Alexander Meschtscherjakov
Boris De Ruyter
Verena Fuchsberger
Martin Murer
Manfred Tscheligi (Eds.)
Preface

Persuasive Technology is a vibrant and highly interdisciplinary research field that focuses on the design, development, and evaluation of interactive technologies with the aim of changing users’ attitudes and behaviors. Attitude and behavior change is achieved by means of persuasive strategies, such as social influences embodied in the design of interactive technologies, without any coercion or deception. Persuasive technologies are used to change people’s behavior in various domains such as healthcare, sustainability, education, or marketing.

PERSUASIVE, the International Conference on Persuasive Technology, is the leading venue for ground-breaking research and novel designs of persuasive technologies. It is the annual conference to discuss the latest persuasive theories, strategies, applications, and artifacts with academics and practitioners from all over the world. Over the past decade the conference was held at exciting places such as Chicago, Padua, Sydney, Linkping, Columbus, Copenhagen, Claremont, Oulu, Palo Alto, and Eindhoven.

PERSUASIVE 2016 was the 11th edition of the conference and took place in April 2016 in Salzburg, Austria. The conference theme was “Contextual Persuasion: Supporting Life Situations and Challenges by Persuasive Design.” With this conference theme, the ubiquity and situatedness of persuasive interactions was emphasized: How are interactions with persuasive technologies influenced and facilitated by spatial, temporal, social, or individual conditions and characteristics? How can we analyze, design, and evaluate for specific contexts or conditions?

This volume collects the accepted poster submissions, demos, workshops, and contributions to the doctoral consortium. It is a companion volume to the conference proceedings that contains long and short papers and which is published by Springer.

We are very grateful for all who contributed to make this conference a success, in particular the authors, chairs, reviewers, and workshop organizers, and hope that you enjoy the submissions presented in the adjunct proceedings.

April 2016

Alexander Meschtscherjakov
Boris de Ruyter
Verena Fuchsberger
Martin Murer
Manfred Tscheligi
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Alexandra Millonig  Austrian Institute of Technology, Austria
Rita Orji  McGill University, Canada
Enhancing Persuasive systems Design’s productivity: 
towards a Domain-Specific Language for persuasion strategies

Saad Abdessettar, Mickaël Gardoni, Bessam Abdulrazak

Saad Abdessettar is a PhD candidate at the École de Technologie Supérieure (ÉTS) (Montréal-Canada). He has a computer engineering diploma since 2001 from ENSIAS (Rabat-Morocco), and an MBA from HEC Montréal in 2008. Email: Saad.abdessettar@gmail.com

Mickaël Gardoni is professor and director of the innovation management program at ÉTS (Québec - Canada) and acting director of the PhD school. He was professor at INSA de Strasbourg and INP Grenoble (France) and Co-Director of the "French-Chinese PLM Centre for Innovation" in Tsinghua University, Beijing, China. Email: mickael.gardoni@etsmtl.ca

Bessam Abdulrazak is professor at the University of Sherbrooke (Québec - Canada), director of the research center on smart habitats, and active researcher at the Research center on Aging and the Interdisciplinary Institute for Technological Innovation (3IT). He received his PhD from Telecom SudParis (France). He has published more than 100 academic papers, and served as general chair for a number of conferences. Email: Bessam.Abdulrazak@usherbrooke.ca

Keywords: Persuasive technology, CAPTOLGY, behavior engineering, DSL, Domain-Specific Language, Persuasion Strategy, Behavior Change, Behavior Design

Abstract. Assisting designers throughout the Persuasive Design processes is key productivity success. Though, there are still lack of tools and models that enable better productivity management. Indeed, all persuasive system design models highlight the need for tests before implementing persuasive strategies. These tests are challenging as they are often time and resource consuming. We believe that Domain-Specific Languages can enhance productivity in Persuasive Design processes. These Languages can provide the expressiveness power needed either for designing and testing persuasion strategies. In our research work, we discuss our analysis of existing tools and models and we explore the possibilities and limitations of a Domain-Specific Languages to be applied and/or adapted to persuasive technologies.

1. Background

Persuasive systems can be seen as systems designed to change user attitude or behavior without coercion or deception (B. J. Fogg, 2002). In this domain, Fogg proposed an eight step methodology to design persuasive systems, which was refined later in a Behavior Wizard (B. Fogg & Hreha, 2010). (Lockton, Harrison, & Stanton, 2008) proposed the Design With Intent (DwI) method, which target a wider field than Persuasive Technology by considering forcing and coercion in behavior.
change strategies. (Oinas-Kukkonen & Harjumaa, 2009) presented a new framework for designing and evaluating persuasive systems called “Persuasive System Design (PSD) Model.” The framework underlined seven postulates behind a three phases PSD model that focus on the use of contexts. Later, (Oinas-Kukkonen, 2010) proposed the “Behavior Change Support Systems (BCSS)” as an information system designed to form, alter or reinforce attitudes, behaviors or an act of complying without using deception, coercion or inducements. All these four existing Persuasive Design models have significantly contributed to the advance of knowledge in persuasive technology science. Nevertheless, productivity limitations still need to be addressed (Torning, 2013).

The persuasive system designing methods and models (presented above) are based or inspired from the Fogg Behavior Model (FBM) (Fogg, 2008). In his FBM, Fogg stressed that in order to drive user (persuaded person) to a target Behavior, three conditions have to be fulfilled: 1) Motivation to do the Behavior, 2) Ability or capacity to do it easily, and 3) the trigger that would fit the right moment to make the Behavior happen. Another model has been proposed by (Michie et al., 2011) to capture a range of mechanisms and rules, that may be involved to ensure behavior change effectively and efficiently. The model was named The Capability, Opportunity and Motivation (COM-B). The later was based on existing theories of behavior and a consensus meeting of behavioral theorists. COM-B hypothesizes that in order to get the target behavior performed, there must be interactions between Capability, Opportunity and Motivation. (Michie et al., 2013) proposed then her Behavior Change Technique (BCT) with a defined taxonomy, to guide behavior change designers in their persuasion strategy or behavior change design.

2. Research motivation

All Persuasive Design methods highlight the need for iterative and quick tests, in order to give designers the ability to evaluate and adapt his persuasion strategy while implementing it. To our knowledge, there is no solution on tools or frameworks for designing and testing persuasive strategies. Existing solutions focus mainly on methods and methodologies to guide the design process of the persuasive system. There is less attention given to facilitate persuasion strategy design, test, simulation and implementation. Moreover, the majority of the presented Persuasive Design methods and models do not offer solutions to measure the efficiency of their Persuasive Design outputs, or test and evaluate
the persuasiveness or the feasibility of the persuasion strategy embedded in the designed product. From another point of view, designers of persuasive systems lack a common vocabulary of expressing behavior change tactics and persuasion strategies, which complicate specification, communication, collaboration and agreement between domain experts.

3. DSL for modeling persuasion strategies

We focus in our research work, on the productivity aspect related to the design process, and we stress the need for more efficient techniques to design persuasive strategies. We then, explore the opportunities of a Domain-Specific Languages (DSL) to facilitate persuasion strategies design. Indeed, DSLs offer focused expressive power that can facilitate designing and testing of persuasion strategies. DSLs have been successfully applied in numerous domains such as financial engineering and mathematics (FORTRAN, COBOL), artificial intelligence (LISP) etc. Still, DSLs have not been explored in the domain of Persuasive Technology. Therefore, our research aims at introducing a DSL for Persuasive technologies.

Numerous research studies (Cleaveland, 1988; Klint & Van Rozen, 2013; Van Deursen & Klint, 1998; Van Deursen, Klint, & Visser, 2000) have been undertaken on how to design and implement DSLs. The majority shares the following steps:

- Analysis: (1) Identify the problem domain. (2) Gather all relevant knowledge in this domain. (3) Cluster this knowledge in a handful of semantic notions and operations on them. (4) Design a DSL that concisely describes applications in the domain.
- Implementation: (5) Construct a library that implements the semantic notions. (6) Design and implement a compiler that translates DSL programs to a sequence of library calls.
- Use: (7) Write DSL programs for all desired applications and compile them.

We believe that bringing the expressiveness power of DSLs to persuasive design processes will enable bring agility and flexibility, as well as reduce the time to finish the design process and improve productivity. Therefore, our goal is to build a DSL for Persuasive technologies. Persuasive technology is now a relatively mature science domain compared to what it was since its initiation by (BJ. Fogg, 1998).

Poster Abstracts
Adjunct Proceedings of the 11th International Conference on Persuasive Technology, April 4-7, 2016, Salzburg, Austria. Copyright held by the authors.
4. Conclusion

As a solution to the existing limitations, we proposed and discussed the use of domain-specific language in order to improve Persuasive Design processes productivity, and facilitate communication and collaboration between domain experts. Currently, we are working on the design and implementation of the proposed DSL for persuasion strategy design. We plan to evaluate the language in a real education case in collaboration with an industrial partner.

References


Using Regulatory Focus Theory for a Mobile Device Renovation Application: Nudging Users Towards Building Green Houses

Jean-Baptiste Corrége, Céline Clavel, Julien Christophe, and Mehdi Ammi
LIMSI, CNRS, Université Paris-Saclay, F-91405 Orsay
jean-baptiste.corregé@limsi.fr

Abstract. We propose a preliminary study aiming to apply Regulatory Focus Theory to building renovations. We developed a mobile application to test if a priming technique could influence users and the choices they make when it comes to select equipment such as a heater or thermal insulation. First results show that choices might be affected by the priming task. The question remains though as to how to ecologically and non-intrusively prime users of such applications.

Keywords: Regulatory Focus Theory, Priming, Persuasive Design, Building Renovation

1 Introduction

A key to reduce households’ energy consumption is to improve the efficiency of the buildings they’re living in. In France, thermic regulation (RT2012) imposes a framework for buildings’ thermic performances and sets an ideal improvement of existing buildings’ performances by 38% by 2020. Although energy and water conservation are assessed in the literature, there is a lack of study applying social and cognitive psychology’s findings to building renovation. Knowing this, it is interesting to develop tools for individuals who wish to renovate existing buildings in order to a) help them elaborate their project and b) motivate them to make their project green.

2 Theory

We propose a study aiming to apply Regulatory Focus Theory (RFT) to a mobile application designed for building renovation. This theory describes two motivational systems (regulatory focuses) coexisting for each individual [4]. Those systems are focused on achievement (promotion focus) or preservation (prevention focus). For every individual one of the two systems is dominant, although both coexist and can be alternatively activated to ensure adaptation. The dominant (chronic) focus influences motivations, decisions and strategies preferentially used [9]. This chronic focus can be used while designing tasks in order to
motivate individuals. Higgins [5] elaborates the Regulatory Fit Effect and shows that a fit happens when context frame and chronic focus match. This fit has two main effects on individuals: it facilitates information processing and makes individual "feel right" about the processing. If this effect applies to completion of specific tasks, it can also be applied in order to manipulate decisions made by individuals [2]. Indeed, any of the two focuses can be occasionally activated with a priming task [10]. In their meta-review, Ludolph & Schultz [8] analyzed the use of RFT for designing health promotion messages. Results show that it is an effective way to improve the impact of these kind of messages. Authors identify possible leads for future works, such as potential differences between chronic and induced regulatory focus on regulatory fit’s effect, or the activation duration of the primed fit. From the literature, we draw two problematics. The first one is whether works presented in the literature could apply to the field of building renovation. We hypothesize that priming a given focus could allow designers to manipulate decisions made by individuals. The second one is to what extent the priming of a regulatory focus, independently of the chronic focus, moderates the regulatory fit effect. Indeed, if there are works covering the impact of priming incongruent regulatory focus on cognition [7], these works don’t cover judgment and decision. We hypothesize that in a decision situation the primed focus will override chronic focus and the decision should mainly fit with primed focus.

