persuasive Technology, pp. 94-105. Springer Berlin Heidelberg (2010)
15. Adomavicius, G., Tuzhilin, A.: Toward the Next Generation of Recommender Systems : A Survey of the State-of-the-Art and Possible Extensions, 17(6), pp. 734–749 (2005)
16. Yan, B., Chen, G.: Appjoy: Personalized Mobile Application Discovery, in Proc. of MobiSys '11, pp. 113–126 (2011)
17. Zaichkowsky, J. L.: Measuring the Involvement Construct. Journal of Consumer Marketing Research, vol.12, pp. 341-352 (1985)
18. Batra, R. and Michael L. R.: Affective Responses Mediating Acceptance of Advertising, Journal of Consumer Research, vol.13 (2), pp. 234-249 (1986)

Exploring the Persuasiveness of Behavior Change Support Strategies and Possible Gender Differences

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Abstract. There is need to investigate the persuasiveness of various health behavior promoting strategies that are commonly employed in behavior change interventions design with respect to possible gender effect. Behavior change researchers have advocated the need to adapt persuasive approaches to various user characteristics. Gender has been identified to influence behavior in many domains. Therefore, this paper presents a comparative study investigating the perceived persuasiveness of health behavior promotion applications depicting ten commonly employed behavior change strategies. The population of interest are males and females and the purpose of the study is to investigate differences in persuadability and the perceived persuasiveness of behavior change strategies overall. To achieve this, we conducted a large-scale study on 1108 participants (575 males and 533 females) to examine the persuasiveness of ten strategies that are commonly employed in health behavior change intervention design. We also examined possible gender effects on the persuasiveness of various strategies. The results of the analysis show that some of the strategies studied are highly persuasive overall, while others were rated low in persuasiveness. The results also suggest that males and females differ significantly in persuadability – with females being more receptive to most of the behavior change strategies. Some strategies are more suitable for persuading one gender than the other. We therefore conclude that gender-dependent approaches would generally be more appropriate for designing behavior change support systems that will effectively promote health behavior change than the one-size-fits all approach.

Keywords: Persuasive Technology, Behavior Change, Gender, Persuasive Strategies, Persuasiveness, Health Behavior, PSD, health intervention, mhealth, health.

1 Introduction

Recent years have witnessed an increasing number of lifestyle-related health problems. Research has shown that adoption of healthy behavior can prevent or at least reduce the risk of many diseases, including obesity, heart disease, and type 2 diabetes [34]. It is, therefore, not surprising that interventions aimed at modifying health behavior have been identified as a major solution to these health conditions

[16]. As a result, research on how to design technology to motivate behavior change is a key area of inquiry of Behavior Change Support Systems (BCSSs) research within the Persuasive Technology (PT) community. Research has shown the potential of behavior change support systems to motivate healthy behavior – help people achieve personal wellness, manage diseases, and engage in preventive behaviors [6,11,14,22] using several persuasive strategies.

Over the years, several persuasive strategies have been developed [9,20]. However, many of these strategies are conjecture and their effectiveness have not been validated on a large-scale study while few of them have only been qualitatively evaluated – with systematic validation. As a result, most of the BCSSs assume a one-size-fits-all approach with respect to their choice of behavior change strategies to employ in their intervention design. This is based on the assumption that the strategies are equally persuasive and would similarly motivate people to change their behavior. However, people differ in motivation; a strategy that motivates one type of person to change her behavior may actually deter behavior change for another type of person [15]. Therefore, designing a technology that will inspire a positive user experience and effectively motivate health behavior change requires adapting the strategies based on the knowledge of their persuasiveness. Research has shown that tailoring behavior change strategies would increase the effectiveness of behavior change support systems in the domain of health [15]. According to Berkovsky et al. [2], tailoring persuasive strategies has a "huge untapped potential to maximize the impact of persuasive applications". The success of different BCSSs will be partly dependent on the persuasiveness of the strategies employed in their design and the appropriateness of the strategies for the target users or user group. However, research on tailoring behavior change strategies based on the knowledge of their persuasiveness is just beginning.

In choosing approaches for group-based tailoring, research has shown that gender is a reliable approach [26]. Research has also established gender differences in many areas including the perception of different behavior determinants [26], gameplay, and health behavior [7]. However, whether or not gender influences the persuasiveness of various behavior change strategies as highlighted by the Persuasive System Design (PSD) framework [20] has not been examined. Investigating the persuasiveness of these strategies and how they are perceived by different gender group is necessary to aid tailoring BCSS to the various gender groups to increase their effectiveness at achieving their intended objective of motivating behavior change.

Therefore, this paper investigates the persuasiveness of various behavior change strategies and possible gender differences in the persuasiveness of the strategies. We achieve this by comparing the effectiveness of ten PT strategies – *competition, comparison, cooperation, customization, personalization, praise, simulation, Self-monitoring* and *Feedback, suggestion,* and *reward* (from Fogg [9] and Oinas-Kukkonen [20]) – within and across the gender groups. The results of a large-scale study of 1108 participants (575 males and 533 females) suggest that males and females differ significantly in persuadability – with females being more receptive to most of the PT strategies. The study also provides a quantitative validation of the persuasiveness of the strategies overall. Some of the

strategies are perceived as highly persuasive by the participants overall, while others were scored low in persuasiveness with respect to their efficacy to motivate healthy behavior change. Yet, some of the strategies are intermediately persuasive.

2 Background

Over the years, a number of strategies for designing behavior change support systems have been developed. For example, Fogg [9] developed seven persuasive tools, and Oinas-Kukkonen [20] built on Fogg's strategies to develop 28 persuasive system design principles. These strategies are often applied in combinations when incorporated in actual software [13]. Therefore, it is common practice for researchers in persuasion to select a combination of strategies from various authors to inform their design. The choice of the strategies based on their persuasiveness and their suitability for particular users or user group are often based on a designer's own intuition, making it difficult to tailor strategies to users or user groups.

Considering that the large number of PT strategies in existence today cannot be exhausted in a studio, in this paper, we adopt 10 strategies (from Fogg and Oinas-Kukkonen). *Personalization* offers system-tailored contents and services to its users, tailoring content and functionality to a particular user's need based on a user's characteristics. For a detailed discussion of the strategies see [20]. *Simulation* provides the means for a user to rehearse the behavior and to observe the cause-and-effect linkage of their behavior. It is one of the rarely employed strategies in health game design. *Self-monitoring* allows people to track their own behaviors, providing information on both past and current states. It is one of the most common strategies for healthy eating and physical activity motivating applications [3,32]. The *Suggestion* strategy suggests certain tasks (for achieving favorable behavior outcomes) to users during system use. *Praise* applauds the user for performing the target behavior via words, images, symbols, or sounds as a way to give positive feedback to the user (for example in [1,30]). *Reward* offers virtual rewards to users for performing the target behavior. It is one of the commonly employed strategies [25]. *Competition* allows the user to compete with others. *Comparison* provides a means for the user to view and compare his/her performance with the performance of other user(s). Competition, and Comparison are included among the commonly used strategies. *Cooperation* requires users to cooperate (work together) to achieve a shared objective and rewards them for achieving their goals collectively. *Customization* is a strategy that provides the user an opportunity to adapt a system's contents and functionality to their needs or choices. These strategies have been employed in the design of several health behavior change support systems (for examples, see [3,15,25,30]).

3 Study Design and Methods

For the purpose of this study, we chose to focus on common application of behavior change technology to ensure uniformity: behavior change technology

for encouraging healthy eating behavior. Through a review of related work in designing behavior change support systems, we established a comprehensive list of persuasive strategies and how they have been operationalized in behavior change support systems. Storyboards provide a common visual language that individuals from diverse backgrounds can read and understand [18]. Considering that we cannot exhaustively study the large number of behavior change strategy from the literature, we selected 10 commonly employed – *competition, comparison, cooperation, customization, personalization, praise, simulation, Self-monitoring* and *Feedback, suggestion,* and *reward* (from Fogg [9] and Oinas-Kukkonen [20]). Recent reviews also identified these strategies among the commonly used PT strategies in persuasive systems design [17,35]. However, it is important to note that these ten strategies are not more important than the rest and may not be representative of all strategies.

To collect data for our model, we follow the approach described by Halko and Kientz [12]. Specifically, we represented each behavior change strategy in a storyboard. Although we could implement the individual strategies and then evaluate their persuasiveness in actual BCSS, we chose to use storyboards because actual implementation may create additional noise as it involves many other design decisions and the results can easily be biased by specific implementation decisions. The storyboards show a character and his/her interactions with a persuasive application for promoting healthy eating. The ten storyboards were drawn by an artist and were based on storyboard design guidelines by Truong et al. [31]. Figure 1 shows examples of two of the ten used persuasive strategies, *reward and self-monitoring*. Prior to assessing the persuasiveness of the various strategies, we ensured that the participants understood the strategy depicted in each storyboard by asking them two comprehension questions – first, to identify the illustrated strategy from a list of ten different strategies; and second, to describe what is happening in the storyboard in their own words. To elicit feedback on the persuasiveness of the strategies, each storyboard was followed by a validated scale consisting of four questions for measuring perceived persuasiveness, adapted from Drozd et al. [8]. Specifically, we asked participants the following questions after they have successfully answered the comprehension questions that show that they understood the strategy depicted in the storyboard:

Imagine that you are using the system presented in storyboard above to track your daily eating, on a scale of 1 to 7 (1-Strongly disagree and 7-Strongly agree), to what extend do you agree with the following statements:

a. The system would influence me.

b. The system would be convincing.

c. The system would be personally relevant for me.

d. The system would make me reconsider my eating habits.

The questions were measured using participant agreement with a 7-point Likert scale ranging from "1 = Strongly disagree" to "7 = Strongly agree".

To eliminate possible bias due to the ordering of the storyboards in the survey, we used a Latin Square to balance the order of presentation of the persuasive strategies. We created ten surveys that varied the position of each strategy and randomly assigned participants to one of the ten surveys.

We recruited participants for this study using Amazon's Mechanical Turk (AMT). AMT has become an accepted method of gathering users' responses [19]. It allows access to a global audience at a relatively low cost, and ensures efficient survey distribution, and high quality results [4,19]. We followed the recommendations for performing effective studies on the AMT by Mason and Suri [19], and used a similar approach to the one described by Halko and Kientz [12]. The study took an average of an hour to complete. Before the main study, we conducted pilot studies to test the validity of our study instruments.

A total of 1384 participants responded to our study. A total of 1108 valid responses were retained and included in the analysis. The participants demographic information is summarized in Table 1. In general, our participants are fairly distributed across the gender groups. With respect to age and education level attained, we have a diverse population.

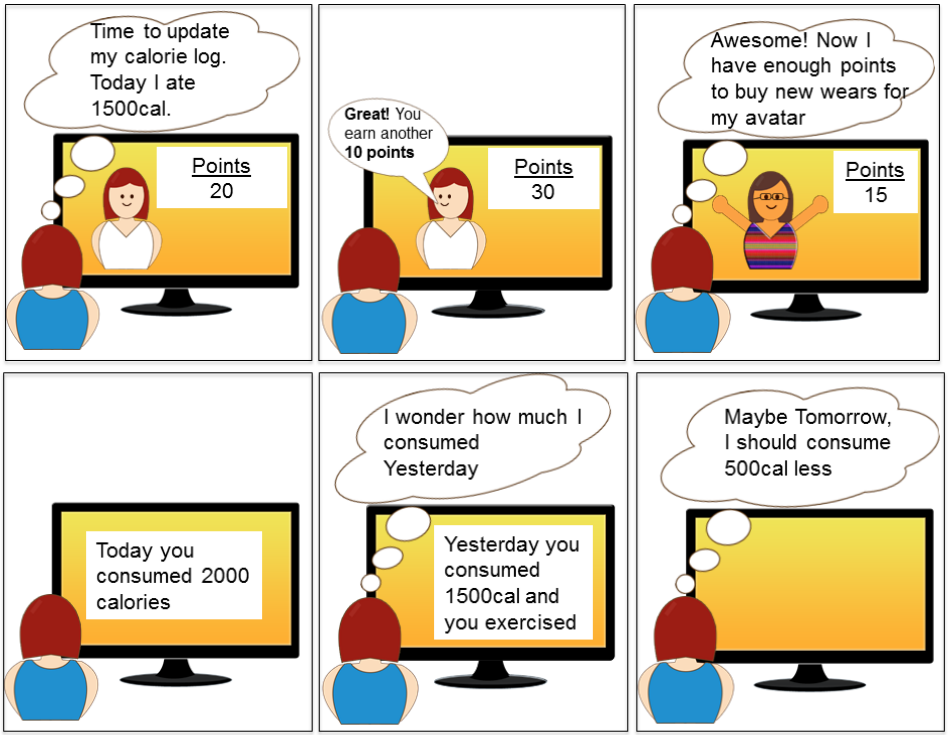


Figure 1: Storyboard illustrating reward and self-monitoring strategy

Table 1: Participants' demographic information

Total Participants = 1108	
Gender	Females (533, 48%), Males (575, 52%)
Age	18-25 (418, 38%), 26-35 (406, 37%), 36-45 (168, 15%), Over 45 (116, 10%).
Education	Less than High School (12, 1%), High School Graduate (387, 35%), College Diploma (147, 13%), Bachelor's Degree (393, 35%), Master's Degree (141, 13%).