3 Experiments

3.1 Study 1

Methodology 46 participants were recruited and dispatched over three experimental groups (10 in the neutral condition and 18 in each of the two others). We used a mixed 3 (priming) x 3 (framing) design. The priming task is a labyrinth-resolution task in which the participant controls a mouse [3]. In the control condition, subjects have to resolve as many labyrinths as possible, without any more context. In the promotion condition, we added context elements (there was a cheese in the middle of the labyrinth) and the goal was to help the mouse get as many cheeses as possible. In the prevention condition, the context changed (there was an owl flying over the maze and an exit gate in the middle of the labyrinth) and the goal was to help as many mice as possible escape the predator. The priming task is set at the beginning of the experiment, after the completion of a questionnaire evaluating regulatory focus orientation. Every participant saw only one condition of the labyrinth. After completion of the priming task, participants were asked to reproduce a plan of a house using a drawing application. They then had to select different kind of equipment (heater, windows, wall and attic insulation). For each equipment, three products were presented and described by a one-sentence text (either neutral, promotion or prevention) and a picture. Picture/product association and presentation order were randomized. Eventually, participants completed three questionnaires evaluating regulatory focus orientation (the same as the one completed at the beginning plus two others, order was randomized), and answered socio-demographic questions.
Results & Discussion  Since distribution did not follow a normal law, we used non-parametric tests. We used Mann-Whitney test to compare results between experimental groups and Wilcoxon Signed-ranks Test to compare results within groups. All statistics tests were conducted under IBM SPSS Statistics. Measure of the chronic regulatory focus revealed a clear imbalance between samples. Participants in the promotion group were significantly more prevention focused (Mdn = -0.37) than those in the prevention group (Mdn = 0.3), U = 93, p < .05, r = .35. Moreover, participants in the promotion group were globally prevention focused, although gap between promotion and prevention score was not significant. On the contrary, participants in the prevention group were more promotion (Mdn = 5.12) than prevention focused (Mdn = 4.65), Z = 2.03, p < .05, r = .48. Manipulation check did not reveal a significant effect of the priming task on participant’s activated focus, although promotion-prevention discrepancy did move in the expected way (from -.18 to .14 in the promotion priming condition, from .51 to .32 in the prevention priming condition). As for the effect of the priming task on participant’s decision, there was no significant differences on number of products chosen for each condition. The lack of significant effect of the priming task on participant’s activated focus could be caused by the particular profile of the participants in each group. Moreover, although the priming task did not seem to affect decision making, feedbacks from participants revealed that they tended to interpret the neutral message according to their available focus. These comments led us to draw the hypothesis that there might be no such thing as a neutral message and our measures would be consequently biased.

3.2 Study 2

Methodology  We tested this hypothesis in a short on-line questionnaire. 83 participants completed it, 4 were excluded because of an excessive completion time. We used a between-subject design, each group was exposed to a specific priming task, either promotion (n = 42) or prevention-focused (n = 37). The priming task is set at the beginning of the experiment and consists of a text previously used for priming in literature [6]. After reading it, participants evaluated the neutral message on both a promotion and a prevention 6-point Likert scale. The order of presentation of the two scales was randomized.

Results & Discussion  Results showed that in the promotion condition the message was evaluated as significantly more promotion (Mdn = 5) than prevention (Mdn = 4), Z = 2.67, p < .05, r = .36. There was no difference between the two scores in the prevention condition. Accordingly, we analyzed results from the first study under a new scope. We aggregated results of the neutral message to those of the primed focus (i.e. neutral message was considered promotion in the promotion priming condition and prevention in the prevention priming condition). In order to counterbalance the fact that there was an uneven number of messages (2 for the primed focus and 1 for the other one), we z-scored the means. New analysis revealed that, despite the absence of significant difference, choices
went in the expected way for the promotion condition. Indeed, participants in this condition chose slightly more promotion than prevention products.

4 General discussion & Conclusion

The first results presented here, although partial, provide useful insights for both researchers and designers. Firstly, it appears to be seemingly impossible to use neutral conditions when it comes to RFT. Indeed, our on-line study showed that the message we designed as neutral was in fact interpreted by participants according to their focus. This raises an important methodological question for future works on RFT and whether using a priming task is actually more efficient than no priming when it comes to influencing participant’s decisions. Secondly, using a priming task to influence decision making, independently of the chronic focus, seems to be possible but should be considered with caution. There is a cultural aspect of the RFT that could explain the difficulty to prime a prevention focus on our sample [1]. Culture of the targeted population is to be be taken into consideration in order to design efficient interfaces.

Acknowledgments. This study was funded by Rénovation Plaisir Énergie (RPE).

References

Technologies for Self-Improvement: The Right Communication Between Product and User

Sarah Diefenbach, Jasmin Niess, and Barbara Mehner
Ludwig-Maximilians-University, Munich, Germany
sarah.diefenbach@lmu.de, jasmin.niess@lmu.de, b_mehner@web.de

Abstract. Technologies for self-improvement (e.g., fitness gadgets, nutrition apps) take an increasingly important role within the field of persuasive technology. Technology enters the role of a well-being coach, supporting people in the achievement of personal goals and behavior change. The present research explores the notion that just like in face-to-face settings, the form of dialogue may present an essential factor for motivation and ultimately behavior change. We present results from an empirical study among users of self-improvement tools (N=177) where we clustered the perceived communication styles based on models from communication psychology. Particular styles could be identified as more associated to change success than others, and were associated with particular elements of interaction design. Conclusions and plans for future research are discussed.

Keywords: Self-improvement technologies; user experience; communication style; change success; interaction design.

1 Introduction

Technologies for self-improvement (e.g., fitness gadgets, meditation apps) take an increasingly important role within the field of Persuasive Technology [4]. Technology, thereby, takes the role of a well-being coach and engages the user into a dialogue. The product becomes a material argument between user and designer [7], encouraging reflection about ways to a psychologically or physiologically healthier lifestyle. In contrast to the profound exploration of the communication style between coach and client as an important medium of successful change in psychology (e.g., [8]), little attention has been paid to this aspect in the context of technology design. As revealed by recent reviews [3], [5], a large part of the available mobile technologies for health and behavior change lack an integration of psychological knowledge, especially motivational factors are not sufficiently considered, although psychological knowledge provides an essential basis for the design of technology [4]. The present research explores the notion of the communication between product and user as a central factor for the user experience of self-improvement technologies. In our opinion this could be one step towards a better integration of psychology and HCI in the domain of self-improvement technologies and persuasive technology in general.
2 Pre-Study: User Experience and Perceived Communication of Self-Improvement Technologies.

A pre-study [2] explored users' experience of existing self-improvement technologies, with a particular focus on the perceived communication style. 62 users reported on different tools for self-improvement such as smartphone apps or fitness wristbands. 58% turned out as "successful users" and reported continued use or having stopped use after successful support. However, 42% cancelled using the technology before significant progress, since not feeling well supported, which indicates wasted potential for change. Characterizations of the product and its interaction provided further insights into potential underlying reasons: While successful users described the product with positive-neutral attributes (e.g., analytical, reliable), drop-outs used more negative characterizations (e.g., dominant, demanding). We further explored users' perceived communication by models from communication psychology, e.g., [9]. Participants' ratings revealed significant differences between the specifications of particular communication styles and a high sensibility to the product's communication in general. The form of dialogue a product suggests is something that users perceive and can actively reflect on.

3 The Right Style of Communication for Interactive Coaches: Emotional Experience, Change Success, Interaction Design

After first support for the general relevance of the perceived communication style of self-improvement technologies, we further explored relations to emotional experience, change success, and elements of interaction design. A sample of 177 users (127 female, mean age 31 yrs., min=18, max=65) reported on their personal change process and the perceived style of communication of a currently used self-improvement technology (e.g., nutrition apps, step counters). The present analysis focused on four different communication styles: critical-aggressive, rational-distanced, diligent-controlling, and helping-cooperative, each assessed by one summary statement such as "Critical-aggressive: reveals my failure and deficits." For all measures, participants indicated their agreement on a 7-point scale (1=not at all, 7=completely). Emotional experience was assessed by two single ratings on positive affect and negative affect. Change success was assessed by three items, e.g., "The technology helped me to reach my goals". A score of change success was computed by averaging the three items (C's α.89).

3.1 Communication Styles, Emotional Experience, and Change Success

The pattern of correlations between the communication styles, emotional experience, and change success (see Table 1) revealed the diligent-controlling and the helping-cooperative style as most related to change success, both equally related to positive affect and non correlated to negative affect. The rational-distanced style appeared to have not much positive but also no negative effect on the emotional experience. In contrast, there were clearly negative experiential associations regarding the critical-aggressive style.
Table 1. Correlations between communication style, emotional experience, and change success.

<table>
<thead>
<tr>
<th>Communication Style</th>
<th>Positive Affect</th>
<th>Negative Affect</th>
<th>Change Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical-aggressive</td>
<td>-.16*</td>
<td>.26**</td>
<td>-.07</td>
</tr>
<tr>
<td>Rational-distanced</td>
<td>.15*</td>
<td>-.11</td>
<td>.12</td>
</tr>
<tr>
<td>Diligent-controlling</td>
<td>.21**</td>
<td>-.03</td>
<td>.25**</td>
</tr>
<tr>
<td>Helping-cooperative</td>
<td>.20**</td>
<td>-.13</td>
<td>.28**</td>
</tr>
</tbody>
</table>

Note: * = p<.05, ** = p<.01.

3.2 Related Change Factors and Elements of Interaction Design

A next step of analysis explored the relations between a particular communication style and so-called bitter and sweet change factors. The positive change model [1] assumes that change always consists of bitter and sweet facets, such as positive visions and the experience of progress (sweet) but also the confrontation with deficits, which ultimately initiates a desire to change (bitter). The present analysis focused on four change factors, with particular strong relations to interaction design: Need for change (bitter) describes the confrontation with deficits, e.g., through visualizations of the status quo and the gap to one's ideals. Appeal (bitter) comprises the clear and definite call to change, e.g., through concrete verbal instructions. Autonomy (sweet) refers to the degree that the product supports autonomous decisions on the way of change and how to reach one's goals such as customization or flexible intervals of reminders. Encouraging feedback (sweet) refers to positive responses to the user's actions, for example, in the form of points or other rewards for steps of change. Each change factor was assessed with three items (see [6] for a detailed description). Sample items are "The product..." "reveals that I have not yet reached my ideal" (need for change) or "provides positive feedback" (encouraging feedback). Average scores were computed for each factor with satisfactory internal scale consistency (C’s α: need for change: .71, appeal .76, autonomy .79, encouraging feedback .83). We further explored relations between particular combinations of such factors and perceived communication styles. Figure 1 shows the specification of the change factors depending on the dominant style of communication (that is, the communication style with the highest ratings among the four).

Fig. 1. Perceived communication styles and related factors in interaction design.
It shows that different communication styles emerge from different patterns of change factors. For example, both the helping-cooperative and the diligent-controlling style are related to a high degree of appeal through the product. For the helping-cooperative style, this is combined with a high degree of autonomy as well. But even if sweet in itself, autonomy must be combined with more bitter factors of change, such as appeal and need for change, to be perceived as helpful. If not, the perceived communication is rather rational-distanced, and, as discussed above, less promising for change success.

4 Conclusion and Future Research

Besides a general readiness to use technology as a coach for self-improvement and behavior change, our studies suggest some degree of wasted potential as well. In our pre-study, almost half of the users stopped using the technology since it did not fulfil its given role in an appropriate way, namely being a helpful coach on the way to change. A more sensible design of the dialogue and communication between product and user may be one way to improve this situation. The present approach provides a first step towards a deeper exploration of a meaningful representation of psychological knowledge in the user-product-dialogue, so that products can actually take a helpful "therapeutic attitude". In particular, future studies will address relations between the feedback provided, visualizations of progress, timing and kind of instructions, and general possibilities for a positive connotation of a need for change in interaction design.

References

Ambient Light Guiding System to Improve the Motility and Mobility of Elderly People

Isabella Hämmerle, Walter Ritter, Guido Kempter
University of Applied Sciences Vorarlberg, Research Centre for User Centred Technologies
Campus V, Hochschulstraße 1, A-6850 Dornbirn, Austria
{isabella.haemmerle,walter.ritter,guido.kempter}@fhv.at

Abstract. This study examined, if intelligent interior illumination (“Guiding Light”) can change the motility and mobility behavior of elderly people over time. The aim was to align increasing motility and mobility with a predetermined desired daily structure – to have the right amount of activity at the right time at the right place. Three groups of elderly people living in their private flats were compared, two intervention groups which got different interventions with the Guiding Light system and one control group. The results indicate that elderly people can be guided to specific places at particular times through a spatial and temporal configuration of the light intensity and light color of LED-lamps. However, a replication study with a bigger sample is recommended to confirm the effects of Guiding Light.

Keywords: Guiding Light, spatial and temporal orientation, LED-lamps

1 Introduction

People usually follow an individual daily structure, which can differ according to weekdays or holidays, but follows a recurrent pattern over a longer time period [1]. Bedtimes, for example, show a big regularity, the time spent in kitchen, living space and bathroom are repeated within a certain fluctuation range and time spent outdoors often follows a pattern [2]. However, under certain circumstances, for example in the course of the aging process, the hitherto habitual daily structure can undergo an unintentional change [3]. In this case, a light guiding system, which enhances not only the day-/night rhythm but also a more differentiated daily structure rhythm through room lighting, could provide a remedy. The influence on the day-/night rhythm of temporal variation of light intensity and color has already been proven several times [4,5]. Findings regarding how spatiotemporal variation of light intensity and color affects where a person prefers to stay at particular times during the day are rare, but there are some studies that indicate that it is possible to guide people with light [6,7].

To answer the question if intelligent interior illumination can influence the spatial and temporal orientation of elderly people without any other information, a project consortium decided to develop an intelligent light guiding system called “Guiding
Light”. This system should change the motility and mobility behavior of elderly people over the time. The aim of Guiding Light is to align increasing motility and mobility with a predetermined desired daily structure – to have the right amount of activity at the right time at the right place.

2 Method

To evaluate if a guiding light system can change the activity patterns of elderly people, LED-technology was used. Different indirect and direct luminaires were installed in private flats of elderly people. First the individual daily structure of the participants was gathered. On the basis of this daily structure a detailed light plan was made for every flat to create an individual lighting situation, which supported the activities of the person best. Indirect illumination (ambient room lighting) was used to illumine the whole room according to the individual circadian rhythm, whereas the direct illumination was used to illumine defined room zones, in which the participants should be at particular times for specific tasks according to their daily structure.

The study consisted of three different groups – two intervention groups and one control group. One intervention group had a day-/night (DN) rhythm and the other group had a daily structure (DS) rhythm. The difference between these intervention groups was, that if the light sensor was actuated, the luminaires of a room zone in the DS group were activated with maximum brightness if a person should stay in this particular room zone according to her individual daily structure. Otherwise, the room zone lighting used the settings of the ambient room lighting. Moreover with the subjects of the DS rhythm illumination a target daily structure was defined, which differed from the identified actual daily structure. This wasn’t done for the DN group.

2.1 Data collection

The test period lasted from summer 2014 until spring 2015. Data collection started at different times in the participating households, but at least one month before the light installation and the activation of Guiding Light. During the entire study the motility and mobility of the participants as well as the alignment of both attributes with the individual daily structure was examined successively by means of Passive-Infrared-Sensors. The gathered data was analysed every 14 days and based on the results the lighting concepts for all luminaires were regularly adjusted.

2.2 Sample

The participants included 3 men and 16 women at the age of 63 to 89 (four participants were assigned to the DS group, seven to the DN group and eight to the control group which didn’t receive the Guiding Light System). At the beginning of the study they didn’t differ substantially regarding their physical fitness, their mental fitness, their extent of social contacts and their quality of sleep and life.
3 Results

A comparison of the individual target daily structure with the continuously updated actual daily structure was made to see how well they match. If a person always is at a predefined time at a predefined location, the daily structure fit is 100%. If the time before the light intervention is compared with the time after the light intervention (for the control group two comparable timeframes – observation period 1 and 2) it can be seen that the fit of the daily structure increased slightly for the DS group from $M_{DS1} = 31\%$ to $M_{DS2} = 32\%$ and decreased for the other two groups (from $M_{CG1} = 37\%$ to $M_{CG2} = 34\%$; from $M_{DN1} = 33\%$ to $M_{DN2} = 32\%$). The daily structure fit of each group (for comparable timeframes) can be seen in figure 1.

![Daily structure fit comparison](image)

**Fig. 1.** Daily structure fit (comparison of the target daily structure with the steadily updated actual daily structure) in %. Top: control group. Middle: lighting with DN rhythm. Bottom: lighting with DS rhythm. Arrows: start of light intervention for the respective participant.

The average degree of movement per day was calculated for each group. Then each group mean of the period before the first light intervention was compared with the group mean of the period after the first intervention. The two periods were depending on the implementation of Guiding Light and thus not the same for all participants. For the control group the process data was divided in two comparable time periods. Univariate ANOVA showed significant differences for the comparison of the degree of movement of different periods ($p < .001$). The degree of movement in the DS group increased from $M_{DS1} = 683$ min. of movement to $M_{DS2} = 789$ min. of movement.
whereas the other groups didn’t show a significant increase (from $M_{CG1} = 352$ to $M_{CG2} = 368$ and from $M_{TN1} = 252$ to $M_{TN2} = 253$ min. of movement). The comparison of the time spent outdoors showed a similar trend – only the DS group showed an increase in time spent outdoors, $p < .001$ ($M_{DS1} = 288$ min. to $M_{DS2} = 300$ min.; $M_{CG1} = 292$ min. to $M_{CG2} = 256$ min.; $M_{DN1} = 318$ min. to $M_{DN2} = 270$ min).

4 Discussion

The aim of this study was to change elderly peoples activity patterns with an intelligent light programming. Since only one daily structure was used for different weekdays and even holidays, the expectations regarding the fit of the target and actual daily structure shouldn’t be too high. The fit within the control group and the DN group decreased over time whereas it increased within the DS group. The fitting accuracy of the DS group isn’t much higher in the end than for the other two groups, but it has to be taken into account, that for the DS group the fit in the beginning was much lower because of the newly defined target daily structure, which wasn’t done for the DN nor the control group. One crucial point are the costs for such a system which are rather high at the moment. To keep costs lower in the future, the implementation of this system should already be envisaged in the planning phase of a building. The results of this study indicate that people can be guided to specific places at particular times during daytime by a spatial and temporal configuration of light intensity and light color of LED-lamps. However, a replication study with a bigger sample is recommended to validate the effects of Guiding Light.

5 References

Increasing Acceptance of Advanced Driver Assistance Systems by Making Use of Driver Profiles

Hanneke Hooft van Huysduynen, Jacques Terken, Berry Eggen

Technische Universiteit Eindhoven, Eindhoven, The Netherlands

Abstract. The acceptance of intelligent systems is a condition for achieving the aims of these systems as for example, increase of safety and efficiency. This requires that we take into consideration that each driver has his or her own needs and interests while driving. In particular, persuasive strategies that are intended to increase the acceptance may influence one type of driver, but may not work at all for another type of driver. This paper presents an exploration of the design potential for applications that aims to increase the acceptance of intelligent driver assistance systems for both careful and risky drivers.

Keywords: Advanced Driver Assistance Systems (ADAS), Intelligent Systems, Design Space, Driving Styles, Persuasive Technologies.

1 Introduction

Advanced Driver Assistance Systems (ADAS), such as Cooperative ACC, are developed with the aim to increase safety, efficiency, driver comfort and to reduce driver’s workload. Most of these systems interact with the driver with the purpose to advise or assist the driver or even to take over control altogether in certain driving situations [1]. Increased use of ADAS may reduce traffic accidents and improve the traffic flow, indicated by a higher average speed and a decrease of the number of shockwaves leading to congestions [2]. An increase in the number of drivers who adopt such systems may therefore enhance the impact of these systems on traffic safety and traffic flow.

Persuasive technologies may be applicable to influence drivers to adopt such systems. Since people differ in their needs and interests, strategies that are intended to influence one type of driver to use intelligent systems may have no or even a negative influence on other types of drivers [3, 4]. For example, when an angry driver receives an advice to slow down to create a gap for another vehicle s/he may just neglect this advice and speed up to close the gap, while a careful driver will likely comply with this advice. Identifying differences between drivers, in terms of their driver profiles and tailoring strategies according to those profiles may help to increase driver’s compliance with intelligent systems in vehicles. Our aim is to explore the design potential for in-car applications to enhance the overall acceptance of intelligent systems by different types of drivers through the use of persuasive technologies.
2 Related Work

2.1 Behavior Change

Multiple studies have been conducted with the aim to change the behavior of people in different contexts. A probe study conducted by Gärtner et al. [5] revealed that driving behavior may change due to specific experiences such as accidents, the availability of supporting technology and learning the consequences of certain behaviors. Also, negative changes of behavior were reported: experience built up over the years can result in loss of attention; and while vehicles become safer, technologies such as mobile services decrease safety. In order to achieve a positive change of behavior, persuasive technologies may be applied, either as a tool, media or social actor [6]. Furthermore, Kaptein [4] showed that personalized persuasion can be more effective in motivating behavior change by creating tailored persuasive messages to influence people’s behavior, making use of the strategies defined by Cialdini [7].

2.2 Driving Styles

One way to personalize persuasion is to look at people’s driving style. Hooft van Huysduynen et al. [8] looked into different questionnaires to determine someone’s driving style. Using the MDSI they could identify six driving styles: Angry, Risky, Anxious, Dissociative, Careful and Distress-Reduction driving style. Depending on the driving styles, specific approaches and strategies may be explored to influence driving behavior. This paper will focus on two driving styles, the Risky and Careful driving style.

3 Design Space

The main difference between a careful and a risky driving style is the driving speed, as risky drivers most of the time drive at or faster than the maximum speed and careful drivers more often drive below the maximum speed [8].

A second dimension, addressing to what extent the behavior of the driver is intentional or unintentional, can be placed perpendicular to the dimension of careful versus risky driving. We assume that someone may drive intentionally risky as a result of wanting to be in time at the end destination and believing that through higher speed and faster acceleration this goal can be achieved, or wanting to achieve a certain level of arousal when driving. Others may drive riskily unintentionally because driving more inattentively / dissociative can result in less awareness of their actual speed, creating more variations in their speed. We consider that an intentionally careful driver mostly tries to maintain control of the vehicle in more difficult situations or aims at more sustainable driving through lower speed and acceleration in order to reduce the fuel consumption. As other drivers drive more carefully as they experience higher speed and smaller gaps as more scary and drive mostly unintentionally at a lower speed.
The four different quadrants resulting from these two dimensions each have their own characteristics, needs and experiences. Selecting the most suitable persuasion strategy for each quadrant is important. Looking at the Captology concept [6] that conceives computers as tools, media or social actors, four different strategies can be defined to personalize the persuasion to the four different design spaces. Tools can provide support to people while driving; media can provide stimulating experiences and social actors can motivate people through correcting behavior or by providing feedback about the effect of their way of driving.

Fig. 1. Framework of Risky and Careful Driving Styles

Drivers who are categorized as unintentionally risky drivers are less aware of their driving by, for example, distraction created by secondary tasks such as the use of a mobile phone while driving. Persuasion through correcting risky behavior may support these drivers in maintaining a more safe and careful driving. Corrections by the system should be noticeable by the driver; this can for example be done through a change in feedback force of the steering wheel or gas pedal. Intentionally risky drivers are aware of their driving behavior and mainly focus on pursuing their goal. For example, trying to be at their destination as fast as possible or maintaining the preferred level of arousal. If intelligent systems in vehicles aim to induce a more careful driving style, it may create a mismatch with this type of driver. To support the compliance for this type of driver a system could be designed that creates an experience that substitutes the experience of risky driving. For example, creating a light beam in the vehicle through which light will move at a faster rate than the driven speed. This may produce a feeling of speed higher than the actual speed. Unintentionally careful drivers tend be more anxious when driving, resulting in lower speed. In order for intelligent systems to effectively support them in their driving it is important that this type of drivers trusts the system. To support the compliance of intelligent systems for this type of driver a system should support and create trust. For example, by creating an auto pilot that will take over the task initiated by the driver. As a last example, intentionally careful drivers tend to drive sustainably, for example, by focusing on the goal to reduce fuel consumption. Intelligent systems support the reduction of fuel consumption; in addition, we assume that these drivers also prefer keeping control / having high situation awareness. To support compliance with intelligent systems, for this type of driver extra information should be provided to keep the driver in the loop without the driver actually driving. For example, through sounds, visual or haptic...
feedback in the car seat the driver is always informed about vehicles or other obstacles around the vehicle.

4 Conclusion & Future Work

In this paper we propose a framework defining four different design spaces that may be taken into consideration when designing persuasive technologies for vehicles as different driver differ in needs and interests. In this framework the driving styles Risky and Careful constitute one dimension. Perpendicular to the dimension of Risky and Careful driving a second dimension was created indicating intentional versus unintentional driving behavior. These two dimensions create four different design spaces around four different driver profiles which can support the exploration of the design potential for in-car applications.

The next step is to verify the assumptions of the different needs and interests within the four different design spaces. Next to that we want to design concepts according to the four different design spaces and evaluate the influence on the acceptance of intelligent systems in vehicles. Secondly, we aim to understand the effect of those concepts when they are not in line with the driver’s driving style.

References


Maurits Kaptein and Jules Kruijswijk
Tilburg University, Tilburg, the Netherlands
Assistant Professor, Statistics and Research Methods
m.c.kaptein@uvt.nl

Researchers in the persuasive technology field have demonstrated the effectiveness and utility of persuasive applications in diverse domains such as healthcare, energy reduction, and interactive marketing (see, e.g., 4; 2). However, there is an aspect of persuasive technologies that has long been advocated by scholars, but has by-and-large not left the research realm; this is the basic notion that persuasive technologies should “deliver the right message, at the right time, to the right user” (see, e.g., 3). Although there is a common understanding that persuasive technologies should be made both adaptive and personalized, creating such systems is challenging. The successful development of adaptive persuasive systems requires a combination of design, social science, and technology. With this poster we contribute to the latter: we introduce StreamingBandit, a platform that supports the “logic and reasoning” of adaptive or personalized persuasive systems. StreamingBandit is available open-source to those wishing to create adaptive persuasive systems.