4 Data Analysis and Results

We begin our analysis by validating our study instrument. First, to ensure that participants understood the intended persuasive strategy in each of the storyboards, we ran chi-squared tests on the participants' responses to the multiple-choice questions that required them to identify the represented persuasive strategy for each of the storyboards. The results for all the strategies were significant at $p<.001$. Second, we determined the consistency of the scale using Cronbach's alpha (α). The α for the strategies were all greater than 0.70 showing that the scales have good internal consistency. Third, to determine whether responses to each strategy were unique in our data, we performed Exploratory Factor Analysis (EFA), which showed that self-monitoring and suggestion loaded into one factor and competition and comparison loaded into one factor as well. Hence, the total number of factors examined in this study was reduced from ten to eight. Next, we examine the persuasiveness of the strategies.

Alongside examining the differences in perceived persuasiveness between males and females, validating the overall persuasiveness of the individual strategies for promoting healthy behavior is of interest. To achieve this, we performed one-sample t-test separately on the data for males and females and on the combined data – to obtain an overall persuasiveness of the strategies. We compared this data against a neutral rating for the perceived persuasiveness scale of 4. Figure 2 and Table 2 present the details of the overall persuasiveness of the individual strategies.

In general, participants perceived most of the strategies as persuasive. Specifically, all the strategies apart from reward and customization were perceived as persuasive. Customization is significantly below the neutral rating of 4 making it the least persuasive among all the strategies studied, Table 2. On the other hand, personalization and simulation emerged as strategies that are perceived as most persuasive (capable of motivating health behavior change) with mean ratings quite high and well above the neutral rating of 4, with mean differences close to 1 – see Figiure 2 and Table 2.

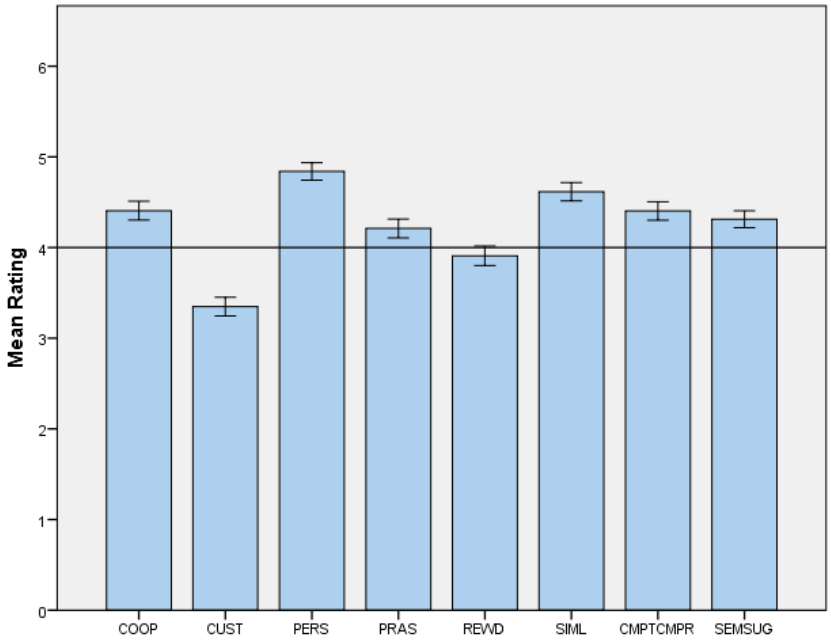


Figure 2: A bar graph of the mean of individual strategies showing their overall persuasiveness. Error bars represent a 95% confidence interval.

Table 2: Mean and Standard Deviations (SD), Mean Difference (MD), t-values (t_2), and significant levels for the individual strategies on a scale from 1(low) to 7(high) for overall persuasiveness.

	N = 1108				
	Mean	SD	MD	t_2	p
COOP	4.40	1.76	0.41	7.69	<.0001
CUST	3.35	1.75	-0.65	12.38	<.0001
PERS	4.84	1.64	0.83	17.04	<.0001
PRAS	4.22	1.75	0.21	4.01	<.0001
REWD	3.91	1.82	-0.09	1.67	<.0960
SIML	4.62	1.72	0.62	11.88	<.0001
CMPTCMPR	4.40	1.72	0.40	7.81	<.0001
SEMSUG	4.31	1.59	0.31	6.57	<.0001

With respect to gender differences, males and females perceived most of the strategies as persuasive, see Figure 3 and Table 3. Similar to the general group, personalization and simulation emerged as the most persuasive strategies that is capable of motivating health behavior change for both males and females. Customization is significantly below the neutral rating of 4 – making it the strategy that is perceived as least persuasive for both males and females. Reward on the other hand is a borderline strategy – that is exactly equal to the neutral rating of 4 – for females while it is below the neutral rating of 4 for males and therefore listed among the least persuasive together with customization for males – Figure 2 and Table 2.

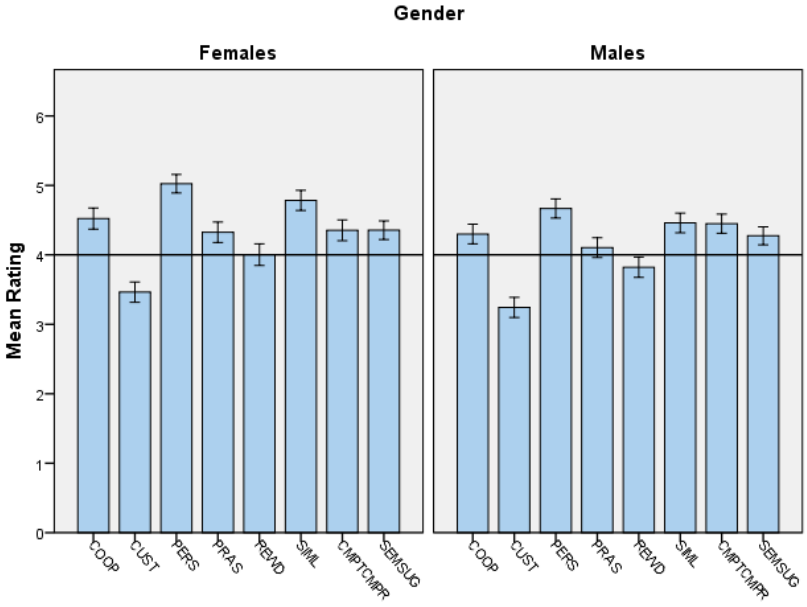


Figure 3: A bar graph of the mean of individual strategies showing their persuasiveness for males and females. Error bars represent a 95% confidence interval.

Table 3: Means and Standard Deviations (SD), Mean Difference (MD), t-values (t_2), and Significant levels (p) of the persuasiveness rating of the ten strategies on a scale from 1 (low) to 7 (high) for females and males separately.

	N = 533					**N = 575**				
	Females					**Males**				
	Mean	SD	MD	t_2	p	Mean	SD	MD	t_2	p
COOP	4.52	1.79	0.52	6.73	<.000	4.30	1.73	0.30	4.16	<.0001
CUST	3.46	1.71	-0.54	7.25	<.000	3.24	1.78	-0.76	10.19	<.0001
PERS	5.02	1.57	1.03	15.04	<.000	4.66	1.68	0.67	9.52	<.0001
PRAS	4.33	1.74	0.33	4.31	<.153	4.10	1.75	0.10	1.43	<.0001
REWD	4.00	1.84	0.00	0.041	<.017	3.82	1.79	-0.18	2.39	<.967
SIML	4.78	1.70	0.78	10.62	<.000	4.46	1.73	0.46	6.39	<.0001
CMPTCMPR	4.35	1.76	0.36	4.64	<.000	4.45	1.68	0.45	6.42	<.0001
SEMSUG	4.36	1.59	0.35	5.17	<.000	4.27	1.59	0.27	4.15	<.0001

COOP = cooperation, CUST = customization, PERS = personalization, PRAS = praise, SIML = simulation, REWD = reward, CMPTCMPR = competition and &comparison, SEMSUG = self-monitoring and suggestion.

4.1 Interaction Between Gender and Behavior Change Strategies

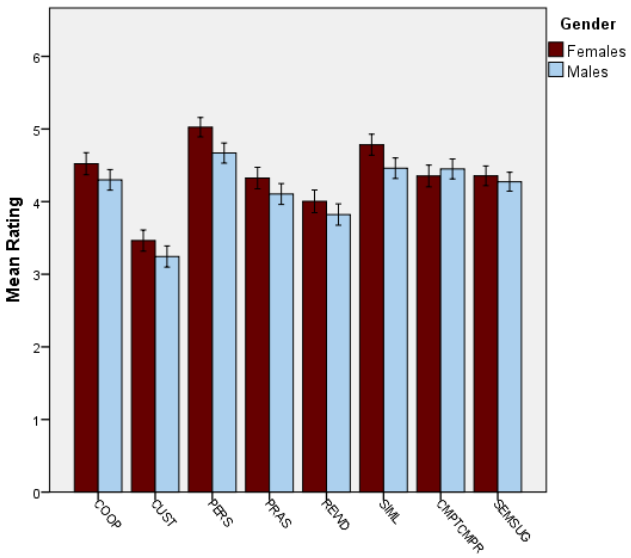
From the t-test, we established that both males and females perceive some strategies as highly persuasive (e.g., personalization and simulation) while other strategies (e.g., customization) scored low in the persuasiveness scale. However, the magnitudes of persuasiveness rating for the individual strategies were different, suggesting possible differences in the persuasiveness of the strategies for males and females – Table 3. To explore for significant differences between males and females with respect to the persuasiveness of various strategies, we performed the Repeated-Measure ANOVA (RM-ANOVA) on our data. Specifically, we examine the effect of gender on the persuasiveness of the various PT strategies using RM-ANOVA in SPSS 21. The analysis was performed after validating our data for ANOVA assumptions, with no violations. When the sphericity assumption was violated, we used the Greenhouse-Geisser method of correcting the degrees of freedom. Pairwise comparison used the Bonferonni method of adjusting for multiple comparisons.

The results of the RM-ANOVA show significant main effects of strategy ($F_{6.05,6687.58}$=184.718, p≈.000, η^2=.143) and gender ($F_{1,1106}$= 5.331, p≈.021, η^2=.005) on persuasiveness (see Table 4 and Figure 4). Overall, females rated the strategies as more persuasive than males, however; there was also a significant strategy by gender interaction on persuasiveness ($F_{6.05,6687.58}$=4.463, p≈.000, η^2=.004). Pairwise comparisons show that females found five out of the eight strategies significantly more persuasive than males: personalization ($F_{1,1106}$=13.153, p≈.000, η^2=.012); simulation ($F_{1,1106}$=9.831, p≈.002, η^2=.009); cooperation ($F_{1,1106}$=4.418, p≈.036, η^2=.004); customization ($F_{1,1106}$=4.386, p≈.036, η^2=.040); and praise ($F_{1,1106}$=4.428, p≈.036, η^2=.004).

Table 4: Mean and Standard Deviations (SD) for the strategies by gender. Bolded means are significantly different across males and females.; p<. 05.

Strategies	**CMPT/ CMPR**	**COOP**	**CUST**	**PERS**	**PRAS**	**SEM SUGG**	**SIML**	**REWD**
	mean(SD)	mean(SD)	mean(SD)	mean(SD)	mean(SD)	mean(SD)	mean(SD)	mean(SD)
Males	4.45(1.68)	**4.30(1.73)**	**3.24(1.79)**	**4.67(1.68)**	**4.10(1.75)**	4.27(1.58)	**4.46(1.73)**	3.82(1.79)
Females	4.35(1.76)	**4.52(1.79)**	**3.46(1.71)**	**5.02(1.57)**	**4.33(1.74)**	4.36(1.59)	**4.78(1.70)**	4.00(1.84)
COOP = cooperation, CUST = customization, PERS = personalization, PRAS = praise, SIML = simulation, REWD = reward, CMPTCMPR = competition and &comparison, SEMSUG = self-monitoring and suggestion.								

Figure 4: Paired mean of individual strategies by gender group. Error bars represent a 95% confidence interval.



5 Discussion

This study presents the results of a large-scale evaluation of ten persuasive strategies that are commonly employed in developing behavior change support systems. Many of these strategies are conjecture and their effectiveness have not been validated in a large scale study while few of them have only been qualitatively evaluated – with systematic validation. The study presented in this paper provides a quantitative validation of the persuasive strategies and the influence of gender on the persuasiveness of the strategies. To achieve this we represented the individual strategies in a storyboard showing persuasive application for promoting healthy eating and collected quantitative measures from 1108 participants – 533 females and 575 males – using the storyboard. The results of analysis of the data show that as expected, most of the strategies are perceived as highly persuasive by the participants overall, while others were scored low in persuasiveness with respect to their efficacy to motivate healthy behavior change.

5.1 Comparing the Persuasiveness of the Strategies by Males and Females

The results show that males and females differ with regard to their perceived persuasiveness of five out of the eight strategies examined in this paper. Surprisingly, females perceive five strategies: cooperation, customization, personalization, praise, and simulation as being more persuasive than males –

Table 4 and Figure 4. Below, we discuss these results with respect to the persuasiveness of the strategies.

Personalization and Customization: Personalization and customization represent two different ways of tailoring from literature. Both personalization and customization emphasize tailoring system contents to the user group. However, in personalization the system initiates and control the tailoring to users based on user characteristics – system-controlled tailoring – while in the customization, the user initiates and controls the tailoring – user-controlled tailoring. Although customization strategy is not explicitly included in the PSD model as a persuasive strategy, research has identified it as strategy different from the popular personalization strategy that is listed in the PSD model [27,28]. The result from our study also confirmed that they are in fact different.

While personalization emerged as the most persuasive strategy for both males and females from our study, customization emerged as the least persuasive strategy that may not motivate meaningful behavior change. A possible explanation while customization is perceived as less persuasive than personalization is that most users tend to use only the default system features [29] and tend to dislike systems that require a lot of input from them [24] – customization. Therefore, although, most people would prefer systems that tailor their contents to them, they would prefer a system that does that automatically (personalization) to a system that requires their input – customization. Therefore, behavior change support systems should be designed to require minimal user input for tailoring purposes. This suggests a need for various ways of tracking and sensing users' behaviors automatically to aid system adaptation – personalization.