1 Introducing StreamingBandit

StreamingBandit is designed using the following formalization of a personalized persuasive system:

- We assume index of the interactions $t = 1, \ldots, t = T$. ($T$ is likely undefined at design time).
- The context $x_t \in \mathcal{X}_t$ where $\mathcal{X}$ is a set of variables describing the current state of the application or user.
- The action $a_t \in \mathcal{A}_t$ where $\mathcal{A}$ is a set of possible actions the application can take.
- The reward $r_t$ is a (function of the) measured response at that point in time.
- A policy $\Pi: x_1, \ldots, x_{t'}, a_1, \ldots, a_{t'-1}, r_1, \ldots, r_{t'-1} \rightarrow a_{t'}$, is a mapping from all possible interactions (their contexts, actions, and rewards) up to some point in time $t = t'$ to the next action $a_{t'}$.

In short, StreamingBandit, provides a platform that allows users to implement different policies: different “rules” to assign new actions based on the historical interactions and the current context.¹

¹ Note that the above formalization of the adaptive persuasive system in terms of context, actions, and reward, is known as a contextual multi-armed bandit problem (cMAB, or MAB for the simpler version without a context) (1).
**StreamingBandit** formalizes the challenge of designing adaptive persuasive systems as a contextual Multi-Armed Bandit problem, and allows designers to implement a policy \( H \) on a webserver. The implementation of a policy is split into two steps:

1. The **summary** step: In each summary step a set of parameters \( \theta_{t-1} \) is updated by the new information \( \{x_t, a_t, r_t\} \). Thus, \( \theta_t = g(\theta_{t-1}, x_t, a_t, r_t) \) where \( g() \) is some update function. Effectively, all the prior data, \( x_1, \ldots, x_t, a_1, \ldots, a_t, r_1, \ldots, r_t \) are summarized into \( \theta_t \).

2. The **decision** step: In the decision step, the model \( r = f(a, x_t; \theta_t) \) is evaluated for the current context and the recommended action at time \( t \) is selected.\(^2\)

Figure 1 presents an overview of the platform. **StreamingBandit** is a python 3 application that runs a Tornado webserver (see [http://www.tornadoweb.org/en/stable/](http://www.tornadoweb.org/en/stable/)) and which discloses a REST API that facilitates the implementation of the **summary** and **decision** steps as described above. The two main REST calls are:

- The **decision** call:

  ```
  http://HOST/EXPID/getaction.json?key=EXPKEY&context={}
  ```

  where EXPID and EXPKEY are the ID and key of the current application and the variable context contains a JSON object encoding the context \( x_t \). The call returns a JSON formatted object containing the selected action given the policy.

- The **summarize** call:

  ```
  http://HOST/EXPID/setreward.json?key=EXPKEY&context={} &action={}&reward={}
  ```

  where the context \( x_t \), action \( a_t \) and reward \( r_t \) at a point in time are used to update \( \theta_t \).

**StreamingBandit** allows users to create a new “experiment” to enable the above two calls, and allows users to write custom python 3 scripts that implement the **summary** and **decision** steps. For the Persuasive 2016 conference we have made an instance of **StreamingBandit** available at [http://131.174.75.205](http://131.174.75.205).

### 1.1 Using StreamingBandit

Configuring **StreamingBandit** consists of three steps; first, one creates a new experiment which initializes up the associated REST calls. Second, one implements the **summary** step logic in a custom python script which can be done using the web-based front-end of **StreamingBandit**. Finally, one implements the **decision** step.

\(^2\) Note that one could naively think that \( a_{max} = \text{argmax}_a f(a, x_t; \theta_t) \) would be the best action to choose. However, this ignores the uncertainty in both \( f() \) and \( \theta \).
Here we provide the implementation of an AB-test using **StreamingBandit**. In this simple example there is no context (thus, this is a MAB problem, not cMAB), there are only two possible actions $a_t \in \{A, B\}$, and the reward is a click on a webpage ($r_t \in \{0, 1\}$). The summarize step can be implemented as follows:

```python
1 import libs.base as base
2 prop = base.Proportion(self.get_theta(key="version", value=self.action["version"]))
3 prop.update(self.reward["click"])
4 self.set_theta(prop, key="version", value=self.action["version"])
```

This code updates and stores the click proportion of the different versions (the actions) of the application. The decision step is given by:

```python
1 import libs.base as base
2 propl = base.List(self.get_theta(key="version"),
3 base.Proportion, ["A", "B"])
4 if propl.count() > 1000:
5    self.action["version"] = propl.max()
6 else
7    self.action["version"] = propl.random()
```

Which implements that up to 1000 interactions ($t = 1000$) randomly version A and B are suggested. After 1000 interactions, the version with the highest click through proportion is suggested.

Note that this very simple implementation of an AB-test merely touches the surface of the functionalities of **StreamingBandit**: The platform has already been used to implement personalized pricing of consumer loans for a consumer bank, persuasion profiling on a large e-commerce store, etc. **StreamingBandit** comes with a number of different libraries (such as `libs.base` mentioned above) to enable streaming processing of data. **StreamingBandit** also allows logging of all the calls that are made and all the data that is collected. We have
tried to make `StreamingBandit` both scalable and secure: the management console can easily be protected using signed cookies, and the REST calls to the core summary and decision steps are protected using the experiment ID and key combination. Scalability is ensured by a) using state-of-the-art technologies in the development of `StreamingBandit` such as Tornado (as a base for the webserver), and Redis (an extremely fast, in-memory data-base system), and b) by forcing, by design, the use of online (streaming) analysis. Finally, `StreamingBandit` allows “nested” experiments: hence, the summary or decision steps of an experiment can call, using `self.run_experiment(id)`, the summary or decision code of another experiment. This extremely powerful feature allows one to implement complex logic to compare multiple methods of adaptation or personalization. The full documentation of `StreamingBandit` can be found at: http://mkaptein.github.io/streamingbandit/index.html

2 Conclusions

`StreamingBandit` is still work in progress: Although we have recently released the first stable version of the application on GitHub, we are still developing additional toolkits, examples, and documentation. Also, we are currently using `StreamingBandit` in the evaluation of adaptive persuasive technologies; we hope to be able to report on actual field trials powered by `StreamingBandit` in the near future. However, we think the current version is mature enough to share with the Persuasive Technology community, and to encourage others to use the application. We are actively seeking feedback to improve the application and maximize its use.

References

Long Term Use of Smart Health Devices for Supporting Healthy Living

Early Findings from the Lotus Study

Jochen Meyer, Jochen Schnauber, Wilko Heuten
OFFIS Institute for Information Technology, Oldenburg, Germany
(firstname.lastname@offis.de)

Abstract. Wearable and networked smart health devices provide tremendous opportunities for supporting health behavior in the long term, contributing to better self-awareness, health knowledge, and health literacy. We conduct a study in which we observe the use of smart health devices over a prolonged period of time under real-life circumstances. Deploying the Theory of Planned Behavior, we measure changes in the user’s attitude towards a healthy behavior. Early findings indicate that using smart health devices has a positive impact on the user’s attitude towards a healthy behavior.

Keywords: self-monitoring; health tracking; long term health behavior; Theory of Planned Behavior

1 Introduction

Wearable and networked “smart” health devices [1] undoubtedly have the potential to change the way we care for ourselves and our personal health. Technology is used in, e.g. health behavior change [2] or management of chronic diseases. Products are now available that are affordable and that people are willing and able to use in their daily lives [3]. However, the engagement with these systems is typically fairly short-term, and many people stop using them after a few months, e.g. because they don’t see further advantages from their use [4]. We believe the long-term use of smart health devices, over years, decades, possibly the whole life provides tremendous opportunities for supporting healthy living [5]. In this long-term use, the focus is on information and knowledge about oneself rather than change towards a recommended behavior. Here smart health devices can increase self-awareness and help making decisions about health behavior [10].

We aim to understand whether smart health devices can be used in the long term and under real-life circumstances and what impact the use has on a person’s opinion towards healthy living. In the “Lotus” study (LOng Term Use of Smart health devices) we equip end-users with smart health devices for tracking major features of health over a prolonged period of time. We observe their use of devices under real-life circumstances and measure the change in their opinion towards healthy living.
2 Measuring opinions on healthy living

We utilize Ajzen’s Theory of Planned Behavior (TPB) [6] to describe the view on one’s health. TPB foresees three main components: The *Attitude* describes the individual’s mindset towards a target behavior. The *Subjective Norm* describes the influence that other persons and groups have on the individual’s behavior. And the *Perceived Control* describes to which extent the individual feels that she or he has the resources and abilities to actually perform a targeted behavior. These three components can be quantified using appropriate survey technologies [7].

We already said that long term use of smart health devices is not about behavior change but about health knowledge. Therefore we use TPB to measure a person’s *change of opinion towards a health behavior* as an outcome of long-term health tracking. Following the process described in [7] we constructed a TPB questionnaire for a *generally healthy lifestyle*. Involving experts and end-users, we identified the most important aspects and factors influencing healthy living such as induced stress, perceived value, costs, social pressure, influence by family, external influences, job duties, or built environment. The final questionnaire comprises 35 questions, e.g. “I’m willing to spend money for healthy living” with possible answers ranging from e.g. “don’t agree” to “agree” on a 7 point scale. For our first evaluations we weighted all factors the same and scaled the three components from 0 to 100, where 0 is the most hindering value, and 100 is the most supporting value.

3 Study design

The Lotus study is conducted with 7 persons (3 male), age 35-65, non-technical and non-health experts, over 6 months of time. The participants’ Technology Readiness Level [8] is fairly high (36.7 of 48 points, stddev 3.7). The participants have varying levels of physical activity (2 low, 2 medium, 3 high) [9]. Four participants had experiences with pedometers or tracking apps. Reasons to participate were, i.a., curiosity about the devices (6) and interest to learn about one’s health (4), with just one person indicating the intention to change towards a healthier living as a reason.

We equip the participants with a comprehensive set of up to date health devices for tracking various aspects of physical activity, weight, and sleep. The participants’ task is to use the devices in their daily lives as continuously as possible, as they see fit, and to check their data regularly in the study portal. They are not requested to achieve certain health goals or change their health behaviors. During the study the users fill out the TPB questionnaire every month, and we conduct semi-structured interviews every few months.

4 Initial results after one month

After the first month, the interviews showed in general a positive feedback. Users are able to operate the devices, and they find the insights interesting. The technology can
successfully be integrated in the participants’ daily lives. Although we didn’t encour-
age them, many users felt that the tracking changed their behavior.

The quantitative results from the TPB questionnaire, broken down into the individual components, showed a quite consistent view (see fig. 1). The changes in the overall opinion towards a healthy lifestyle were small (average at t0: 67.8→ average at t1: 66.5). However the attitude (“do I like a healthy lifestyle?”) is going up (78.1→ 83.8) for all participants (stdev 8.3→ 3.6), while the subjective norm (“how important is other persons’ opinion?”) is going down (71.3→ 63.7), and the perceived control (“what prevents me from living healthy?”) is decreasing slightly (53.9→ 52.1) but remains fairly widespread (stdev 14.3).

![Fig. 1. Opinion on healthy living per participant, overall (top left) and by TPB component](image)

5 Discussion and conclusion

The qualitative results from the interviews confirm our previous findings [4]. However, the users are still in the novelty phase of device usage, and it will take more time before we achieve truly novel insights.

We see a change in the three TPB components across the seven participants, which could be interpreted as:

- Increase in attitude: Users are more aware of healthy living. They appreciate the positive aspects of a healthy lifestyle more and/or assess the negative aspects less important
- Decrease in subjective norm: Other persons’ opinions have a more negative influence on health behavior. We will need more insights to explain this.
- Slight decrease, but wide range in perceived control: Users experience some difficulties in living healthy, but this perception varies considerably.

After one month only, the results are preliminary and need further proof in the course of the study. If they persist, they confirm that health tracking has a positive impact on self-awareness. The Lotus study will thus provide novel and valuable insights into individual user behavior and deliver clues for the successful design of technologies for a life-long health and wellbeing.

**Acknowledgments.** This work has been co-funded by the Hewlett-Packard Innovation Research Program.

**References**

Unmasking Player Types
On Exploring the Persuasive Potential of Specific Game Elements for Social Groups in the Context of Mobility Choices

Alexandra Millonig1,*, Konstantin Mitgutsch2, Maximilian Leodolter1, Josef Froschauer3, Wolfgang Ponweiser1

1Austrian Institute of Technology, Vienna, Austria
{alexandra.millonig,maximilian.leodolter,wolfgang.ponweiser}@ait.ac.at
2MIT Game Lab, Cambridge, MA, USA
k_mitgut@mit.edu
3ovos media, Vienna, Austria
jf@ovos.at

Abstract. Mobility decision making is one of the major challenges regarding climate change. Thereby the question arises how users can be motivated to change their mobility behaviour based on informed decision making. Although an increasing amount of attempts to use gamification for triggering such behavioural changes can be observed, little is known about the actual impact. The outlined project highlights a digital game prototype that analyses the effects of game mechanics motivating users to explore mobility alternatives and to take more informed and more sustainable mode or route choice decisions. The results reveal varying correlations between different player types, game mechanics, mobility styles and social milieu groups.

Keywords: social milieus; player types; gamification; transportation; mobility

1 Introduction

The concept of gamification has gained dramatic popularity during recent years [1,2,3]. Recently, also the field of transportation has seen an increasing amount of attempts to encourage changes of mobility patterns towards more sustainable behaviour by implementing game elements in transportation services [4,5,6]. However, users show heterogeneous reactions to different game mechanics and the effectiveness of related measures can hardly be assessed [3], [7]. Although there have been several approaches in gamification research describing different “player types” and corresponding effective game elements (e.g. highscores, badges, or team competitions) [8,9,10], these concepts usually focus on habits and preferences specifically related to (online) gaming but do not reveal sufficient information about other type-related characteristics such as socio-economic features (e.g. age, gender, or social status) or lifestyle characteristics (e.g. traditional or post-materialistic). Hence, existing ap-
proaches lack information about which elements to use for motivating specific target groups, which decreases the effectivity of current gamified transportation services. This study systematically investigates the effectiveness of different game mechanics addressing the motivators of different users through a digital game prototype.

2 Study Design

The study investigated the potentials of using type-related motivators and corresponding mechanics in order to influence mobility choices. Based on the knowledge concerning motivators of player types [9,10] and the values and attitudes of social milieus [11], we designed an online game which served as a research tool for identifying correlations between values of different social milieu groups and the motivational effect of specific game elements, focusing on these questions:

- How do player typologies impact preferences for game mechanics in the context of an abstract mobility game?
- What are the most effective mechanics – target group relations for initiating intrinsic motivation for making informed decisions?
- Which motivators correlate with which milieu-related values?

The abstract digital game represents mobility choices in the form of different challenges related to six selected game mechanics (exploration, points & highscore, badges, individual competition, team competition, team sharing), matching four selected player types (Achievers, Free Spirits, Socializers, Philanthropists). Alternating to the game challenges, short questionnaires were provided requesting feedback (e.g. how much the participants liked the respective challenge) and comprising questions related to player types, social milieus, and mobility behaviour patterns.

In total, more than 400 players registered for the study; 183 among them eventually completed all parts of the game including all questionnaires. In addition to the data collected from the questionnaires and challenge feedbacks, the system tracked the players’ behaviour while playing the challenges (e.g. how many levels were played, how much information was collected). Also, general motivations of the players to participate in the study have been investigated (interest in research purpose, lottery, etc.), which provided further indicators about group-specific motivators.

3 Game Design

The design process for the game followed an iterative approach based on a rapid prototyping phase. In order to test different game mechanics, we designed several variations of one core game, each equipped with one specific gamification mechanic (implemented in Unity3D). The user navigates an avatar through a grid with the goal to travel through a set of checkpoints. By playing the different levels of the game the players are motivated by different incentives to explore the quality of paths and get the best result possible. To measure the impact of different game mechanics, specific
data was tracked in every game variation, e.g. lines hovered in every level, time spent in a level and the number of tries for a level. We defined seven game variations, each equipped with its own set of incentives, i.e. game mechanics (except variation 1 and 2; see Figure): (1) Tutorial, (2) Challenge “Exploration”, (3) Challenge “Points & Highscore”, (4) Challenge “Badges”, (5) Social Challenge “Team Competition”, (6) Social Challenge “Team Sharing”, (7) Challenge “Competition”.

Fig. 1. Screenshot of game variation “Competition” (against a computer-controlled opponent).

4 Results

The results show that there are similarities between the compared groups, although the correlations are not equally distinct for all investigated interrelations. Feedback questions revealed that some of the player types (e.g. achievers) react very clearly to type-related game mechanics (e.g. points), whereas for other player types (e.g. free spirits) the preference for type-related game mechanics (e.g. customisation) was not as clearly observed. This may be caused by the type of game that has been developed for the study, as mini games are attractive for most players, but not to the same extent. The comparison of preferences for specific challenges and social milieus showed plausible links between the nature of game mechanics and the basic values of milieu groups. This discloses valuable insights into the potential effectiveness of using specific game mechanics for encouraging target groups based on communities of values. As a result of the comparison of all outcomes of the game data, three main target groups have been described for gamified mobility behaviour change interventions:

- Multimodal Trendsetters: mobility cluster: multimodal; player type: Free Spirit, Achiever; preferred game mechanics: exploration, competition, points; social milieu group: creative individualists
- Environmentally Aware Drivers: mobility cluster: walking driver; player type: Philanthropist, Free Spirit; preferred game mechanics: exploration; social milieu group: cosmopolitan, critical well-educated, responsible and creative
- Achievement-oriented Drivers: mobility cluster: driver; player type: Achiever; preferred game mechanics: competition; social milieu group: technophile, educated, career-minded performers
These results will be used for recommendations concerning the application of game mechanics in a multi-modal routing service. As test and demonstration set-up for the effectiveness of incentive mechanisms, a smartphone-app is currently designed which will provide the users with personalised routing options for their trips and the related information. Based on the outcomes of this study, specific game mechanics will be implemented in the app to motivate the target groups to make informed decisions and change their behaviour to more sustainable mobility behaviour patterns.

Acknowledgement. This project is supported with funds from the Austrian Climate and Energy Fund and implemented in line with the "ELECTROMOBILITY’S TECHNICAL BEACONS" programme.

References

Motivating Healthy Water Intake through Prompting, Historical Information, and Implicit Feedback

Davide Neves¹, Donovan Costa¹, Marcio Oliveira¹, Ruben Jardim¹, Ruben Gouveia¹, Evangelos Karapanos¹²

¹Madeira Interactive Technologies Institute, Funchal, Portugal
²Cyprus University of Technology, Limassol, Cyprus
rubahfgouveia@gmail.com, evangelos.karapanos@cut.ac.cy

Abstract. We describe Hydroprompt, a prototype for sensing and motivating healthy water intake in work environments. In a 3-week field deployment of Hydroprompt, we evaluate the effectiveness of three approaches to behavior change: historical information enabling users to compare their water intake levels across different times of day and days of week, implicit feedback providing subtle cues to users on the current hydration levels, and explicit prompting attempting to remind participants when hydration falls below acceptable levels or when substantial amount of time has elapsed since the last sip.

Keywords. Behavior change technologies, water intake, longitudinal study.

1 Introduction

Water is essential to our everyday functioning. Over 50% of the human body consists of water and an average sized person should drink at least 2-3 liters of water per day in order to remain hydrated [1]. However, recent studies have revealed that both adults and children often fail to maintain appropriate levels of hydration throughout the day [3, 4].

One of the most effective triggers for water intake is thirst, the sensation of needing to drink [2]. Yet this signal is triggered when there is already a water deficit [2], thus, technology may play a role in establishing healthy water intake habits, and a number of attempts have been made towards this direction. For instance, playful bottle [5] senses water consumption through a mobile phone attached to an everyday drinking mug and attempts to influence users’ habits through implicit feedback. Hydracoach (www.hydracoach.com) is a commercial bottle that monitors water consumption and provides historical information such as the average water consumption per hour and the amount of time elapsed since the last sip.

Yet, despite some recent interest on the topic, the domain currently lacks an understanding of the effectiveness of different techniques in motivating healthy water intake, with recent work in the broader area of behavior change tools raising concerns over the long-term effectiveness of existing approaches (see [6,7]).
In the current paper we describe the design and evaluation of Hydroprompt, a prototype for sensing and motivating healthy water intake in work environments. In a 3-week field deployment of Hydroprompt, we evaluate the effectiveness of three approaches to behavior change: historical information enabling users to compare their water intake levels across different times of day and days of week, implicit feedback providing subtle cues to users on the current hydration levels, and explicit prompting attempting to remind participants when hydration falls below acceptable levels or when substantial amount of time has elapsed since the last sip. In addition, we attempt to measure the impact of subliminal conditioning [8] (through presenting positive phrases such as “water is good”) on the effectiveness of prompting.

2 The Hydroprompt System

Hydroprompt employs a load sensor from a regular kitchen scale for sensing water intake (see figure 1). Signal from the load sensor of the scale is led to an operational amplifier and then read by the Arduino platform. This communicates with a C# application that serves as the front-end of Hydroprompt. For successful sensing, the user has to continuously place her bottle or mug on top of the scale. Following the bottle’s removal from the scale, the platform senses any difference in weight and records the amount of water intake, if any. The proposed approach offers a simple, cost-effective and reliable sensing platform for water intake applications in stationary settings, such as office environments.

Hydroprompt records the date, time and quantity of each sip and attempts to motivate healthy water intake in three ways: prompting, historical information and implicit feedback.

Prompting. Hydroprompt alerts the user at regular time intervals using a notification at the bottom right part of the user’s screen (see figure 1c). The notification consists of a glanceable visualization of the user’s hydration level and a short sentence relying on the principle of subliminal conditioning [8]. The idea of subliminal conditioning...
suggests that priming behavioral concepts (e.g., drinking water) motivates individuals outside conscious awareness, especially when primes match a current need (e.g., fluid deprivation) [9]. A collection of 10 short sentences were created (such as “water is good”, “Drinking water helps you feel more energetic”, “Drinking water can make you more productive”) and were interchanged during different notifications. The frequency of prompting depends on two variables: a) the hydration level of the individual at any given moment, and b) users’ stated preference about prompting frequency. Three levels of hydration were defined by the threshold values of 20% and 80%.

**Historical Information.** Hydroprompt presents – using graphs – the amount of water consumed over the course of a week, a day or recent individual sips. In addition, Hydroprompt presents the hydration level of the user at a given moment in time (see figure 3) as well as the extent of goal completion for the day (e.g., 760 of 1140 mL).

**Implicit feedback.** Hydroprompt attempts to provide implicit feedback on individuals’ hydration state through altering the wallpaper of their computer environments. The system uses 5 different wallpapers, varying in hydration, to represent five levels of hydration (i.e., above 80%, 60%, 40%, 20%, 0%, see figure 3).

### 3 Field trial of Hydroprompt

We conducted a three-week-long deployment with 6 participants (5 female, all office workers), using an ABA study design, with the goal of assessing the impact of Hydroprompt on individuals’ water intake behaviors. The first three and the last three days of the three-week period were used as baseline; during these days, we deployed a stripped-down version of Hydroprompt that sensed water intake without providing any form of feedback to the users. All interactions with the system and water intake behaviors were logged. At the end of each week we conducted an interview with each user to inquire into their experiences and any observed changes in their behavior.

Overall, we observed strong temporal patterns in users’ behaviors in all three phases of the study (the two baseline, phase A and phase C, and the intervention, phase B). While Hydroprompt, in Phase B, increased initially the average water intake, this change did not sustain over time, with users quickly reverting to their old behaviors after 6 days. Interestingly, similar temporal trends can also be observed in users the two baseline Phases of the study. These results highlight the role of novelty and increased attention on users’ behaviors and stress the importance of longitudinal studies in the establishing the impact of behavior change applications.

To compare the impact of the three intervention approaches (i.e., prompting, historical data and implicit feedback), we contrasted users’ behaviors during the five minutes following an event of either three categories (i.e., a notification, an interaction with historical data, and a change in wallpaper).

Users interacted with historical data on a total of 454 times, their desktop wallpaper (implicit feedback) was changed 638 times and received a total of 1383 notifications (prompting). Interacting with historical data was more likely to lead to the user taking a sip of water (with a chance of 30%) than implicit feedback (17%, $\chi^2=26.9$, $p<.05$).
p<0.001). Similarly, implicit feedback was more likely to lead to a water intake than prompting (7%, $\chi^2=46.6$, p<0.001).

Fig. 1. (left) Water consumption over the course of the study, (right) Number of total and effective events (i.e., events that resulted to the user taking a sip in 5 minutes following the event: a) user’s interaction with historical data, b) a change in the wallpaper – implicit feedback, and c) a notification displayed to the user - prompting.

<table>
<thead>
<tr>
<th>Type</th>
<th>Effectiveness (Effective out of total events)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical data</td>
<td>30.40% (138 out of 454)</td>
</tr>
<tr>
<td>Implicit feedback</td>
<td>17.08% (109 out of 638)</td>
</tr>
<tr>
<td>Prompting</td>
<td>7.16% (99 out of 1383)</td>
</tr>
</tbody>
</table>

During our interviews we found users’ preferences regarding the different techniques to vary greatly per user. While some participants preferred the notifications and found them not to be intrusive, others commented that they didn’t pay attention to them and most participants could not recall the priming messages presented: “[P4] The notifications get my attention as I’m always busy [thus forgetting to check historical data]”, “[P6] I know that the notification shows some messages, but I never notice them”. Some participants reported the most of their behavior change was induced by implicit feedback, primarily for two reasons. First, wallpaper changes were often visible to the individual’s social circle, often leading to discussions around the individual’s water consumption. Secondly, some participants reported that the wallpapers impacted their emotions: “[P2] I feel bad when having ‘deteriorating’ wallpapers... looking at the screen and seeing the skull, the trees... the other one has a color that forces me to drink”.