Fortunately, personalization is among the strategies that are moderately employed in health behavior change systems design [17]. Interestingly, although males and females perceive personalization as highly persuasive, personalization is also a differentiator of males and females. Females perceive both personalization and customization as more persuasive than males.

Simulation: Simulation strategy which deals with providing users opportunity to rehearse their behavior and to observe the cause-and-effect linkage of their behavior emerged as the second highly persuasive strategy that is capable of motivating health behavior change for both males and females. Although simulation is not among the commonly employed persuasive strategies in health behavior promoting applications, the persuasiveness score stresses a need for behavior changing application to include some features that allows people to rehearse and observe the simulated impact of their behaviors both in short and long-term. This is important because the intangible and the gradual nature of achieving the benefit of adopting healthy behaviors are often barriers to adopting healthy behavior. Adopting healthy behavior is a lifestyle than spans over a lifetime with no quantifiable benefit [22], therefore, simulation strategy that allows users to view both immediate and projected impacts of their health behavior may bridge this gap and make the benefit of adopting health behavior more visible and tangible. Similar to personalization and customization, females perceive simulation as more persuasive than males.

Cooperation: According to the PSD framework, "a system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to cooperate."[20]. From the results of our study, females found cooperation more persuasive than males and therefore will be motivated to change their behavior by any behavior change system that employs the cooperation strategy. This is probably because females are more susceptible to social influence, social facilitation [9], and social support [20] and therefore, more inclined to performing the target behavior when they are working together with others than males. This result is in line with research in other domain that found that females generally cooperated and their cooperation unlike males are largely unconditional [33]. Our study is also in line with previous studies that found that social influence is a contributing factor that influence how females perceive their weight and how it affect their behavior [23,26], while it is not significant for males. Unfortunately, cooperation strategy is rarely used in health intervention design [17]. However, cooperation is the third strategy that is perceived as persuasive (after personalization and simulation) for females and therefore should be employed in designing behavior change systems especially those targeting healthy behaviors.

Competition and Comparison: Competition and Comparison are listed as two separate strategies by the PSD model [21]. However, according to our analysis, they belong together. This is understandable considering that in most situations; competition is often a by-product of comparison. Competition/comparison is among the strategy that is frequently used in health behavior change intervention. The results from our study show that competition/comparison is moderately persuasive. According to previous research, males are more inclined to competition and can even be motivated to cooperate to win a competition than females [33]. The results from our study support this finding by showing that competition/comparison is the only strategy that is perceived as more persuasive by males than females (although the difference is not significant). This suggests that employing competition strategy in the design of a behavior change system will motivate behavior change in males than females.

Self-monitoring and Suggestion: Self-monitoring and suggestions are listed as two separate strategies by the PSD model [21]. However, according to our analysis, they belong together. This is understandable considering that effective suggestion would require context awareness (that is often achieved through monitoring) to determine the opportune moments.

Self-monitoring is among the most frequently employed persuasive strategies, especially those aimed at promoting healthy eating behaviors [17]. However, from the results of our study, self-monitoring is intermediately persuasive. This is probably because of the labour intensive nature of current (diet) self-monitoring systems that often requires some level of input from the user to be effective. Self-monitoring is equally persuasive for both males and females.

Praise: According to the PSD model, systems that applaud users for performing the target behavior are more likely to motivate them to adopt healthy behavior [20]. Praise is intermediately persuasive and therefore, can moderately motivate behavior. It is infrequently used in behavior change motivating systems [17]. Males and females differ with respect to the persuasiveness of praise. Females

perceive praise as more persuasive than males. This is probably because females are more inclined to respond to strategies that appeal to emotions than males.

Reward: Reward is the least persuasive strategy after customization. This is probably contrary to popular expectations. Many behavior change systems offer one type of reward or the other to the users to encourage them to perform the behavior. The use of any form of reward to motivate behavior change has been a subject of debate because of the tendency of reward to trivialize the benefit of adopting healthy behavior and make it extrinsically motivated [5,10]. The results from our study show that reward is not all that important a strategy for motivating behavior change and therefore, can be excluded. There is no difference between males and females with respect to the persuasiveness of the reward strategy.

6 Limitation

This study examined the perceived persuasiveness using the storyboards implementation of the strategies, however, actual persuasiveness may be different when implemented and used in actual behavior change support system. Although we use the application for motivating healthy eating as a sample in our storyboards, the storyboards were drawn at a high enough level that it does not encapsulate much of a specific application domain. However, further work is needed to establish the applicability of our result in other domains.

7 Conclusion and Future Work

The study validated that the persuasiveness of various persuasive strategies in use today (which have not been validated in large-scale studies). The results suggest that these strategies could be employed to design behavior change support systems to motivate healthy behavior change overall. We also establish that gender influences the persuasiveness of the strategies. Specifically, males and females differ with regard to the perceived persuasiveness of five out of the eight strategies examined in this paper. Surprisingly, females perceive five strategies: cooperation, customization, personalization, praise, and simulation as being more persuasive than males. This implies that females can be more easily persuaded using these strategies. It also suggests that females are more persuadable than males with respect to the influence of the strategies on their behavior. The gender-related differences across a number of strategies also suggest that gender-dependent approaches would generally be more appropriate for designing behavior change support systems that will effectively promote health behavior change than the one-size-fits all approach.

In general, regardless of gender, personalization and simulation emerged as the most persuasive (significantly different from all other strategies), whereas reward and customization were the least persuasive (also significantly different from all others). The rest of the strategies – competition/ comparison, cooperation, self-monitoring, and praise – were in the middle with competition/comparison and cooperation leading the group.

Future work should examine the applicability of our result in other domains by examining the persuasiveness of the strategies using application from other domains. Research should also design and compare the effectiveness of behavior change support systems designed using strategies that are listed as highly persuasive (personalization and simulation) with those that are scored low in the persuasiveness scale (e.g., reward and customization).

Acknowledgements: The author of this paper is being sponsored by the Natural Sciences and Engineering Research Council of Canada (NSERC) Vanier Graduate Scholarship. Many thanks to the reviewers for their insightful comments.

References

1. Bang, M., Torstensson, C., and Katzeff, C. The PowerHhouse: A Persuasive Computer Game Designed to Raise Awareness of Domestic Energy Consumption. *Persuasive Technology*, (2006), 123–132.
2. Berkovsky, S., Freyne, J., and Oinas-kukkonen, H. Influencing Individually. *ACM Transactions on Interactive Intelligent Systems 2*, 2 (2012), 1–8.
3. Brown, B., Chetty, M., Grimes, A., and Harmon, E. Reflecting on health: a system for students to monitor diet and exercise. *CHI'06 extended abstracts on Human factors in computing systems*, ACM (2006), 1807–1812.
4. Buhrmester, M., Kwang, T., and D, G.S. Amazon's Mechanical Turk A New Source of Inexpensive, Yet High-Quality, Data? *Perspectives on Psychological Science 6*, 1 (2011), 3–5.
5. Colineau, N. and Paris, C. Can Beneficial Habits Be Induced through Reflection ? Workshop on User Models and Motivational Systems: the effective and the rational routes to persuasion, with UMAP'2010., .
6. Consolvo, S., McDonald, D.W., and Landay, J.A. Theory-driven design strategies for technologies that support behavior change in everyday life. *Proceedings of the 27th International Conference on Human factors in Computing Systems*, ACM (2009), 405–414.
7. Dawson, K. a, Schneider, M. a, Fletcher, P.C., and Bryden, P.J. Examining gender differences in the health behaviors of Canadian university students. *The Journal of the Royal Society for the Promotion of Health 127*, 1 (2007), 38–44.
8. Drozd, F., Lehto, T., and Oinas-Kukkonen, H. Exploring perceived persuasiveness of a behavior change support system: a structural model. *Persuasive Technology.*, (2012), 157–168.

9. Fogg, B.J. Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann, 2003.
10. Gneezy, U. and Rustichini, A. Pay Enough or Don't Pay at All*. *Quarterly Journal of Economics 115*, 3 (2000), 791–810.
11. Grimes, A., Kantroo, V., and Grinter, R.E. Let's play!: mobile health games for adults. *Proceedings of the 12th {ACM} International Conference on Ubiquitous computing*, ACM (2010), 241–250.
12. Halko, S. and Kientz, J. Personality and Persuasive Technology: An Exploratory Study on Health-Promoting Mobile Applications. *Persuasive Technology*, (2010), 150–161.
13. Harjumaa, M. Understanding persuasive software functionality in practice: a field trial of polar FT60. *Persuasive Technology*, (2009).
14. Kaptein, M., Duplinsky, S., and Markopoulos, P. Means based adaptive persuasive systems. *Proceedings of the 2011 annual conference on Human Factors in Computing Systems*, (2011), 335.
15. Kaptein, M., De Ruyter, B., Markopoulos, P., and Aarts, E. Adaptive Persuasive Systems. *ACM Transactions on Interactive Intelligent Systems 2*, 2 (2012), 1–25.
16. Lau, D.C.W., Douketis, J.D., Morrison, K.M., Hramiak, I.M., Sharma, A.M., and Ur, E. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne 176*, 8 (2007), S1–13.
17. Lehto, T. and Oinas-kukkonen, H. Persuasive Features in Six Weight Loss Websites : A Qualitative Evaluation. (2010), 162–173.
18. Lelie, C. The value of storyboards in the product design process. *Personal and Ubiquitous Computing 10*, 2-3 (2005), 159–162.
19. Mason, W. and Suri, S. Conducting behavioral research on Amazon's Mechanical Turk. *Behavior Research Methods 44*, 1 (2012), 1–23.
20. Oinas-Kukkonen, H. and Harjumaa, M. A systematic framework for designing and evaluating persuasive systems. *Persuasive Technology*, (2008), 164–176.
21. Oinas-Kukkonen, H. and Harjumaa, M. Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems 24*, 1 (2009), 28.
22. Orji, R., Mandryk, R.L., Vassileva, J., and Gerling, K.M. Tailoring persuasive health games to gamer type. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, ACM Press (2013), 2467–2476.
23. Orji, R., Vassileva, J., and Mandryk, R. Towards an effective health interventions design: an extension of the health belief model. *Online journal of public health informatics 4*, 3 (2012).
24. Orji, R., Vassileva, J., and Mandryk, R.L. Modeling the Efficacy of Persuasive Strategies for Different Gamer Types in Serious Games for

Health. *User Modeling and User Adapted Interaction: Special Issue on Personalization and Behaviour Change*, .

25. Orji, R., Vassileva, J., and Mandryk, R.L. LunchTime: a slow-casual game for long-term dietary behavior change. *Personal and Ubiquitous Computing*, (2012), 10.1007/s00779–012–0590–6.
26. Orji, R.O., Vassileva, J., and Mandryk, R.L. Modeling Gender Differences in Healthy Eating Determinants for Persuasive Intervention Design. *Persuasive Technology 7822*, (2013), 161–173.
27. Sundar, S.S., Bellur, S., and Jia, H. Motivational Technologies: A Theoretical Framework for Desiging Preventive Health Application. *Persuasive technology 7284*, (2012), 112–122.
28. Sundar, S.S. and Marathe, S.S. Personalization versus Customization: The Importance of Agency, Privacy, and Power Usage. *Human Communication Research 36*, 3 (2010), 298–322.
29. Sundar, S.S. and Marathe, S.S. Personalization versus Customization: The Importance of Agency, Privacy, and Power Usage. *Human Communication Research 36*, 3 (2010), 298–322.
30. Toscos, T., Faber, A., An, S., and Gandhi, M.P. Chick clique: persuasive technology to motivate teenage girls to exercise. *{CHI} '06 extended abstracts on Human factors in computing systems*, ACM (2006), 1873–1878.
31. Truong, K., Hayes, G., and Abowd, G. Storyboarding: an empirical determination of best practices and effective guidelines. *DIS*, (2006), 12–21.
32. Tsai, C.C., Lee, G., Raab, F., et al. Usability and Feasibility of PmEB: A Mobile Phone Application for Monitoring Real Time Caloric Balance. *Mobile Networks and Applications 12*, 2-3 (2007), 173–184.
33. Van Vugt, M., De Cremer, D., and Janssen, D.P. Gender differences in cooperation and competition: the male-warrior hypothesis. *Psychological science 18*, 1 (2007), 19–23.
34. Wansink, B. Mindless Eating: Why We Eat More Than We Think. Bantam, 2006.
35. Wiafe, I. and Nakata, K. Bibliographic Analysis of Persuasive Systems: Techniques, Methods and Domains of Application. *Persuasive Technology*, (2012), 61 – 64.

The persuasive role of Explanations in Recommender Systems

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Abstract. Explanations in Recommender Systems can operate like motivators influencing consumers to purchase the recommended items. In this study, we rely upon the well established and verified framework of Cialdini's Influence Principles in order to enrich recommendations with explanations and examine their effect on the persuasive power of recommendations. The results of the experiment revealed that all six Influence Principles positively affect users' perception about the recommended movie while Authority and Social Proof seem to be the more effective ones. These findings indicate that a user's intention to consume a recommended good is increased if the item is accompanied with a persuasive explanation.

Keywords: persuasion, recommender systems, personality

1 Introduction

Recommender Systems elicit users' preferences and interests in order to filter available information and then to provide them recommendations that match their tastes (Xiao and Benbasat, 2007; Bollen et al., 2010; Pu et al., 2012).