4 References

The Impact of Cultural Differences on the Persuasiveness of Influence Strategies

Rita Orji
Accessible Computing Technology Lab, McGill University, H3A 1X1, Canada
{rita.orji@mail.mcgill.ca}

Abstract. Persuasive technologies are more effective when they are personalized. This paper explores the relationship between culture and the six persuasion strategies (authority, reciprocation, scarcity, liking, commitment and consensus) developed by Cialdini. The results of a large-scale study of 335 participants suggest that individualist and collectivist differ significantly in with respect to their likelihood of being influenced by the strategies – with collectivist being more susceptible to most of the strategies. Some strategies are more suitable for persuading one cultural group than the other.

Keywords: Persuasion, personalization, persuasive technology, culture, Cialdini, individualist, collectivist, influence strategy, susceptibility, tailoring

1 Introduction

Research has shown that individuals can be motivated to perform desired behaviors using various persuasive strategies [2, 3, 6, 9, 10, 13]. Over the years, several persuasive strategies that can be employed in promoting desired behavior change has been developed, for examples see [2, 3, 9]. Considering the large number of persuasive strategies in existence, how to employ these strategies to effectively motivate desired behavior change has attracted researchers’ attentions. In line with this, research has shown that personalizing the strategies can increase their efficacy at motivating behavior change in various domains.

In choosing approaches for group-based personalization, research has shown that culture is a reliable characteristic [7, 14]. Research has also established gender and age differences in many areas including the perception of different behavioral determinants [12, 14], gameplay, and health behavior [11]. However, the effect of culture on the persuasiveness of the six strategies highlighted by Cialdini [2] have not been explored quantitatively.

This paper explores the relationship between culture and the six persuasion strategies (authority, reciprocation, scarcity, liking, commitment and consensus) developed by Cialdini [2]. The results of a large-scale study of 335 participants suggest that individualist and collectivist differ significantly with respect to their likelihood of being influenced by the strategies – with collectivist being more susceptible to most of the strategies. Some strategies are more suitable for persuading one cultural group than the other. Hence, culture is a reliable characteristic for tailoring persuasive technologies.
2 Study Design and Methods

To investigate the extent to which cultural variability influence the appeal of persuasive strategies, we adopt the well-established strategies (reciprocity, scarcity, authority, commitment and consistency, and liking) developed by Cialdini [2]. These strategies have been widely employed in various persuasion domain ranging from advertising to health [6]. We examined the effects of cultural differences between Asians and North Americans on their propensity of being influenced by the six strategies. We choose North America and Asia because according to many cultural models, they represent two distinct cultural groups. For example, according to Hofstede [5], Asian countries are highly collectivists while North American countries are highly individualists and recent research has confirmed the validity of the Hofstede’s cultural model [7, 15].

To collect data for our study, we adapted the Susceptibility to Persuasive Strategies Scale (STPS) developed by Kaptein et al. [6]. The items were used to assess participants’ susceptibility to Cialdini’s six persuasive strategies. The questions were measured using participant agreement with a 7-point Likert scale ranging from “1 = Strongly disagree” to “7 = Strongly agree”. The STPS scale has been shown to adequately predict participant susceptibility to individual strategies and the efficacy of the strategies for motivating behavior change in real life [6]. We also included questions for assessing participants’ demographic information (such as age, gender, geographical territory). Furthermore, we employed attention questions to ensure that participants were actively considering their answers.

We recruited participants for this study using Amazon’s Mechanical Turk (AMT). AMT has become an accepted method of gathering users’ responses [8]. It allows access to a global audience, ensures efficient survey distribution, and high quality results [1, 8]. We followed the recommendations for performing effective studies on the AMT by Mason and Suri [8] and before the main study, we conducted pilot studies to test the validity of our study instruments.

A total of 335 valid responses were included in our analysis. 155 (46%) of our participants are Asians and 180 (54%) are from North America. Incomplete responses, responses from participants that are neither from Asia nor North America, and responses from participants who got the attention questions wrong were not included in this analysis.

3. Data Analyses

We begin our analysis by validating our study instrument. To determine the validity of our survey instrument we performed Principal Component Analysis (PCA) using SPSS. Before conducting PCA, the Kaiser-Meyer-Olkin (KMO) sampling adequacy was determined and found to be 0.79, well above the recommended 0.6. The Bartlett Test of Sphericity was significant at ($\chi^2(105) = 1759.059, p < 0.0001$). These two measures indicate that the data was suitable to conduct factor analysis [4].

Indicator reliability can be assumed because Cronbach’s $\alpha$ of the strategies are all higher than the threshold value of 0.7 except for liking and consensus strategies which showed a Cronbach’s $\alpha$ of 0.44 and 0.40 respectively. This is acceptable because
according to Peter [25], Cronbach’s $\alpha$ should be $\geq 0.7$, but for variables with 2-3 indicator, an $\alpha \geq 0.4$ is acceptable. The liking and consensus strategies contains 2 indicators each, therefore, Cronbach’s $\alpha$ is within the acceptable range of $\geq 0.4$.

After establishing the suitability of our data, we computed the average score for each strategy and then performed Repeated-Measure ANOVA (RM-ANOVA) with the strategies (reciprocity, scarcity, authority, commitment and consistency, and liking) as within-subject factors and culture as between-subject factors to explore for significant differences between the Asians and North Americans with respect to their propensity of being influenced by the six strategies. 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. Following findings of significant effects, we performed post-hoc pairwise comparison, using the Bonferonni method for adjusting the degrees of freedom for multiple comparisons, to determine the groups that significantly differ from each other.

4. Results

Our results show significant main effects of strategy type ($F_{4,1350.96} = 57.968, p \approx 0.000, \eta^2=0.148$) on the likelihood of influencing respondents from both cultures (i.e., persuasiveness). This means that there are significant differences between the strategies with respect to their perceived persuasiveness overall. Regardless of culture, commitment, reciprocity, and liking emerged as the most persuasive strategy (significantly different from all other strategies as shown by the Bonferonni-corrected pairwise comparisons), see Table 1.

The results also showed a significant main effect of culture on persuasiveness of the strategies ($F_{1,333} = 6.46, p \approx 0.001, \eta^2=0.019$). Overall, Asians are more likely to be influenced by the strategies than North Americans. See Table 2.

The results of the RM-ANOVA showed a significant interaction between culture and strategy ($F_{4,1350.96} = 12.53, p = 0.000, \eta^2=0.36$). Pairwise comparisons showed that Asians and North Americans significantly differ in four out of the six strategies. Specifically, Asians found four out of the six strategies significantly more persuasive than North Americans: authority ($F_{1,333} = 21.166, p = 0.000, \eta^2=0.060$); likeness ($F_{1,333} = 12.087, p = 0.001, \eta^2=0.035$); and consensus ($F_{1,333} = 25.188, p = 0.000, \eta^2=0.070$). Scarcity is the only strategy that North American’s found more persuasive than Asians, see Table 1.

Table 1: Mean and Standard Deviations (SD) for the strategies by cultural groups. Bolded means are significantly different across the age group; $p<0.05$.

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Authority mean(SD)</th>
<th>Reciprocity mean(SD)</th>
<th>Scarcity mean(SD)</th>
<th>Commitment mean(SD)</th>
<th>Consensus mean(SD)</th>
<th>Liking mean(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asians</td>
<td>5.06(1.14)</td>
<td>5.70(1.11)</td>
<td>4.67(1.40)</td>
<td>5.70(1.13)</td>
<td>5.15(1.08)</td>
<td>5.20(0.97)</td>
</tr>
<tr>
<td>North Americans</td>
<td>4.42(1.38)</td>
<td>5.38(1.26)</td>
<td>4.69(1.39)</td>
<td>5.66(1.17)</td>
<td>4.54(1.13)</td>
<td>4.81(1.09)</td>
</tr>
</tbody>
</table>
5. Conclusion

Individualists (North Americans) and Collectivists (Asians) differ significantly with respect to their likelihood of being influenced by four out of the six persuasive strategies (reciprocity, scarcity, authority, commitment and consistency, and liking) developed by Cialdini. Surprisingly, collectivists perceive four out of the six strategies: authority, reciprocity, consensus, and liking as being significantly more persuasive than individualists. This implies that collectivists are more likely to be persuaded using these strategies than the individualists. It also suggests that collectivists are more persuadable than individualists with respect to the influence of the strategies on their behavior. Scarcity emerged as the only strategy that the individualists perceived as more persuasive than the collectivists.

In general, regardless of culture, commitment, reciprocity, and liking emerged as the most persuasive strategies that have the highest likelihood of influencing participants from both cultures (significantly different from all other strategies). This is followed by the remaining strategies consensus, authority, and scarcity (listed in decreasing order of influence). Culture is a reliable characteristic for tailoring persuasive technologies.

References

Persuasive Cities: Health Behavior Change at Scale

Agnis Stibe
MIT Media Lab
agnis@mit.edu

Abstract. Can you imagine a city that feels, understands, and cares about your wellbeing? Future cities will reshape human behavior in countless ways. New strategies and models of urban spaces are required for creating future cities to properly respond to human activity, environmental conditions, and market dynamics. Persuasive urban systems will play an important role in making cities more livable and resource-efficient by addressing current environmental problems and enabling healthier routines. Drawing on socio-psychological theories and integrating them with new concepts for urban design, the persuasive cities research focuses on improving wellbeing across societies. This research presents an ecosystem of future cities, describes three generic groups of people depending on their susceptibility to persuasive technology, explains the process of defining behavior change, and provides tools for social engineering of persuasive cities. Further research should continue exploring how urban design in combination with socially influencing systems could encourage healthy and sustainable behaviors at scale.

Keywords: persuasive cities, social engineering, socially influencing systems, behavior change, wellbeing, health, persuasive technology

1 Perspective

As population in cities continue grow exponentially the architecture and design of future urban places will become more dominant in impacting human behavior. According to social cognitive theory [1], any well-designed environment can become a strong influencer of what people think and do. There is an endlessly dynamic interaction between a person, a particular behavior, and an environment in which that behavior is performed. The persuasive cities research leverages this knowledge to engineer persuasive environments for altering human behavior on societal levels.

The proposed research reflects on novel ways of how persuasive technology [2] and socially influencing systems [3-4] enable mechanisms to perpetually support motivation of individuals comparing to conventional methods, such as those that are based on carrots and sticks. Instead, persuasive urban systems harness social influence from crowd behavior to craft influential messaging aimed at shifting behavior and attitude of an individual, who naturally is an integral part of the same crowd. Such continuous interplay can ultimately result in an ongoing process that reshapes communities and societies without any other incentives.
2 Emergence of Persuasive Cities

Ongoing research streams focus on sensible cities (researching sensing technologies to read human behavior in urban spaces) and smart cities (analyzing big data to classify groups of people based on their distinct behavioral patterns), however there is a lack of knowledge about perspective ways to achieve persistent behavioral changes at scale. Therefore, the proposed research extends an ecosystem of future cities (Table 1) by introducing the notion of persuasive cities that aims to advance and refine influential strategies designed for intentionally reshaping how people think and act in urban environments.

<table>
<thead>
<tr>
<th>Role</th>
<th>Character</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSUASIVE</td>
<td>Change</td>
<td>Care</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Socially Influencing Systems</td>
</tr>
<tr>
<td>SMART</td>
<td>Classify</td>
<td>Understand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Big Data Analytics</td>
</tr>
<tr>
<td>SENSIBLE</td>
<td>Read</td>
<td>Feel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensor Networks</td>
</tr>
</tbody>
</table>

Table 1. Ecosystem of future cities

Each layer of future cities has its role, character, and supportive technology. Sensible cities employ sensor networks to read crowd behaviors. In other words, these cities feel human movements. These crowd behaviors further serve as an input for big data analytics that smart cities apply to classify groups of people according to similar behavioral patterns (profiles). When that is accomplished, the groups having better routines can be exemplified to other underperforming groups through intentionally designed socially influencing systems, which are at the core of persuasive cities.

3 Susceptibility to Persuasive Technology

People generally can fall into one of the three generic categories depending on their susceptibility to persuasive technology (Fig. 1). Self-contained people (the red circle) most likely are not open for changing anything in them. They are fully satisfied with who they are and what they do on daily basis, thus many behavioral interventions might fail in attempts to influence this group of individuals. Self-driven people (the green circle) typically have comparatively high levels of motivation and can achieve everything that they have envisioned. Thus, these people most likely are not looking for additional sources of encouragement, and therefore persuasive technologies might become unnecessary for this group.

However, there is another group of people that oftentimes would like to change their routines, but rarely succeed in doing so. That reminds of New Year’s resolutions that in many cases end around February. Therefore, this group is entitled as January 1st (the yellow circle) and seem to be the most welcoming towards technology sup-
ported behavioral interventions designed to help achieving target behaviors. Although, Fig. 1 presents all three groups as equal circles, in reality the size of each group might significantly vary depending on the context and particular behavior.

![Fig. 1. Susceptibility to persuasive technology](image)

4 Defining Behavior Change

To achieve an envisioned target behavior, the process and components of behavior change have to be well understood and clearly defined. In the process of defining behavior change, there are three main components, namely the target group, its present behavior, and its envisioned future behavior (Table 2).

### Table 2. The three main components for defining behavior change

<table>
<thead>
<tr>
<th>Target Group</th>
<th>Current Behavior</th>
<th>Future Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A group of people currently having an unsatisfactory behavior. It is important to narrow down the target group as precise as possible.</td>
<td>A certain behavior of the target group that currently is not in line with an envisioned future behavior in a given context.</td>
<td>An ultimate future behavior of the target group that is envisioned to be more beneficial for everyone.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>There are MIT faculty members.</td>
<td>Who currently commute alone in their private cars.</td>
<td>They could commute by bicycles instead whenever possible.</td>
</tr>
</tbody>
</table>

5 Tools for Social Engineering

Earlier research on persuasive technology [2] describes several ways how social dynamics can influence human behavior, which have been further refined and structured as a framework for Socially Influencing Systems (SIS) [3], depicted in Fig. 2. The SIS framework is a useful tool for scholars and practitioners aiming at improving future cities by introducing persuasive urban interventions targeted to support wellbeing.
The framework describes seven socially influencing principles that can support persuasive urban interventions. The principles are interlinked and have potential to exert stronger effects depending on the context of a particular behavioral challenge. Normative influence and social comparison seem to be more effective to achieve involvement of the target group as the two principles focus on attitudinal changes. Cooperation and social facilitation seem to be more effective to make individuals participate and do the envisioned future behavior even without a formed attitude towards it. Competition and recognition seem to be more effective in engaging the target group to do the future behavior as the principles focus on both attitude and behavior simultaneously. For example, the effects several socially influencing principles have already been studied in the context of urban mobility, e.g. bicycling [5].

6 References

Dynamic, context-aware behavior change support: combining distributed reasoning and central processing

Arlette van Wissen, Annerieke Heuvelink, Cliff J. R. H. Laschet, Charlotte Vinkers
Philips Research, High Tech Campus 34, 5656 AE Eindhoven, the Netherlands
[Arlette.van.Wissen; Annerieke.Heuvelink; Cliff.Laschet; Charlotte.Vinkers]@philips.com

1 Introduction

A behavior change support system (BCSS) is a technology that supports its user in changing behaviors and cognitions related to (mental) health and wellness [1]. There is an increasing availability of such systems, which can for example take on the form of an app, website or smart device. For a system to choose the most suitable interaction elements (IEs) for a user at a certain point in time, it should consider user preferences and context (i.e., knowledge of the user stored in a user model), as well as which behavioral change technique (BCT) to use. BCTs are techniques to deliver interventions that are used to help people to change their behavior, such as giving feedback to the user based on their measurements, or verbally persuading them about their capability, see e.g. [2]. Importantly, a system should consider the match between the current user state and the BCT – or the intervention technique (IT) [3], which is the more general term that we will use throughout this paper – with respect to suitability to establish the optimal change for that user.

Current BCSSs are constrained in their capability to successfully support behavior change, as they have limited ability to tailor or adapt the components of their intervention (i.e., which, how and when they offer them) to the state and context of users in real-time and over time [4]. It is therefore important to develop BCSSs that can be dynamically adapted to fit the user’s need at any point in time. In this paper, we present the rationale and proof-of-concept of such a system.

There are three main reasons why current BCSSs typically have limited capabilities to dynamically adapt interaction elements and intervention techniques to the user. First, ITs are often not declaratively specified, which hinders the ability to separately control which IT is deployed when and for whom. In order to advance our knowledge on which BCSSs are effective and why, there is an urgent need to make these ITs assignable within systems. Second, which ITs are provided and when is often predefined and prescheduled by developers or behavior change experts, making it difficult to adapt different ITs to different user and context states once the intervention program has started. In these cases, it is the responsibility of the designer of the system to think beforehand about the coordination of the ITs and the resulting IEs, and to ensure that the timing and number of received IEs are in line with the preferences and context of the user. Although this is manageable for relatively small, focused BCSS, this becomes difficult when scaled across different domains, interventions and developers. Third, knowledge about the user (and context) is often only updated at one or a few moments in time, which makes it very hard to deploy dynamic and real-time coaching based on the changing need of the user over time and in different contexts. To illustrate, the IT of giving Annie information about her behavior predictors can be effective when she is at home and feeling happy, but not when she is at work and feeling stressed. As a consequence of this inadaptability, BCSSs run the risk of failing to establish a change in behavior or to elicit a bad user experience.

2 Developing an adaptive, context-aware BCSS

Many contemporary BCSSs are limited in their use of ITs, and which ITs are used is typically not based on theory nor evidence [5, 6]. This has led to a plethora of technology-based BCSS that have limited effectiveness [6]. Recently, Mohr et al. [3] proposed a model to address this issue. It describes a ‘behavioral intervention technology model’ in which the ITs are defined separately and the system reasons real-time
about their activation and execution. However, as the model proposes workflows to determine which ITs are triggered, this method is still vulnerable to inflexibility due to the fact that the workflows are designed beforehand and specify predetermined scenarios and conditions in which ITs become executable. In this work we propose and describe an implementation of a new approach to design BCSS such that they are (i) adaptive to the user state and context, and (ii) scalable over different users and contexts, as well as over the number and types of ITs and IEs they can offer. As a result, such a system will provide users with a stable and tailored experience.

The approach is inspired by Brooks’ subsumption architecture [7], which couples sensory information to action selection by decomposing the complete behavior into sub-behaviors, implemented as a hierarchy of layers. The layers, which all receive sensor-information, work in parallel and generate outputs. This architecture emphasizes the strength of distributive and parallel control to come to action selection. Our approach proposes similar distributed processes followed by a central process to determine which IT should be used and sent to the user. Fig. 1 visualizes the proposed approach, in which different sensors capture data about the user and its environment. As a first reasoning step, distributed reasoning elements process updates in user states in order to determine the priority of the ITs based on their applicability and relevance. In the second reasoning step a central deliberation process determines which from these applicable and relevant ITs should be executed.

The distributed reasoning processes are triggered by user data. Each process corresponds to one IT and in parallel they determine a priority for their IT’s execution. This priority is based on several features (i.e. characteristics) of the user input, which is stored in the database. How these distributed processes are implemented is domain specific and can vary for every application. In a simple example one can imagine these processes to be implemented as workflows that result in a Boolean value (yes: priority to be executed, no: no priority to be executed). Alternatively, the priority can be calculated using a function based on features such as the user’s preferences, psychological traits, physiological state, external context, and the history of send ITs. It could also be that the priorities of the ITs depend on each other. In that case, activation of one IT inhibits other activation of other ITs, such that in the end there is only one IT with the highest priority.

The central deliberation process determines which IT is selected for execution. This process receives the priority values for ITs from the distributed reasoning processes and returns an IT (or a list of ITs) and corresponding IEs that will be executed by the actuator. Again the way in which this process is implemented can differ for different domains and applications, and vary in complexity level. For example, the central deliberation process could simply select the IT with the highest priority that surpasses a certain fixed thresh-

Fig. 1. A BCSS with two types of reasoning: distributed and central
old, and select a random one if multiple ITs surpass it. This threshold can be based on the number of available interventions (e.g., the threshold is high in case there are many available interventions). In a more complex alternative the threshold can be a dynamic value based on (for instance) limitations on the number of IEs that can be scheduled, or on the history of the number of executed IEs for this user.

3 Proof of concept

As a proof of concept, the two-step approach was used to generate coaching content in an app to support patients with physical activity. The aim of the implementation was to use this approach to show how behavior change intervention techniques and elements can be dynamically offered, such that users receive content that is not just personalized but also tailored to their current state. The implemented ITs consist of the following: ‘review behavior goal’, ‘feedback on behavior’, ‘discrepancy between behavior and goal’, ‘problem solving’, and ‘commitment’ (see [2]). For each of the techniques, there is a reasoning process that determines their priority to be executed, given the incoming data about the current user state (such as activity and location) and current data in the system. In our implementation, the priority depends on four different features of the ITs.

Table 1 describes these features and gives examples for a user Annie, with respect to the IT ‘feedback’ (to monitor and provide informative or evaluative feedback on performance of the behavior). The instantiations of the features differ between the ITs. The efficacy is always determined by the predicted effect of the IT on the user’s behavioral determinants. Currently, the efficacy is estimated from literature (see e.g. [2]), but it could be learned by observing and measuring the effects of the IT. The way the urgency is calculates varies greatly between ITs. For example, the ‘review behavior goal’ urgency depends on the period the user is over- or underperforming, while the urgency for ‘commitment’ (where the user is asked a questions to commit to his/her daily goal) decays during the day.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Example for IT feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>The probability that this IT has the desired effect for the user given normal circumstances.</td>
<td>Giving feedback is expected to increase the Annie’s motivation somewhat.</td>
</tr>
<tr>
<td>Capability²</td>
<td>The ability of the user to at this moment respond to the IT given his/her physical and psychological state.</td>
<td>The capability is low when Annie suffers from high ego-depletion, otherwise high. If Annie is tired, she is less likely to be able to improve the behavior.</td>
</tr>
<tr>
<td>Opportunity¹</td>
<td>The ability of the user to at this moment respond to the IT given his/her environment.</td>
<td>Is high at home, when Annie has the opportunity to take an additional walk. Is low at work, when there are limited opportunities to do so.</td>
</tr>
<tr>
<td>Urgency</td>
<td>The importance for the user to receive the IT at this moment.</td>
<td>Is high if her physical activity has changed with &gt;10 min, otherwise low. This ensures that feedback gets a high priority if there is a significant change in Annie’s behavior.</td>
</tr>
</tbody>
</table>

How the features are combined to calculate the final priority, can also differ per IT. In our solution the priority is determined by a weighted sum of the features, whose weights vary between ITs. The used function reflects that some features can moderate others. That is, the user’s capability and opportunity at a given moment act as a moderator for the (theoretical) efficacy given normal circumstances and for the urgency to deliver the IT at this moment in time. In the future we would also like to explore the use of a combination function that reflects that the ITs can influence each other. For example, the priorities of ‘feedback’ and ‘goal discrepancy’ could be interdependent: if for one of them the priority values increases, it will decrease the priority value of the other one. Alternatively, this could be used to schedule different ITs close to each other, if they are related.

1 See http://www.bcts.23.co.uk/2_2_feedbackBehaviour.html
2 Capability and opportunity are both key conditions of ‘behavior systems’ according to [2].
Consider a scenario where Annie’s goal is to walk 45 minutes every day, but her motivation is low to do so. The system sensors detect that Annie has walked 15 minutes (using e.g. an accelerometer) and that she is at home (using e.g. iBeacons). The system will be triggered by this new data and starts to reason about what is the most appropriate intervention to support Annie (if any). The parallel reasoning processes calculate the feature values and combine them into one priority value. In our scenario, the priority values per IT could be: ‘feedback’ – 0.73, ‘goal discrepancy’ – 0.58, and ‘commitment’ – 0.32 (the other ITs don’t become active at all, because, for instance, they are not applicable or there is not enough data). Annie has indicated that her preferred frequency of interactions is ‘many’; she does not mind getting multiple interventions. Therefore, the threshold for priorities to get selected is low, e.g. 0.5. The central processing unit compares the priorities between the ITs and selects those who have a priority above the threshold, in this case both ‘feedback’ and ‘goal discrepancy’. Annie will receive both ITs with corresponding IEs.