The mainstream of research in Recommender Systems has traditionally been focused on their algorithmic aspect and more specifically on the development and evaluation of algorithms that provide accurate recommendations (Xiao and Benbasat, 2007, Pu et al., 2012). The implicit assumption that accuracy of the algorithm is the most significant factor that affects the quality and eventually the acceptance of a Recommender System has been recently challenged since other factors that play also a significant role have emerged (Nanou et al., 2002; Knijnenburg et al., 2012). Such factors based on more user-centric characteristics including recommendation's presentation (i.e. Nanou et al. 2010), the needed effort in order to interact with Recommender System (i.e. Cremonesi et al., 2012), system's transparency or explain to end users how the systems works (i.e. Sinha and Swearingen, 2002; Pu et al., 2011), recommendation's novelty (i.e. Pu and Chen, 2011) and persuasion (i.e. Cremonesi et al., 2012). Studies also shown that the majority of the aforementioned factors also affect the persuasive ability of a recommendation defined as '*the attempt of changing people's attitudes or behaviours or both*' (Fogg, 1998). An important aspect of recommendation that

may influence its acceptance by a user is explanations (Herlocker, 2000; McSherry, 2005). Additionally, Tintarev and Masthoff (2011, 2012) specify that explanations have six main aims, one of whom is persuasion.

The aim of this study is to investigate if certain persuasive strategies (applied in the form of recommendation explanations) can affect user's adoption of recommendations. The rest of the paper is organized in five sections. The persuasive role of explanations is detailed in Section 2. We explain the importance of explanations is Recommender Systems as well as the role of persuasion. Our experiment is presented in Section 3, while in Section 4 the experimental results are discussed. In Section 5 we present the main conclusions of this research and proposals for future work.

2 The persuasive role of explanations

Explanations in Recommender Systems

An explanation can be considered as any type of additional information accompanying a system's output, having as ultimate goal to achieve certain objectives (Tintaver and Masthoff, 2011). One of the aims of explanations according to Tintaver and Masthoff (2011) is to persuade users to try or purchase the item that is recommended. In general, persuasion can lead a person to change his/her attitudes or adopt behaviours that lead to a better lifestyle (Guadagno and Cialdini, 2007). For instance, a smoker needs to be persuaded in order to quit smoking. According to Fogg (2003), there are two level of analysis in the design and study of computers as persuasive technologies: Macrosuasion and Microsuasion. In Macrosuasion the whole unit of the product has as ultimate goal to persuade. For example websites, such as Amazon.com, are designed in order to persuade customers to consume goods. In Microsuasion the products do not have as ultimate goal to persuade but to increase productivity or user's loyalty (e.g video games that they aim at entertaining not persuading).

Tintarev and Masthoff (2012) indicate that explanations have an important role on Recommender Systems since an explanation is a mean through which a consumer perceives the value of the recommended item so as to decide whether is close to his/her interests or not. In other words, this item description facilitates user's decision making. Explanations can operate like motivators and are being used by several systems such as MovieLens (Herlocker et al., 2000) and Social software items (Guy et al., 2009). However, there is no clear indication in extant literature about what type of explanations can actually lead to persuasion and at what extend. For example, transparency of recommendations (i.e. a description of how the recommendation has emerged) is associated with an increase of trust in recommendations (Herlocker, 2000) while still there is no enough empirical evidence that demonstrates what type of influence strategy could lead to persuasion (Halko and Kientz, 2010).

2.1 Persuasion

The first who talked about persuasion is Aristotle in Rhetoric, claiming that the elements that play important role on the procedure of persuasion is the ethos/character of the speaker, message's receiver pathos/emotions and logos/argument. Since then, other scholars have identified factors or principles that can lead to persuasion. For example, Fogg (2002) describes 42 persuasion strategies, Cialdini (2001) 6 Influence Principles (also known as Six Weapons of Influence), while there have been listed more that 160 influence tactics by Rhoads. In this experiment, we rely upon Cialdini's Influence Principles since they have been broadly used and verified (i.e. LeBourveau et al., 1988; Fogg, 2002; Guthrie, 2004). According to Cialdini (2001) if Influence Principles are implemented in a system then they increase its persuasive effect. These Influence Principles include: Reciprocity (humans have the tendency to return favours), Commitment (or consistency: people's tendency to be consistent with their first opinion), Social proof (people tend to do what others do), Scarcity (people are inclined to consider more valuable whatever is scarce), Liking (people are influenced more by persons they like) and Authority (people have a sense of duty or obligation to people who are in positions of authority). Cialdini (1987, 1993) suggested that when a compliance professional (e.g. salesperson) uses six specific psychological principles (Reciprocity, Commitment, Social proof, Scarcity, Liking and Authority) in his/her strategy then (s)he managed to influence more successfully the customer to consume a product/service/information. In the same vein, Kaptein (2012) suggests that applying the influence principles on text messages people get persuaded to reduce snacking consumption.

As indicated before, there is relatively limited research that evaluates persuasion in Recommender Systems and investigates the conditions under which Recommender Systems do have a persuasive effect (e.g. Cosley et al. 2003, Nguyen et al. 2007). In the extant literature, several studies are based on direct constructs in order to measure persuasion in the field of Recommender Systems, such as transparency (how a Recommender System works) (Nanou et al., 2010; Gretzel and Fesenmaier, 2006), trust towards a Recommender System (Nanou et al., 2010), Recommender System's credibility (Nanou et al., 2010; Ricci et al., 2011; Brinol ans Petty, 2009), cognitive effort in order to acquire a recommendation (Gretzel andFesenmaier, 2006; Cremonesi et al, 2012), recommendations' novelty (recommendations that user does not listen or see before) (Cremonesi et al, 2012), perceived accuracy of recommendations (Cremonesi et al, 2012) and recommendations' presentation (Nanou et al., 2010).

The aforementioned Principles provide a solid framework in order to investigate the persuasive power of explanations in recommender systems. In this study we utilize the above framework in order to develop persuasive explanations and experiment in order to investigate (a) if the applications of these strategies do lead in a change of users behaviour (in term of intention to use a recommendation) and (b) if the power of persuasion differentiates among of the strategies applied.

3 Methodology

The application domain of the study is the movie recommendation which is very popular in the field of Recommender Systems (Alspector et al., 1997; Good et al., 1999; Herlocker et al., 2002; Said et al., 2011; Kim and Oh Park, 2013; Jung, 2012).

The first step for the execution of the experiment was the design of persuasive explanations, following Kaptein's (2012) methodology. Thirty (30) textual explanations were created in total, i.e. five (5) for each Cialdini's Persuasion Principle. The content of each explanation was developed in order to comply with the main purpose of each Persuasion Principle. Then, 17 experts in the field of Information Systems and Marketing were invited in order to evaluate each explanation in terms of their compliance with the respective Persuasion Principle. Finally, the six (6) best-matching explanations (one for each strategy), were used in the experiment (Table 1).

Table 1. Best-matching Explanations on each Influence Strategy

Influence Strategy	Explanations
Reciprocity	A Facebook friend, who saw the movie that you suggested him/her in past, recommends you this movie
Scarcity	The recommended movie will be available to view from 15/1/2014 to 31/1/2014 on cinemas
Authority	The recommended movie won 3 Oscars!
Social Proof	The 87% of users in this survey rated the recommended movie with 4 or 5 stars!
Liking	Your Facebook friends like this movie
Commitment	Watch this movie and you may change your mind about this kind of movies

For the purpose of the experiment, a movie recommendation system was developed. At the first step of the experiment, participants evaluated (through 1-5 ratings) a set of 20 movies (Picture 1), in order to have an adequate number of ratings for each user to produce recommendations based on the collaborative filtering algorithm For each movie the information presented included the movie's category, its plot, and the starring actors. If they had not already seen the movie, they chose the option 'I have not seen the movie and my intention to see it is:' on a dropdown box, otherwise they chose the second option which is 'I have seen this movie and my rating is:'. In both cases users inserted a rating, expressing their intention to see the movie (first option) or their actual evaluation for the movie they have seen (second option).

Picture 2. The first step of the experiment. For each movie the title, image and genre, a short description and participating actors are provided. In addition, a dropdown menu enables users to state whether they have seen or not the movie, in order to distinguish the ratings that express intention to see the movie from the ratings that express actual evaluation of a movie that the user has seen in the past.

At the second step, the Recommender System provided a "least matching" recommendation enriched with persuasive explanations. More specifically, a collaborative filtering algorithm was implemented and produced estimation of ratings for each of the items that the user has declared that he/she has not seen in the past. In order to ensure the proper selection of items to be recommended, the ratings estimated by the algorithm were cross-checked with the actual ratings that the user provided at the first step of the process (expressing actually his intention to see the specific movie). In order to be able to measure any differences in users' intention to watch the movie stemming from the use of persuasive explanations, the users were recommended items with low ratings (i.e. low intention to watch the movie), i.e. "least matching" recommendations. This choice enable us to record "behaviour change" more easily since in computational terms it is much easier to identify changes in intentions from the lower to the higher levels of the 1-5 scale.

As mentioned above, the recommended movie was enriched with persuasive explanations, based on Cialdini's Principles (the explanations from the first level

of the study) and was reassessed from participants in order to examine whether (and which) strategies influenced users in order to change their intention to watch the recommended movie or not. Each strategy was evaluated separately (through 1-5 rating). The difference between the initial rating at the first step and the rating on each strategy denotes the persuasive effect of every strategy.

4 Results

In total 148 users participated in the experiment. Participants were invited through posts or personal messages on social media. The analysis of data was held using the statistical software SPSS. First, we examined if users' behaviour changed by comparing the averaged value of the initial rating that users provided for the movie that was finally recommended to them with the average value of the ratings after the application of the influence strategies. The results demonstrate that on average there is statistically significant change in user's intention to watch the movie. In order to identify which strategies perform better in terms of persuasiveness, paired t-tests were used upon the differences between the initial rating and the one for each strategy. The results (Table 2) indicated that explanations based upon the strategies Authority and Social Proof have proven to be more effective compared to the other strategies.

Table 2. Paired t-test was used to examine significance, where 0.05 is set as the threshold for p-value to evaluate the significance and p-value lower than 0.001 indicates strong significance.

	Scarcity	Authority	Social Proof	Liking	Commitment
Reciprocity	0.173	<0.001	<0.001	0.002	0.001
Scarcity		<0.001	<0.001	<0.001	<0.001
Authority			0.116	<0.001	<0.001
Social Proof				<0.001	<0.001
Liking					0.353
Commitment					

5 Conclusions and Discussion

The ultimate role of a Recommender System is to provide items that match consumers' preferences and interests. A question that comes forth is what happens when a system recommends a product/service/information that the user does not like it at all, or in other words the recommendation algorithm has low accuracy. The present experiment reveals that even if a consumer has low intention to accept a recommendation, the application of an appropriate influence strategy in the form of explanation can significantly increase the adoption of the recommendation. More specifically, the Influence Principles of Authority and

Social Proof revealed as the most powerful principles. They increased participants' intention to consume a recommended item to a great extent even if this item is not of their interests. This is not surprising, since people have learned from their early life to follow rules, authority's suggestions and in general someone who is expert on a particular subject. Moreover, since we are sociable beings then is expected to be influenced from other people. If a mass of people has a particular behaviour then the unit is more likely to follow the mass in case it has not form an opinion about a particular situation, in our case has not seen the movie.

Certainly, the study presented in this paper has limitations. First, the sample size is rather small to derive conclusive results. Further extension of the experiment to a larger and more diverse group of user will provide additional validity support to the findings. Furthermore, the above results provide insights only for the movie recommendation domain, in which the recommended items (movies) present certain characteristics that are not applicable to other domains (e.g. other product categories).

In this study we focused on movies that users were actually not interested in. This served our purpose to safely measure differences in the users' intention to watch. However, users expect items similar to their interests to be proposed by a recommender system, and therefore the potential effect of such expectation must be controlled and measured. In our future research we plan to apply the same experimental process on items where users have expressed high levels of intention to use and compare the findings with the ones of the present study (on items with low intention to use).

We must also acknowledge that enhancing the influence of recommendations utilizing the influence principles should not violate the basic purpose of recommender systems, i.e. to support users in their decision making process and not act as marketing/promotional vehicles. As part of our future research we aim to measure the users perception on this type of explanations and examine the impact of the influence principles on the perceived effectiveness of the recommendations.

Acknowledgments. This research has been partially funded by the "Action I – Research Support Program – Athens University of Economics and Business", 2013-2015.

References

1. Alspector, J., Koicz, A., Karunanithi, N.: Feature-based and Clique-based User Models for Movie Selection: A Comparative Study. User Modeling and User-Adapted Interaction, 7, 279–304 (1997).

2. Bollen, D., Knijnenburg, B. P., Willemsen, M. C., Graus, M.: Understanding choice overload in recommender systems. Proceedings of the fourth ACM conference on Recommender systems, 63-70 (2010)
3. Briñol, P.,Petty, R.E.:Persuasion: Insights from the Self-Validation Hypothesis. In Mark P. Zanna, editor: Advances in Experimental Social Psychology, Vol. 41, Burlington: Academic Press, pp. 69-118 (2009)
4. Cialdini, R. B.: Compliance principles of compliance professionals: Psychologists of necessity. In M. P. Zanna, J. M. Olson,&C. P. Herman (Eds.), Social influence: The Ontario symposium (Vol. 5, pp. 165- 184). Hillsdale, NJ: Lawrence Erlbaum (1987)
5. Cialdini, R. B.: Influence: Science and practice (3rd ed.). New York: HarperCollins (1993)
6. Cialdini RB. Influence, Science and Practice, Allyn & Bacon, Boston (2001)
7. Cremonesi, P., Garzotto F., Turrin, R.: Investigating the Persuasion Potential of Recommender Systems from a Quality Perspective: An Empirical Study. ACM Trans. Interact. Intell. Syst., 2(2), 11:1–11:41 (2012)
8. Cosley, D., Lam, S.K., Albert, I., Konstan, J. A., Rield, J.: Is seeing believing?: how recommender system interfaces affect users' opinions. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 585-592 (2003)
9. Cremonesi, P., Garzotto F., Turrin, R.: Investigating the Persuasion Potential of Recommender Systems from a Quality Perspective: An Empirical Study. ACM Trans. Interact. Intell. Syst., 2(2), 11:1–11:41 (2012)
10. Fogg, B.J.: Persuasive computers: Perspectives and research directions. In: Proceedings of the SIGCHI conference on Human factors in computing systems CHI ’98 (1998)
11. Fogg, B. J. (2002) Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann.
12. Fogg, B. J., Cuellar, G., Danielson, D.: Motivating, influencing, and persuading users. The human-computer interaction, pp 133-147 (2002)
13. Good, N., Schafer, J. B., Konstan, J. A., Borchers, A., Sarwar, B., Herlocker, J., Riedl, J.: Combining Collaborative Filtering with Personal Agents for Better Recommendations. In Proceedings of AAAI(American Association for Artificial Intelligence), Orlando, Florida (1999)
14. Gretzel, U., Fesenmaier, D.R.: Persuasion in Recommender Systems. International Journal of Electronic Commerce, International Journal of Electronic Commerce, 11(2), 81-100 (2006)
15. Guadagno, R.E, Cialdini, R. B.: Persuade him by email, but see her in person: Online persuasion revisited. Computers in Human Behavior, 23, pp 999-1015 (2007)

16. Guthrie, C.: Influence: Principles of Influence in Negotiation. Marquette Law Review (2004)
17. Guy, I., Zwerdling, N., Carmel, D., Ronen, I., Uziel, E., Yogev, S., Ofek-Koifman, S.: Personalized recommendation of social software items based on social relations. Proceedings of the third ACM conference on Recommender systems, pp. 53-60 (2009)
18. Halko, S., Kientz, J.A.: Personality and persuasive technology: An exploratory study on health-promoting mobile applications. Persuasive technology, pp. 150–161 (2010)
19. Herlocker, J.L., Konstan, J.A., Riedl, J.,: Explaining collaborative filtering recommendations. CSCW 2000: 241-250 (2000)
20. Herlocker, J., Konstan, J. A., Riedl, J.: An Empirical Analysis of Design Choices in Neighborhood-Based Collaborative Filtering Algorithms. Information Retrieval, 5 (4), 287-310 (2002)
21. Jung, J. J.: Attribute selection-based recommendation framework for short-head user group: An empirical study by MovieLens and IMDB. Expert Systems with Applications, 39(4), pp 4049–4054 (2012)
22. Kaptein, M., De Ruyter, B., Markopoulos, P., Aarts, E.: Adaptive persuasive systems: a study of tailored persuasive text messages to reduce snacking. ACM Transactions on Interactive Intelligent Systems (TiiS), 2(2) (2012)
23. Kim, M., Oh Park, S. Group affinity based social trust model for an intelligent movie recommender system, Multimed Tools Applications, pp.505–516 (2013)
24. Knijnenburg, B.P, Willemsen, M. C., Gantner, Z., Soncu, H., Newell, C.: Explaining the user experience of recommender systems. User Model User-Adap Inter, pp. 441–504 (2012)
25. LeBourveau, C. A., Dwyer, F. B., Kernan, J. B.: Compliance strategies in direct response advertising. Journal of Direct Marketing, 2(3), pp. 25-34 (1988)
26. McSherry D.: Explanation in recommender systems. Artificial Intelligence Review, 179-197 (2005)
27. Nanou, T., Lekakos, G., Fouskas, K.: The effects of recommendations' presentation on persuasion and satisfaction in a movie recommender system). Multimedia systems, 16(4-5), 219–230 (2010)
28. Nguyen , H., Masthoff, J., Edwards, P.: Persuasive Effects of Embodied Conversational Agent Teams. Human-Computer Interaction. HCI Intelligent Multimodal Interaction Environments, 4552, pp 176-185 (2007)
29. Pu, P., Chen, L., Hu, R.: E-Commerce product recommendation agents: Use, Characteristics, and impact. Proceedings of the fifth ACM conference on Recommender systems, 157–164 (2011)

30. Pu, P., Chen, L., Hu, R.: Evaluating recommender systems from the user's perspective: survey of the state of the art. User Modeling and User-Adapted Interaction, 22(4-5), 317–355 (2012)
31. Rhoads, K. How many influence, persuasion, compliance tactics & strategies are there? http://www.workingpsychology.com/numbertactics.html.
32. Ricci, F., Rokach, L., Shapira, B.: Introduction to recommender systems handbook. Recommender Systems Handbook, Springer. (2011)
33. Said, A., Berkovsky, S., De Luca, E. W.: Challenge on Context-Aware Movie Recommendation: CAMRa2011. Proceedings of the fifth ACM conference on Recommender systems, pp. 385-386 (2011)
34. Sinha, R., Swearingen, K.: The role of transparency in recommender systems. CHI'02 extended abstracts on Human factors in computing systems. 830–831 (2002)
35. Tintarev, N., Masthoff J.: Designing and evaluating explanations for recommender systems. Recommender Systems Handbook, Springer, p. 479–510 (2011)
36. Tintarev, N., Masthoff J.: Evaluating the effectiveness of explanations. User Model User-Adap Inter. pp.399–439 (2012)
37. Xiao, B., Benbasat, I.:E-commerce product recommendation agents: use, characteristics, and impact. Mis Quarterly, 31(1), 137–209 (2007)

A Reward Design Pattern in BCSS

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Abstract. Although constructs have been developed for designing the features of Behavior Change Support Systems (BCSSs), detailed descriptions and guidelines for their software level implementation are lacking. Through developing software design patterns one is able to examine BCSSs at a more intricate technical level instead of merely a black-box approach to them. In this paper, we present a software design pattern for rewarding users as a way of enhancing persuasive human-computer dialogue in BCSS. The resulting pattern contributes to both research on software design of persuasive system features, and for assisting the practical development of such systems.

Keywords: behavior change supports systems, persuasive technology, persuasive systems design, human-computer dialogue, software design patterns

1 Introduction

Behavior change support systems (BCSSs) have been defined as information systems that form, alter, or reinforce attitudes, behaviors, or acts of complying without using deception or coercion [1]. They can provide solutions for problem areas such as improving health and sustainability. The research into BCSSs focuses on the approaches, methodologies, processes, and tools for their design, as well as their potential effects [1]. There are many features that add to the persuasiveness of a system, such as those contributing to support user's primary task, human-computer dialogue, system credibility or social influence [2]. In this paper we focus on conceptualizing a software design pattern for specifically implementing rewards as a feature of *persuasive human-computer dialogue in BCSSs*. Our study uses the design science research methodology, which includes an iterative process of designing and evaluating a functional IT artifact to produce a solution to the research problem [3].

Although a prominent research area, BCSSs have in prior studies been described at an undetailed technical level [cf. 4–5]. The persuasion context, containing the case-by-case use, user, and technology contexts should be fully regarded when describing a BCSS [2]. Describing systems without knowledge of its internals, or so-called "black-box approach", makes it difficult to argue generalizable results related to systems design [1]. By utilizing more software engineering oriented approaches and tools such as software architectures and software design patterns, BCSS research can be enhanced from proof-of-concepts to concrete software development guidelines. There has been prior research on design pat-

terns for persuasive systems, such as discovering persuasive patterns in social networks and introducing a set of general patterns for influencing user behavior through design [cf. 6–7]. While covering many aspects of persuasive design issues, these patterns have been mostly presented at a generally high conceptual level. We are aiming to reach a more detailed technical view into persuasive systems design by inspecting our patterns also from the object-oriented modeling and code implementation level. This will also make our results presentable to both researchers studying persuasive systems design and practitioners implementing future BCSSs. In this paper we will, based on the background literature on Persuasive Systems Design and software design patterns, present a Reward design pattern for BCSSs.

2 Background

2.1 Rewards in Persuasive Systems Design

Oinas-Kukkonen and Harjumaa's Persuasive Systems Design (PSD) model states that the development of persuasive systems (including BCSSs) requires three steps: understanding the key design issues related to persuasive systems, analyzing the persuasion context, and designing the system qualities [2]. For understanding persuasion in a system, its use, user, and technology contexts should be recognized. The use context covers the characteristics of the problem domain in question, the user context includes the differences between the individuals, and the technology context contains the technical specifications of a system [2]. A lack of precision in describing the technological context has been common in prior studies on BCSSs, making it difficult to understand the persuasiveness of these systems as a whole [1].

Concerning the design of the *software features* of persuasive systems, Oinas-Kukkonen and Harjumaa have proposed four categories of design principles: primary task, dialogue, system credibility, and social support [2]. These design principles may function as guidelines for determining software requirements, as well as an evaluation method for persuasive systems. The dialogue support category contains design principles for system features that concern the dialogue between a system and its users. These features include praise, rewards, reminders, suggestion, similarity, liking and social role. By providing virtual *rewards* a system works as a motivational tool [2]. In this paper we will focus on the rewards feature of persuasive systems.

2.2 Software Design Patterns

Patterns are reusable solutions that can be applied to commonly occurring problems in software design and enable building of systems with good object-oriented design qualities [8]. They do not provide the code, but rather provide solutions to general design problems, which are to be applied to specific applications – a solution to a problem in context. They serve as templates that can be used in different ways for solving problems. Most patterns allow some part of a system to vary independently of all other parts and these varying parts are often encapsulated.

Use of patterns provides a shared language that maximizes the value of communication amongst developers and reduces the time spent on making design decisions related to feature changes and enables reuse of solutions that have previously been effective. Furthermore, they aid in avoiding design alternatives that compromise reusability and they can improve documentation and maintenance of existing systems by providing an explicit specification of class and object interactions and their underlying intent [8–9].

Patterns depict the static and dynamic structures and collaborations of successful solutions to problems–discerning of non-functional features for example–that arise when developing applications within a particular context. Patterns (or their solutions) should be applicable in many different situations without the need to make extensive changes as they provide ways to arrange and categorize relatively mundane solutions in technology-related development projects. According to Gamma et al. [8], patterns have four essential characteristics:

1. The **pattern name** – a common term that eases the communication amongst stakeholders and enables design at a higher abstraction level while simplifying thoughts on designs and communicating these and their trade-off to others.
2. The **problem** describes when a pattern should be applied and its context.
3. The **solution** provides an abstract description of a design problem and how a general arrangement of elements (classes and objects) solves it.
4. The **consequences** are the results and tradeoffs of applying the pattern

According to Buschmann et al. [10], there currently is a common set of well-known generic software patterns but when looking toward future developments, patterns could be more domain-specific and tailored to particular focus areas. Many domain areas such as behavior change support systems are yet to be properly covered by the pattern languages.

3 Reward Design Pattern for BCSSs

Rewards and virtual achievements are powerful motivational tools. A reward system can make the process more enjoyable and help users get pleasure from their tasks [cf. 11–12]. Rewards have an effect on intrinsic motivation, although depending on the way they are delivered [13]. We now present a design pattern for implementing reward features in behavior change support systems. For issuing virtual rewards in a web-based BCSS, the performance of its users must be monitored. This can be efficiently done utilizing the well-known object-oriented *Observer* design pattern [8], which defines and maintains a one-to-many dependency between objects such that a change in one object leads to all its dependents being notified and being updated automatically.

Building on Model-View-Controller (MVC) [14] and Representational state transfer (REST) [15] approaches, we presume that the application's resources are implemented as their corresponding Models, Views, and Controllers with Create, Read, Update, and Delete (CRUD) actions. There are at least two generalizable resource entities that are necessary for a BCSS: the User resource and the Entry resource. The User resource depicts the users of the systems, containing their account information and possible behavioral profiles. The Entry resource is an abstraction of the data that the user submits to the system to monitor her behavioral habits – for example weight measures in a weight monitoring application, or individual exercise activities in exercise a tracking application.

Hence, for providing the rewards functionality in BCSS, *User*, *Entry*, *EntryObserver*, *Reward*, and *Accomplishment* components are needed as seen in the class diagram (see Figure 1). In the diagram, theUser model contains the profile information of a certain user, User has a one-to-many relationship to the Entry–being an actualization of a pursued behavioral habit–model: an Entry depicts an action that the user submits to the system,, The Reward model contains the description of the reward in question. The Accomplishment model depicts the many-to-many relationship between the User and the Reward and is used for maintaining the record of the rewards users have gained. The EntryObserver class then contains the logic that observes upon creation of Entries, if they account for a reward and if so, creates the corresponding Accomplishment. See Table 1 for summarization.

Table 1. Reward pattern

Pattern name	*Reward*
Problem	The system should give virtual rewards to users to further motivate them to stay involved.
Components	User, Entry, EntryObserver, Reward, Accomplishment
Solution	The resources in the system should be modeled to implement the User, Entry, EntryObserver, Reward and Accomplishment components. When the User submits an Entry to the system, the EntryObserver component observers whether the action is eligible for issuing a reward to the user.
Consequences	Rewarding users for performing after their target behavior motivates them and assists their goal setting. But it should be minded that all users might not find rewards as desirable.

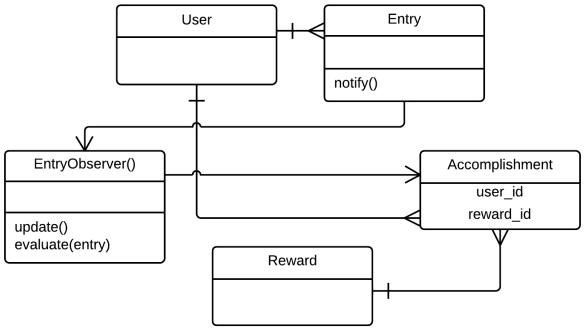

Figure 1. Class diagram of the Reward pattern

4 Conclusion and discussion

In this study we have proposed the Reward software design pattern to facilitate enhanced computer-human dialogue in behavior change support systems, based on the PSD model. The paper's implications for research are in providing an intricate implementation level view of the software development aspects of BCSSs. We hope that the object-oriented design and code level findings presented will result in breaking out from the black-box thinking approach in persuasive systems design, allowing researchers to inspect the internals of software components needed to produce persuasive applications. In the future, a full set of design patterns for BCSSs could be accomplished. Practitioner-wise, using the pattern will assist in creating conventions to bootstrap future BCSSs development. The pattern can be used to add rewarding features to existing behavior change support systems, thus potentially increasing their persuasiveness. This study is limited by the fact that the verification of the implied pattern was conducted only as describing the development of a demonstrative system prototype. For further proof, more complex applications, which apply the pattern, should be developed. The application of the pattern in different programming environments, languages, and frameworks should also be studied. For example, whether the pattern applies in the development of a native mobile application as well as of a web-based BCSS could be studied. The presented pattern solely concerns the rewarding features in a system, and there still remain many other persuasive system features that should be covered when studying persuasive software design patterns. Thus, the future work will include further definition and verification of the presented pattern and developing new ones focusing on both human-computer dialogue and the other aspects of persuasive systems design, such as social influence.

Acknowledgements. This research is part of OASIS research group of Martti Ahtisaari Institute, University of Oulu.

References

1. Oinas-Kukkonen H. (2013). A foundation for the study of behavior change support systems. *Personal and ubiquitous computing*, Vol. 17, No. 6, August 2013, pp. 1223-1235.
2. Oinas-Kukkonen, H., Harjumaa, M. (2009). Persuasive systems design: Key issues,process model, and system features. In: Communications of the Association forInformation Systems, 1, vol. 24, pp. 485-500.
3. Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. MIS Quarterly: Management Information Systems, 28(1), 75-105.
4. Bennett, G.G., Glasgow, R.E. (2009). The Delivery of Public Health Interventions Via the Internet: Actualizing their Potential. Annual Review of Public Health, vol. 30, 273–292.
5. Lehto T., Oinas-Kukkonen H. (2011). Persuasive Features in Web-Based Alcohol and Smoking Interventions: A Systematic Review of the Literature. In: Journal of Medical Internet Research, 3, vol. 13, e46.
6. Weiksner, G., Fogg, B., Liu, X. (2008). Six patterns for persuasion in online social networks. *Persuasive Technology*.
7. Lockton, D., Harrison, D., & Stanton, N. (2010). The Design with Intent Method: a design tool for influencing user behaviour. *Applied ergonomics*, *41*(3), 382–92. doi:10.1016/j.apergo.2009.09.001
8. Gamma, E., Helm, R., Johnson, R., and Vlissides, J. (1995). *Design Patterns: Elements of Reusable Object Oriented Software*. Addison-Wesley.
9. Zhu, Z. (2009). Study and application of patterns in software reuse. Control, Automation and Systems Engineering, 2009. CASE 2009. IITA International Conference on, 550-553.
10. Buschmann, F., Henney, K., & Schmidt, D. C. (2007). Past, present, and future trends in software patterns. *Software, IEEE, 24*(4), 31-37.
11. Ritterband, L., Thorndike, F., Cox, D., Kovatchev, B., & Gonder-Frederick, L. (2009). A behavior change model for internet interventions. *Annals of Behavioral Medicine, 38*(1), 18-27. doi:10.1007/s12160-009-9133-4
12. Sohn, M., & Lee, J. (2007). UP health: Ubiquitously persuasive health promotion with an instant messaging system. *CHI '07 Extended Abstracts on Human Factors in Computing Systems,* San Jose, CA, USA. 2663-2668.

13. Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology*, 18(1), 105-115.
14. Krasner, G., Pope, S. (1988) A Description of the {Model-View-Controller} User Interface Paradigm in the Smalltalk-80 System. In: Journal of Object Oriented Programming, 3, vol. 1, pp. 26-49.
15. Fielding, R.T., Taylor, R.N. (2002) Principled design of the modern Web architecture. In: ACM Transactions on Internet Technology, 2, vol. 2, pp. 115-150.

Ludo Modi Varietas: A Game-architecture inspired design approach for BCSS

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Abstract.

The design of Behavior Change Support Systems (BCSSs) is a multi- and interdisciplinary process that involves a deep understanding of the user, mediator, social contexts and ultimately the socio-technical system. This paper attempts to demonstrate the benefit in the design process of combining four abstract modes of use (Trigger, Intervention, Assessment and Participation) from gaming, the Ludens Modi Varietas Model. MATTIE (Mobile adaptive therapeutic tool in psycho-education), a BCSS for youngsters (aged 12-18) with a mild intellectual disability aiming at behavior change in their social information processing, is used to exemplify the inner workings of the design model.

Keywords. Behavior Change Support System, Serious Gaming, Ludens Modi Varietas Model, Persuasive Technology.

1 Introduction

All games are meant to be persuasive, and try to form and reinforce compliance to keep the user playing. Though persuasive design is inherent to game design, persuasive games have become a genre on their own merit. Bogost [1] defines persuasive games as depending on successful procedural rhetoric's, while Visch [2] outlines the essentials of user experience, gamification and transfer.

Not all persuasive games are developed with behavioral change in mind and vice versa not all games with behavioral change in mind are in design persuasive. Simulations often don't aim to be persuasive in nature and are often positioned as training tools without specific entertainment goals. Serious games [3] often attempt to find a mix between entertainment and the serious content [4]. In Persuasive technology [5], Oinas-Kukkonen [6] found two main modalities to persuade, either computer-human or computer mediated persuasion. Rao [7] found similar modalities for persuasive games and outlined the need for a model similar to the Persuasive Systems Design model (PSD) [8] to effectively design games as Behavior Change Support Systems (BCSSs) [9,10]. Designing serious games through a model similar to the PSD is intricate, in particular because of the mechanisms, dynamics and aesthetics that are inherent to game design [11]. There-

fore often game elements, i.e. gamification, are used in BCSSs. Gamification has proven to be a promising tool towards behavior change, compared to captology and persuasive technology [12]. Some argue however that, gamification strips away the essence of a game [13]. Without taking away the essentials of game design, games with different goals and within differing domains can have very similar architectures. From a model-based approach and the authors experiences with serious gaming [14,15,16], the Ludens Modi Varietas (LMV) Model is being developed. The abstract modalities model focuses at the modes of use in serious media and uses them as a starting point for designing persuasive game artifacts. The essential goal of the model is to develop a framework for different game dynamics, mechanisms, aesthetics and overall design patterns that fit the different modes of use in games, leading to specific changes in attitude, behavior and/or compliance.

This paper focuses on the model as a design tool, illustrated through a BCSS named MATTIE [14]. This application demonstrates all four modes of use as a BCCS for adolescents with a mild intellectual disability, attempting to alter, form and reinforce the target audience's social decision-making behaviors.

2 The Ludo Modi Varietas Model

The abstract modalities model (Figure 1) was developed from the users perspective, as well as the mediator's perspective. The different social contexts in which the game can be used as well as the sociotechnical system in which the game will be implemented, both influence the design parameters of the artifact. The archetypical modes of use can potentially singularly be a game. However when combining more than one at the same time, a game can function as a tool that facilitates the needs of the user, the mediator and the social as well as socio-technological system in which it will be embedded. The model consists of four archetypical modes of use;

- **Intervention*:*** From a healthcare perspective, an intervention is an evidence-based method that has been proven successful as an analog version. However, in BCSS it can also be any newly developed method or barrier aimed at behavior change. The translation of an existing method to a digital game-version often proves to be difficult. The intervention is usually from the domain-specific field in which the game will be implemented and depending on the context can be metaphorically re-contextualized [17].
- **Trigger [**18, 19]: Fogg's functional triad and behavior model for persuasive technology describe a trigger as the onset for behavioral change in a medium. A Trigger gives feedback with persuasive features that lures the user into participation.
- **Participation** [20, 21]: Murray [22] defines participation as on of the four essential properties of digital artifacts. The rational behind participation lies in different user-perspectives as well as the specific qualities of the medium. Participation can go beyond in-game participation and manifest in adding comments, ratings or even desired features to the game itself.

- **Assessment** [23]: Assessment of skill, knowledge, attitude or behavioral change all can be core purposes of a game. Assessment within a social or sociotechnical system can also take place outside of the game; this however often creates a mismatch between the content in the game and the measurements. Therefor more often the assessment is the game, or part of the game; i.e. embedded assessment. The embedded assessment can also go completely unnoticed by the user through hidden design, leading to unobtrusive measurements. Embedded assessment can take place on persuasion appeal of the product as well as the didactic transfer related potential.

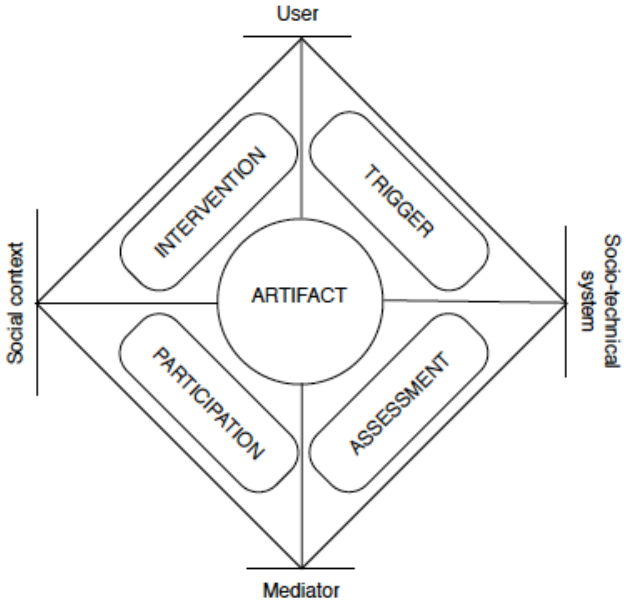

Fig. 1. Ludens Modi Varietas Model: shows the abstract modes of use as well as the users and environments for which and in which the artifact is developed.

The socio-technical system [24], attempts to facilitate the interactions between human and technology in the environment(s) where the application will be implemented. The different social contexts the users take place in outside of the initial scope of the system are also taken into account. The design of BCSSs is often a multi-disciplinary process that involves a deep understanding of the user, mediator, social contexts the user and mediator take part in and socio-technical system. The LMV model uses modes from design (trigger & participation) as well as from analytical science (intervention & assessment), thereby attempting to represent both the communities of practice as well as the communities of observers [25]. The LMV model offers a multi-view-centered design approach that attempts to isolate the specific mechanics as well as behavioral outcomes linked to the abstract modes of use.

3 Case Studie: Mattie

In this paper Mattie is used to exemplify design through the LMV because of the relatively transparent game architecture and the uses all the four modes of use in regard to design for behavior change.

MATTIE is a BCSS for adolescents with a mild intellectual disability (clients) and their therapists (mediator). The onset of the project was to create a digital application out of the analog psycho-education folder that was developed for the target audience. The application was created for the general healthcare facility as well as for the different social environments outside of the facility the client takes part in, in daily life.

"The mobile application introduces a simulated facetime call by an actor that is in a social predicament wherein social decision-making is warranted. The patient is asked to advise in the presented dilemma, making a decision and is afterwards confronted with the outcome. Important design choices in the workings of the application are the choice of actors alike the target audience enhancing the para-social interaction, the presentation of video-cases outside of the therapeutic setting, empowerment and self-efficacy of the patient through role reversal and an answering system befitting the social information processing of the target audience. Furthermore it gives therapists the opportunity to gather valuable input for their sessions and an adaptive system that gives them the control over the video-cases that are presented to the patient, thus picking the content befitting the specific needs of the patient." [cf.12]

Mattie as a BCSS operates from three connected platforms.

1. The Mobile Application Mattie
   Which is used by the clients and runs on their mobile devices, prompting video-cases: featuring Face time conversations that contain an avatar-mediated social dilemma. Through use of the mechanic of role reversal, the client get's asked for advice by the avatar, breaking with the traditional dynamics of the therapeutic environment, where the client gets told what to do.
2. A backend behind the application Mattie
   Which gives the therapists the options to;
   (a) Select video-cases based on subject or answer possibilities for the clients.
   (b) Select timeslots on the week schedule of the clients to prompt the video-cases.
   (c) Look at the answer-patterns of the clients through the week.
   (d) Walkthrough and remediate the presented video-cases during the week. Talk the motivations and circumstances behind the decisions.
3. A website platform named *www.maakmattiemee.nl*;
   (a) Which gives the clients and therapists the possibility to rate video-cases and inform whether they've been in similar situation themselves.
   (b) Give suggestions about dilemma's they've been in themselves, or subjects they would like video-cases about.

3.1 Mattie as an Intervention

As an intervention Mattie, harnesses the core principles of the Attitudes towards Social Limits (ASL) [26], a reaction response model in social information processing, that is used in the therapeutics setting as an assessment of the social information processing of the clients. The four standard reaction responses (Adjust, Avoid, Negotiate or Exceed) are used to create two answer possibilities to every case onset in the database. Per case dilemma two options from the ASL are given, after a scripted interval depending on the case subject and the consequence of the chosen response for the avatar. The mediator in the therapeutic setting will facilitate relevance and sense making by working through the application with the client. The social context or situation where the client was in while getting the prompt from the application can also be taken into the remediation conversation.

3.2 Mattie as a Trigger

Several design principles were used to attempt to make Mattie a persuasive trigger;

- In the choice of the perceived similarity of the actor with the user;
  - The actor acts and looks like a youngster with a mild intellectual disability.
- The framing of the message;
  - The actor asks the client for help (role-reversal from the traditional therapeutic setting) and trusts them enough to follow their advice (empowerment and self-efficacy for the client).
  - The message is portrayed similar to a video chat-conversation, giving it an authentic look and feel.
- The Use and User context;
  - The timing and onset of the application reaches beyond the context of the therapeutic setting. Placing Mattie in the social contexts where authentic dilemmas in social decision-making take place.

3.3 Participation in and through Mattie

As the client forms a para-social relationship [27] with the avatar, engagement concerning the consequences of the video-cases increases, as well as compliance with the application. This engagement in the use of the application can result in *liking* of video-cases on the site as well as creating video-cases of their own, by the clients as well as the therapists, through filling out the dilemma text-based at the hand of a number of questions. The self-made case descriptions and likes or dislikes are all displayed on the site as social proof and social comparison. The designer can use these ratings and the generation of video-cases can be used to develop new video-cases and extract salient features of video-cases that make them more persuasive and effective.

3.4 Assessment in and through Mattie

The therapist, to mediate and determine the content of the video-cases for the client, uses Mattie as a therapeutic tool. Through the logging of the decisions

made for the avatar by the client, the therapist gains insights in the social decision-making of the client and their tendencies towards specific contexts, situations and social limits. Through iterations, the therapist can adapt the video-cases, based on specific needs of the patient, video-case-load and subjects as well as answer possibilities of the cases. In this way the content on the mobile application can be tailored to the specific needs of individual clients.

4 Discussion

Mattie aims to be a therapeutic tool that aids the needs of the therapist as well as the client and fit seamlessly in the socio-technical and social contexts of the users. Reinforcing compliance towards answering video-cases from the application and reinforcing compliance through the website. Forming and altering behavior related to social information processing in social dilemmas. Finally through mediation and assessment the mediator can attempt to alter the attitude of the client towards social dilemmas.

In the design of Mattie through the use of the LMV model, an intervention from analytical science was designed and complemented by a trigger with persuasive features from the design science. Through participation and assessment both the trigger and intervention are refined and co-developed into a more effective and more persuasive BCSS. During this iterative development social and socio-technical system development around the development and implementation of Mattie, also take place through participation and assessment.

Mattie as a BCSS has to potential to, after several iterations, act as an adaptive therapeutic tool and use case-patterns (patterns in the exposure of certain case topics and certain case answers) for co-morbidity or other specific patient characteristics. Designing through the use of the four modalities in the LVM model. Through its cross-medial nature and different platforms it aims at creating a self-sustaining BCSS, wherein the therapist and clients can create continuous input into the design process.

Mediation can take place trough computers as social actors. However remediation of a BCSS within a clinical setting will involve human healthcare professionals. Therefore the LVM model uses the mediator as an incremental stakeholder in the development of the BCSS artifact. Remediation of altering, reinforcing or forming of compliance, behavior or attitude change is vital whether by a machine as a social actor or a human operator. The involvement of a human mediator as remediation of the BCSS also contributes to the social system development around the BCSS.

The LVM as a design model aims to facilitate design for the major stakeholders of the BCSS in use and co-development of BCSS artifacts. The model, as of now, harbors little to no information about the actual aesthetics, mechanics and dynamics that lead through the proposed behavior change [28], as well as the specific persuasive cues. However through the use of the four modes from the LMV create a multi-view of the juxtaposition of the mechanics in place. This way the mechanics, dynamics and aesthetics can be divided into the framework according to the four modes of use. Through the modes of use, different results from and me-

chanics leading to the Outcome/Change Design Matrix [10] can be identified and isolated in one artifact. The model offers a novel way of looking at product system design, attempting to simplify the overlap of mechanics and goals in one product.

References

1. Bogost, I. Persuasive games: The expressive power of videogames. Mit Press. (2007).
2. V. Visch, N. Vegt, H. Anderiesen, and K. Van Der Kooij, "Persuasive Game Design : A model and its definitions. CHI conference publication, Paris (2013).
3. Abt, C. C. *Serious games*. University Press of America. (1987).
4. Ritterfeld, Ute, and René Weber. "Video games for entertainment and education." Playing Video Games. Motives, Responses, and Consequences. Mahwah, NJ: Lawrence Erlbaum Associates (2006): 399-413.
5. Oinas-Kukkonen, H., Harjumaa, M.: Towards deeper understanding of persuasion in software and information systems. In: Proceedings of the First International Conference on Advances in Human-Computer Interaction (ACHI), pp. 200–205 (2008)
6. Fogg, B. J. (2003) Persuasive technology: Using computers to change what we think and do. Morgan Kaufmann, San Francisco.
7. V. Rao, "A Framework for Evaluating Behavior Change Interventions through Gaming," pp. 368–379, 2013.
8. Oinas-Kukkonen, Harri, and Marja Harjumaa. "Persuasive Systems Design: Key Issues, Process Model, and System Features." *Communications of the Association for Information Systems* 24 (2009).
9. Oinas-Kukkonen, H. (2010) Behavior Change Support Systems: A Research Model and Agenda. Lecture Notes in Computer Science, Vol. 6137, pp. 4-14, Springer-Verlag.
10. Oinas-Kukkonen, H. A foundation for the study of behavior change support systems. Personal and Ubiquitous Computing, (2012).
11. Hunicke, Robin, Marc LeBlanc, and Robert Zubek. "MDA: A formal approach to game design and game research." *Proceedings of the AAAI Workshop on Challenges in Game AI*. 2004.
12. Hamari, Juho, Jonna Koivisto, and Tuomas Pakkanen. "Do Persuasive Technologies Persuade?-A Review of Empirical Studies." *Persuasive Technology*. Springer International Publishing, 2014. 118-136.
13. Bogost, Ian. "Gamification is bullshit." *Ian Bogost blog* 8 (2011).
14. Wartena, B. O., Kuipers, D. A., Drost, J., & van't Veer, J. (2013). Mobile Adaptive Therapeutic Tool In psycho-Education (MATTIE). Design

principles for a persuasive application tailor-made for adolescents with a mild intellectual disability. *Proceedings of ISAGA 2013*.

15. Wartena, Bard O., and Hylke W. van Dijk. "Bias Blaster–Aiding Cognitive Bias Modification-Interpretation through a bubble shooter induced gameflow." *Games for Health*. Springer Fachmedien Wiesbaden, 2013. 47-60.
16. Bard O. Wartena, Derek A. Kuipers and Hylke A. van Dijk, "Play It Safe; an situational Occupational Safety Game", *In Press* Proceedings of SGSC 2013, 2013.
17. Kuipers, D. A., Wartena, B. O., Dijkstra, A., Prins, J. T., & Pierie, J. P. E. Design for Transfer. In *Serious Games Development and Applications* (pp. 239-246). Springer Berlin Heidelberg. (2013)
18. Fogg, B. J.. Persuasive technologies. Communications of the ACM, 42(5), 26–29(1999).
19. Fogg, B. J. "A behavior model for persuasive design." Proceedings of the 4th international Conference on Persuasive Technology. ACM, 2009.
20. Raessens, J.: Computer games as participatory media culture. In: Raessens, J., Goldstein, J. (eds.) Handbook of Computer Game Studies, chap. 24, pp. 373{388.MIT Press (2005)
21. Van den Bosch, Frederik, Wannes Ribbens, and Jan Van Looy. "Doing It Themselves! A Mixed-Method Study into the Motivations of Players to 'Create' in the Context of Gaming." *Think Design Play: 5th International DiGRA Conference (DIGRA-2011)*. Gent University, Department of Communication studies, 2011
22. Murray, Janet Horowitz. *Hamlet on the holodeck: The future of narrative in cyberspace*. Simon and Schuster, 1997.
23. Francesco Bellotti, Bill Kapralos, Kiju Lee, Pablo Moreno-Ger, and Riccardo Berta. 2013. Assessment in and of serious games: an overview. *Adv. in Hum.-Comp. Int.* 2013, Article 1 (January 2013)
24. Trist, Eric. "The evolution of socio-technical systems." *Occasional paper* 2 (1981): 1981.
25. Klabbers, Jan HG. "A framework for artifact assessment and theory testing."*Simulation & Gaming* 37.2 (2006): 155-173.
26. Grietens, Hans, and Walter Hellinckx. "Attitudes towards social limits and self-reported undersocialized behaviour. A theoretical outline and an empirical contribution to the validation of the Standard Reaction Instrument." *status: published* (1999).
27. Horton, Donald, and R. Richard Wohl. "Mass communication and para-social interaction: Observations on intimacy at a distance." *Psychiatry* 19.3 (1956): 215-229.
28. Fogg, B. J., and Jason Hreha. "Behavior wizard: a method for matching target behaviors with solutions." *Persuasive technology*. Springer Berlin Heidelberg, 2010. 117-131.

Influencing Behaviour by Modelling User Values: Energy Consumption

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Abstract. A variety of social and digital media technologies are being used to influence a change in an individual's or group's behaviour. A major challenge is in understanding what leads to or prevents different forms of influence from having an effect, what those effects are, how long they take to come about and for how long they last. This research is concerned with the problem domain of climate change and with using social and digital media technologies to influence users to change their energy consumption behaviour. The objective is to understand how user information may be utilised within the development of persuasive technologies and behaviour change support systems. This paper contributes fundamental and applied research on how user values, lifestyle aspects and energy consumption behaviours may be modelled to support systems in delivering relevant and personalised information and knowledge that can influence behaviour change.

Keywords: User Profiles · Values · System Design · Influence · Energy Consumption Behaviour

1 Introduction

There is growing interest in understanding how social and digital media can be used to influence an individual's or a group's behaviour in areas including health, defence and security, climate change, and more. Research in this area seeks to understand fundamental and applied aspects of what leads to or prevents different forms of influence from having an effect, what those effects are, how long they take to come about and for how long they last. This requires an understanding of both the explanatory and predictive aspects of different forms of influence. In addition, research into how digital technologies might play a role in influencing behavioural change is of concern to researchers in cyber influence and persuasive technologies [5].

This paper contributes fundamental and applied research on influencing behavioural change in the area of carbon reduction. There are a myriad of reasons why serious action needs to be taken to reduce our carbon footprints. A plethora of highly commendable courses of remedial action are being taken including developing alternative and/or more efficient technologies for creating, storing and using alternative forms of energy. A major concern of others and our research is

to change people's understanding and behaviour towards energy usage and to bring about reductions in carbon rich energy consumption. Our means to do that is through people and society themselves, and our medium for mediating that change is personal and societal digital solutions. Our approach is to understand people's values, to recognise those values as being important influences on behaviour and to create, using the medium of digital technology, data, information and knowledge resources that are both personal and community-based to influence people to change their behaviour towards lower carbon energy usage.

People use information that is created, accessed and stored on their laptops, tablets and smart phones to help them make both everyday and important decisions. People are enabled to create, and share information and knowledge. This information and knowledge creating, searching, and sharing, results in people and broader communities adopting new ways of acting, doing and behaving. It also supports the establishment of new communities, which in turn create and share new information and knowledge.

Persuasive technologies [5] and behaviour change support systems [8] have been defined as "computerized software or information systems designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception" [8]. An aside here is that it is questionable if such systems do truly avoid using any form of force to try to change people's behaviour. Many forms of force exist -- some of which use both social conscience and the person's own conscience to influence behaviour change. These are forms of force, as are those, which seek to create cognitive dissonance to influence behaviour change.

Within the area of energy reduction some systems use predictive modelling to calculate and provide feedback on potential energy saving opportunities for the user (e.g. work by Fischer [4]). Other approaches promote pro-environmental values and attitudes with the goal that this will influence a change in behaviour. One major criticism of such systems is that they prescribe changes in behaviour without understanding why people behave in particular ways, or why particular behaviours are carried out. Consequently, many case studies report a lack of long-term engagement [7,11,19].

A primary aim of our research is to understand how people's values can influence long-lasting behaviour changes. From this understanding we can then investigate attributes of software systems to influence people to reduce their high carbon, energy consumption behaviours. This paper outlines how user values, lifestyle aspects and energy consumption behaviours may be modelled within software systems and utilised to deliver relevant and personalised information and knowledge that can influence behaviour change.

2 Current Approaches

Software systems that influence energy consumption behaviour vary in their design, and their requirements are often based on popular theories of behaviour change, such as the behavioural model of rational choice [16], value-belief-norm model [18] or action-behaviour-choice [15]. These theories and methods allow

designers to get a better understanding of what user information is necessary, how to model this information, and how the system makes decisions based on this information to influence a change in behaviour in a personalised way.

Some current approaches utilise predictive modelling and simulation techniques to calculate and provide feedback about potential energy saving opportunities at certain time periods. Designs that decide what is best for the user solely based on limited sources of data (such as electricity usage) are in danger of forcing users to conform to efficiency targets without understanding the motivations or reasons behind why particular energy usage behaviours happens. Here again, many case studies have reported limited success and a lack of long-term engagement [3]. People soon find this unacceptable and either disable/ignore or find ways to work around the system. Hence, what the system was (unknowingly) compromising or preventing was more than just energy usage it was an important aspect of their life that people were not prepared to have compromised or prevented.

Other approaches aim to promote pro-environmental values and attitudes with the goal that this will lead to a change in behaviour [14,21]. However, a person holding a particular value or attitude does not necessarily act upon it [2,6,15]. In this case there is a failure to recognise that people hold multiple values and life causes them to prioritise, compromise and trade-off these different values. Simply creating pro-environmental values creates more conflict and compromise. This results in pro-energy values having little influence on behaviour. Of course if we understood what these different values were and how people resolve the conflicts, make compromises and prioritisations, we might then be able to more effectively influence behaviour. That is exactly our aim.

Therefore we need to identify, understand and make good use of the complex information about people's values, how they affect their everyday lives, and how they might have implications on their energy consumption behaviour. In addition, while there may be common values and common aspects to people's lives we need to recognise their individual and personal forms, their differences, and their relationship to consequential behaviour. Hence we need to personalise and tailor any influences to the individual.

3 Our Approach: Values-based User Modelling

Designers of software systems that aim to influence behaviour change need to take into account the broad spectrum of ways to frame behaviour change interventions, in order to make them personalised and relevant to individuals and groups of people. Based on existing work into the content and structure of values [1,12,13], lifestyle aspects [1,10,20], and energy consumption behaviour [20] we discuss our motivation and outline how this information may be modelled to personalise and tailor behaviour change influences.

3.1 Motivation

Our underpinning philosophy is that saving energy is not always the governing or guiding principle around which everyday lives are organised. Everyday lives are

organised primarily due to values, around contexts and ways of living. Software systems that aim at influencing behaviour change therefore need to take into account the complex trade-offs that are made to meet the demands and challenges of everyday life while maintaining the values they hold. Of course the value of nature and the environment is a value that many individuals hold [13], and performing activities with the sole purpose of curtailing energy-use may be instrumental in supporting this value. However, it is important to recognise that this is potentially one of many values that an individual or group hold and strive to maintain.

People have many values. They are used to select and justify activities, and to evaluate artefacts and events (including other people and themselves) [13]. The values people hold are considered as important influencers and drivers for their specific energy related behaviours [6,12]. Those values may be articulated in rather generalised forms by collective terms. Existing research into the structure and content of values can be seen in work by Schwartz [13] who presents a set of 10 universal value types including security, conformity and tradition among others. Similarly, work by Rokeach [12] also presents work on collective values including a comfortable life, social recognition and wisdom. Each of these types contains subtypes of instrumental motivational values; for instance the value type of security contains a set of 7 instrumental subtypes such as family security, healthy, social order, and so on. However, these generalised value forms take on real meaning and influence at a much more personal and individual level. Moreover, the values for an individual are constructed and operationalised through the connections they have with the terms and contexts of their everyday life.

Activities, artefacts and events are important aspects of everyday life. They are related to the way in which individuals spend their time and are instrumental in supporting their values. An activity may be defined as a set of actions that have a goal [10]. For instance, the activity of cooking may be performed and in doing so will support the value of health and wellbeing. However, the activity of cooking may be performed to create healthy meals to maintain the value of health, or alternatively, to provide food for many people at a family event and subsequently supporting the different value of family. Therefore, activities alone do not dictate energy consumption behaviour. Values provide a powerful motivational and determining function on activities and behaviour.

In addition to activities, there are other types of important information. These are events and artefacts. For instance, a family member's birthday party may well require them to have a birthday cake to mark the occasion. This would give rise to very different cooking behaviour than if an individual was cooking an evening meal alone. This suggests that information about the activity alone may not be enough information to explain why behaviour is performed in a certain way. Using the example of a birthday party, it is possible to see that everyday life is connected and/or constrained by values influencing particular events (e.g. birthday) and particular artefacts (e.g. cake).

Due to the constraints of values on activities, events and artefacts, energy consumption behaviour is a consequence of the way in which individuals and groups of people make decisions and trade-offs. The decisions and trade-offs are

between their important values, determining their lifestyles, motivating their activities, and contextualising events and artefacts and determining their energy related behaviours.

3.2 Main Information Types in the Influence Structure

Table 1 lists six types of modelling information that act as drivers of our energy consumption behaviour. They are all defined as objects as they would be represented as separate objects within a software system object model.

Table 1. Influence Structure - main information types.

Name	Description
Value	Something of importance to an individual or group
Lifestyle Aspect	Ways that values are supported in their socio- cultural context.
Activity	What people do, a set of actions with a goal.
Event	Something that happens, natural or created.
Artefact	An object - physical or informational
Energy Consumption Behaviour	Behaviour that has direct implications on an individuals carbon footprint

A Value represents something that an individual or group sees as an important part of their lives. Lifestyle Aspects represent the socio-cultural context in which people live their lives. They provide patterns that may change during different periods in people's lives, they maybe self-chosen, circumstance driven -- or a mixture of both. Activities represent what people do. They can be related to work, home, entertainment, caring for others, etc. Artefacts are largely physical in some form, but include images and sounds such as in the case of music. Informational artefacts are also relevant; such as news, facts, or ideas. Events can be natural events such as sunsets and/or created events such as birthdays. Energy Consumption Behaviours are behaviours that are directly energy consumption related, they can include both using energy such as providing heating for warmth or cooking and saving energy such as turning the thermostat down or creating heat from renewable energy sources.

Activities, Artefacts and Events are all important contextual features of Energy Consumption Behaviours. Energy Consumption Behaviours are consequential to ways in which Lifestyle Aspects are performed. Lifestyle Aspects are in turn instrumental in supporting Values. These associations form an important influence structure that can subsequently be modelled within a system to influence a change in energy consumption behaviour by tailoring implemented strategies of influence.

3.3 Applying The Influence Structure

Table 1 shows that the pivotal parts of the structure are Values, Lifestyle Aspects, Activities, Events, Artefacts, and Energy Consumption Behaviour. The Energy Consumption Behaviour objects are the part of the model that is specific to the problem domain of energy-use. The remainder of the model is general and related to everyday life and decision-making. In short, the model connects what people do, why they do it, and the implications this has on energy use. In order to visually represent this information and their associations, we exemplify their construction in Figure 1 based on universal values, activities and energy consumption behaviours in the literature [1,10,13,20].

An object model was chosen as the information instances are of central importance to the system design. It formalises the relationship between information that drives decision-making in real life at the same time as representing the associations between object instances implemented within a system. In other words the decisions that individuals make within their lifestyles are instrumental to their values; these are represented as associations between Lifestyle Aspect objects and Value objects. For ease of reading, the information type is shown for each of the four hierarchical layers.

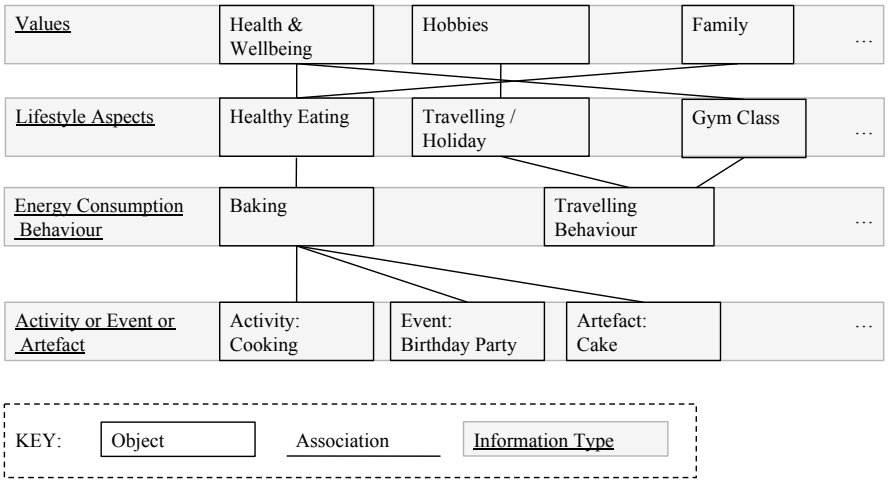

Fig. 1. Example of Values, Lifestyle Aspects and Energy Consumption Behaviour.

The connection between the Lifestyle Aspect of healthy eating and the Value of health and wellbeing shows that the Lifestyle Aspect of healthy eating is instrumental to supporting the Value of health and wellbeing. The Lifestyle Aspect of healthy eating may have different ways in which it is carried out which affect how well the Value is supported. Energy Consumption Behaviour of baking is consequential to the ways of carrying out the Lifestyle Aspect of healthy eating. The important contextual information related to the Energy

Consumption Behaviour of baking is the Activity of cooking, the Event of a birthday party and the Artefact of the cake.

Constructing the influence structure allows for designers of behaviour change interventions to reason logically about how to frame interventions for different situations. For instance, using the example given previously, we can see that the Energy Consumption Behaviour related to baking is consequential to the Lifestyle Aspect of healthy eating. Healthy eating is instrumental to two Values: health and wellbeing, and family. Using this influence structure, behaviour change interventions may be framed in the context of a valued aspect of a person's life that may be either directly or only indirectly related to energy. To relate this to the example, interventions may be framed by supporting valued interactions with family and/or promoting health and wellbeing through energy efficient ways of baking. The outcome of the intervention is that the person(s) is influenced to change behaviour in favour of behaviour that consumes less energy while directly supporting their highly valued activities.

4 Conclusion and Future Work

This paper argues how the construction of a user model, based on values, lifestyle aspects and energy use behaviour may be utilised within a software system to inform strategies that influence a change in energy usage behaviour. These information types were chosen as they are the key drivers of everyday decision-making that lead to energy consumption behaviour. As such the content and inter-relationship of these information types may inform intervention strategies that are relevant and personalised.

The model explained in this paper illustrates the main conceptual types that are important. A natural progression of this work is towards an implementation-level design. The additional implementation-level detail that is necessary may add lower level implementation specific detail but should not change the conceptual model. It is important to take into account the tensions and trade-offs between values. This is because the tensions and trade-offs are important to select and understand the consequences of a particular strategy of influence.

In future work we aim to empirically evaluate the influence structure through the design an online social media system that aims at influencing a change in energy consumption behaviour. Iterative system development will allow for the model to be specified at a lower level of granularity.

Acknowledgement. Eviz project. The work reported in this paper is funded by the Engineering and Physical Sciences Research Council (EPSRC) under the Transforming Energy Demand in Buildings through Digital Innovation (TEDDI) (grant reference EP/K002465/1).

References

1. American Occupational Therapy Association: Occupational therapy practice framework: Domain and process. American Journal of Occupational Therapy 56, 609 – 639 (2002)
2. Blake, J.: Overcoming the value-action gap in environmental policy: Tensions between national policy and local experience. Local environment 4(3), 257–278 (1999)
3. Brynjarsdottir, H., Håkansson, M., Pierce, J., Baumer, E., DiSalvo, C., Sengers, P.: Sustainably unpersuaded: how persuasion narrows our vision of sustainability. In: Proc. of the 2012 ACM annual Conf. on Human Factors in Computing Systems. pp. 947–956. CHI '12, ACM, New York, NY, USA (2012)
4. Fischer, J.E., et al, S.D.R.: Recommending energy tariffs and load shifting based on smart household usage profiling. In: International Conference on Intelligent User Interfaces. pp. 383–394 (2013)
5. Fogg, B.J.: Persuasive technology: using computers to change what we think and do. Ubiquity 2002(December), 5 (2002)
6. 6. Kennedy, E.H., Beckley, T.M., McFarlane, B.L., Nadeau, S.: Why we don't walk the talk: Understanding the environmental values/behaviour gap in Canada. Human Ecology Review 16(2), 151 (2009)
7. Kluckner, P.M., Weiss, A., Sundstrm, P.: Two actors: Providers and consumers inform the design of an ambient energy saving display with persuasive strategies. In: 1st International Conference on Behavior Change Support Systems. pp. 33–44 (2013)
8. Oinas-Kukkonen, H., Harjumaa, M.: Towards deeper understanding of persuasion in software and information systems. In: International Conference on Advances in Computer-Human Interaction. pp. 200–205 (Feb 2008)
9. Oinas-Kukkonen, H.: A foundation for the study of behavior change support systems. Personal Ubiquitous Computing. 17(6), 1223–1235 (Aug 2013)
10. Pierce, D.: Untangling occupation and activity. The American Journal of Occupational Therapy 55(2), 138–146 (2001)
11. Pierce, J., Paulos, E.: Beyond energy monitors: interaction, energy, and emerging energy systems. In: Proc. of the SIGCHI Conf. on Human Factors in Computing Systems. pp. 665–674. CHI '12, ACM, New York, NY, USA (2012)
12. Rokeach, M.: The nature of human values. Free press (1973)
13. Schwartz, S.H.: Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. Advances in Experimental Social Psychology, vol. 25, pp. 1 – 65. Academic Press (1992)

14. Sheppard, S.R.: Landscape visualisation and climate change: the potential for influencing perceptions and behaviour. Environmental Science and Policy 8(6), 637–654 (2005)
15. Shove, E.: Beyond the abc: climate change policy and theories of social change. Environment and planning 42(6), 1273 (2010)
16. Simon, H.A.: A behavioral model of rational choice. The Quarterly Journal of Economics 69(1), 99–118 (1955)
17. Stern, P.C.: New environmental theories: toward a coherent theory of environmentally significant behavior. Journal of social issues 56(3), 407–424 (2000)
18. Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A., Kalof, L.: A value-belief-norm theory of support for social movements: The case of environmentalism. Human Ecology Review 6(2), 81 (1999)
19. Strengers, Y.A.: Designing eco-feedback systems for everyday life. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 2135–2144. CHI '11, ACM, New York, NY, USA (2011)
20. Wei, S., Jones, R., de Wilde, P.: Driving factors for occupant-controlled space heating in residential buildings. Energy and Buildings 70(0), 36 – 44 (2014)
21. Zaalberg, R., Midden, C.: Enhancing human responses to climate change risks through simulated flooding experiences. In: Persuasive Technology, LNCS, vol. 6137, pp. 205–210. Springer (2010)