4 Conclusion & Discussion

In this paper we introduced a new approach to design behavior change support systems such that they are (i) adaptive to the user state and context, and (ii) scalable over different users and contexts as well as over the number and types of ITs and IEs they can offer. This approach enables tailored coaching from the very start of the user’s use of the system (by estimating the different feature values for each IT). Importantly, the system is designed to also be able to learn the specific nuances of what works best for a particular user. The weights of the features and the threshold of the priority, for example, can be learned from the user interactions and observing his/her behavior. Also, these values could be estimated from analyzing data of user groups. As a result, it has the potential to provide better tailored content to the user as well as an improved user experience. The proposed approach is more scalable than one in which conditions and triggers are defined for each IT in isolation by the designer, because in our approach the system automatically handles interactions effects and competition between the ITs. One limitation of this is, however, that it is hard to determine upfront the type of interactions the user will receive. Therefore, our approach is less suited for BCSSs that implement fixed programs where content is sent in a strict order. It is on the other hand very well suited for BCSSs that need to interact and motivate the user for a longer period of time, given its potential to seamlessly adapt the content and delivery of this content to the constantly changing state and context of the user. Whether the system can fulfill this potential, depends for a large part on the experts that determine under which circumstances each IT becomes relevant (i.e. receives a high priority), and on clear guidelines on how to assign the priorities in order to ensure stability of the system.

References

Plank Challenge with NAO: Using a Robot to Persuade Humans to Exercise Longer

Johannes Vollmer, Patrick Schuster and Manuel Giuliani

Department of Computer Sciences, University of Salzburg, Austria
{johannes.vollmer, patrick.schuster}@stud.sbg.ac.at, manuel.giuliani@sbg.ac.at

Abstract. Modern humans exercise too little and spend the majority of their day sitting. In this paper, we study whether the anthropomorphic features of a humanoid robot encourage humans to exercise longer. We programmed a robot to compete against humans in a plank challenge. The participants of a preliminary study reported that they felt persuaded to compete against the robot and to exercise longer.

Keywords: persuasion · plank challenge · exercise · NAO robot

1 Introduction

Health experts show that prolonged sitting can lead to cardio-metabolic risk biomarkers, type 2 diabetes and premature mortality [1]. With the help of the humanoid robot NAO by Aldebaran1, our aim is to motivate people to perform the plank challenge and to improve their physical fitness. Specifically, we are interested in determining if working out with a humanoid robot will persuade people to exercise longer. We programmed a NAO robot to do the plank exercise alongside a person. The plank is a basic exercise that can be utilized by a majority of people. When doing a plank, a person lays on a flat surface while resting on one’s elbows. The back is kept straight and the legs are stretched out. The forearms point forward and are parallel to the torso. The goal is to stay in this position for as long as possible.

1 https://www.aldebaran.com/en/cool-robots/nao (last access: 23rd of January 2016)
Fig. 1b shows a picture of the NAO robot competing against a human in the plank challenge. Similar to our study, Brandstetter et al. successfully used NAO to represent a coworker trying to motivate people to perform micro exercises. They found that the participants enjoyed the experience [2]. Contrary to our setup, they did not establish a second group, doing the plank challenge without NAO. Also, they did not make use of NAO’s built-in LEDs. Chidambaram et al. measured the persuasiveness of a robot’s vocal and bodily cues on humans and found that "the presence of bodily cues alone improved compliance, while the presence of vocal cues alone did not affect participants’ compliance" [3]. An entry on tumblr.com\(^2\) by the "RoboCoach team" describes a plank challenge with a NAO robot, which is similar to our study, but does not describe technical details or study results.

We conducted a qualitative study, in which three participants planked against NAO and three participants did the plank challenge at home using a traffic light application on their computer. We interviewed both groups to find out if NAO was able to persuade the participants to plank longer.

greeting. After that, NAO drops down on its knees, leans forward and supports its upper body using its stretched out arms. It then lowers itself onto its elbows before stretching out its legs. NAO is now in a stable plank position (Fig. 1b). The plank challenge begins with NAO counting down "three, two, one, plank!". During the plank exercise, NAO's eye LEDs show a green color to indicate that the exercise is easy for the robot. As soon as 75 % of the set time is reached, NAO switches its eye LED color to yellow and says "I'm starting to feel exhausted". When the 85 % mark is reached, it claims "This is getting really hard" and as soon as 95 % is reached, it encourages the participant by saying "Come on, try to beat me!", while fading its eye LED color into red, indicating it cannot plank much longer. Once 100 % of the set plank time is reached, NAO holds the position for another second before collapsing on the floor. NAO gets up, wipes its forehead and says "Wow. That was intense again! Goodbye, see you next time." and waves goodbye (Fig. 1c).

Participants: Six participants took part in the study aging between 23 and 30 years with an average age of 25.67 years. Participants of the robot group were students of the Department of Computer Sciences of the University of Salzburg, while participants of the control group were employed in office environments. We had two males and one female in each group.

User Study: Due to different fitness levels we could not use the same initial plank time for all participants. Therefore, we asked the participants to plank and record their initial plank time at home. Each participant had to plank twice during the course of one week. We met the members of the robot group twice at our department, where they participated in the challenge. The participants of the second group planked at home. In each case, they told us their initial plank time. We entered this time into NAO's plank program as well as into the traffic light program that we sent to the participants of the control group. Both programs added five percent to the initial time and every consecutive time after, as long as the participant succeeded in planking their previously required time. The participants were not informed about this time increase. After the study, we conducted an unstructured interview with the participants. We wanted them to tell us about their thoughts and feelings during a plank session and particularly if they felt pressured by NAO or the traffic light application. We conducted an unstructured interview in order not to influence the participant’s opinions.

3 Results
In the interview, one male and one female participant of the robot group stated that they could imagine planking with NAO in the future again. The remaining male participant ranked planking with NAO in the future as highly unlikely. One female and one male participant also stated that they felt the time pass quicker during the plank challenge with NAO than it did while planking on their own. The other participant did not notice any change in time. All three stated that they felt motivated to beat NAO. One male even stated that he felt pressured by NAO and that its "voice output was very encouraging". The remaining participants only felt light pressure as a result of the motivation from NAO. The female participant claimed that she felt nervous during the challenge because
she was unsure if anybody was watching her ("Hopefully, nobody’s watching!"). even though she was alone in the room. In the control group, both males would consider using the traffic light application again to plank in the future. All of them noticed the step up in time when using the program. All of them agreed that the red background could motivate them, but it was not enough to make them feel pressured. None of the three participants of the robot group found NAO’s head and eye LEDs to be effective indicators for its level of exhaustion. Most of them did not notice the eye LEDs since they had their head down the entire time. All participants of the robot group perceived NAO’s voice output to be motivating. They felt challenged and adopted it as the main anthropomorphic feature.

4 Discussion and Conclusion

In terms of persuasive ability, our results suggest that NAO is able to motivate people to plank longer. All participants felt passionate to beat NAO. The results also suggest that NAO does not pressure people into challenging themselves to a plank challenge. This shows that even though NAO’s motivational capabilities are present during the plank challenge, it does not currently have the ability to challenge people to begin an initial plank. Future work will have to focus on NAO’s ability to actively challenge people first. Concerning NAO’s hardware, we had to deal with overheating of the motors. To resolve this, we shut down NAO’s motors during the plank and turned them back on before it stood up. We also suggest to rely more on NAO’s voice output in future studies and to disregard NAO’s LEDs. A limitation of our study is the small sample size of participants and the short study time. In this work, we focused on a qualitative evaluation to get initial results for our approach. In the next step, we plan to conduct a long-term study with a larger participant group to get quantitative results.

We showed that a humanoid robot as well as a traffic light application can motivate people to plank longer. Our study results are only qualitative and therefore we are not able to make a definitive statement, of whether the anthropomorphic features of NAO persuaded the participants of our study to exercise more. However, we believe that our study provides a valuable contribution to the young research field of using robots as persuasive interaction partners.

References

Demos

Demo and Showcase Chairs

Marc Busch  
Austrian Institute of Technology, Austria

Margaret Morris  
Intel, USA
Mobile Persuasive Apps for Changing Passengers’ Attitudes towards Aviation Safety

Luca Chittaro¹, Cynthia L. Corbett², G.A. McLean, Nicola Zangrando¹

¹Human-Computer Interaction Lab
University of Udine
Italy

²Civil Aerospace Medical Institute (CAMI),
Federal Aviation Administration (FAA)
USA

Abstract. This interactive demo will illustrate how persuasive technology can foster awareness and educate users about safety topics, by allowing participants to try first-hand three different, fully implemented mobile apps. The purpose of the apps is to foster awareness about aviation safety in passengers. Each app deals with a specific aviation safety aspect (brace position, life preserver, evacuation procedures), and has been designed by following different persuasion theories, as we summarize in the paper.

Keywords: safety, persuasive technology, mobile apps, games, aviation safety

1 Introduction

A major issue in aviation safety concerns how to foster awareness of cabin safety knowledge in passengers, and cultivate positive passengers’ attitudes to affect appropriately their behavior when an emergency occurs [1]. Unfortunately, the methods currently used by airlines suffer from lack of passengers’ attention and understanding. Comprehension of traditional safety instructions is below acceptable limits even in passengers who do pay attention, see for example [3,6]. Moreover, passengers tend to have a fatalistic, pessimistic attitude towards aviation accidents, seeing them as non-survivable events, or showing an external locus of control and a low-level of self-efficacy, which shift the responsibility and capability of their safety to the cabin crew [6]. This serious combination of lack of safety knowledge and inappropriate attitudes can lead to passengers’ injuries and deaths in emergencies that would be instead survivable.

Persuasive technology could play a significant role in changing this scenario, helping passengers to learn the proper safety behaviors as well as change their attitudes towards aviation safety. Our research project is exploring how to leverage the power of digital media to this purpose. In particular, this demo will focus on mobile apps as a persuasive technology for safety.
2 The Demonstrated Apps

Participants to the interactive demo will have the opportunity to try first-hand three different, fully implemented mobile apps we developed for the purposes described in the introduction. We will also be able to share results of the attitude change studies we have carried out. Each app deals with a specific aviation safety topic (brace position, life preserver, evacuation procedure), and has been designed based on different persuasion theories, as we briefly summarize in the following. We also include links to download the apps on mobile devices (Android, iOS, Windows).

2.1 Brace Position Demo

This app (http://hcilab.uniud.it/brace) focuses on a fundamental action that passengers can take to contribute to their survival in aircraft accidents, i.e. assuming an appropriate “Brace for Impact” position that can significantly reduce injuries sustained. The app is a simulation game that enables players to explore hypothetical situations, and instantly observe the link between cause and effect, as suggested by Fogg [4], providing immediate feedback and showing the positive consequences of recommended behavior, and the negative consequences of dangerous behavior. Moreover, app design decisions have been guided by a specific persuasion theory, i.e. Protection Motivation Theory (see [7] for a survey of this and other “fear appeal” models). Players can pose a virtual passenger (Figure 1) in a 3D aircraft cabin, and watch a realistic simulation of what would happen in a crash, including a detailed report of the injuries suffered due to errors in the position. A recent study compared this app with traditional materials used by airlines, showing that it significantly improves passengers’ knowledge as well as their attitudes towards emergency landings [2].

![Fig. 1. Posing the user’s character for the crash simulation in the first app.](image)
2.2 Life Preserver Demo

This app (http://hcilab.uniud.it/lifevest) focuses on wearing a life preserver in case of a water landing. Unlike the previous one, its design does not resort to fear appeals. It follows a constructivist approach in which the user directly acts on the life preserver through the touchscreen (Figure 2), and has to figure out how to wear it. Social cues and dynamics have been used, both to provide feedback (a virtual agent uses body language as well as its voice to provide users with feedback about how they are progressing), and to encourage repetitive rehearsal of the procedure (the user can compete with other users for the best time in quickly wearing the life preserver, an aspect that is particularly important in real-world water landings). We have just completed a study that has compared this app with traditional materials used by airlines, showing that it significantly improves passengers’ behavior in donning life preservers as well as their attitudes towards water landings.

![Fig. 2. Acting directly on the life preserver in the second app.](image)

2.3 Evacuation Procedures Demo

This app (http://hcilab.uniud.it/planetroubles) pursues a completely different design approach from the previous two, focusing on positive emotional appeals that use funny content. The strategy of using positive, humorous content for persuasion is recently gaining attention in the safety community, although research still focuses on non-interactive media. For example, Lewis et al. [5] contrasted humorous and fear-evoking road safety advertising, concluding that fear-evoking content has greater persuasiveness immediately after exposure, whilst humorous content produces greater improvement over time. The app is an entertainment game that focuses on fast and safe evacuation of aircraft during emergencies. Instead of reproducing evacuations in their dramatic and fearful aspects, it turns them into comedy-like situations with cartoon characters and objects (Figure 3), while at the same time keeping the safety messages clear: each of the 48 levels of the game can be completed only by taking into account proper safety knowledge.
Fig. 3. One of the easiest and one of the most difficult game levels.

Acknowledgements

This research is partially supported by a grant of the US Federal Aviation Administration (FAA).

References

Dorsal Haptic Sensory Augmentation: Fostering Drivers awareness of their surroundings with a haptic car seat

Thomas Grah, Felix Epp, Alexander Meschtscherjakov, and Manfred Tscheligi

1 Center for Human-Computer Interaction, Department of Computer Sciences, University of Salzburg, Austria, firstname.lastname@sbg.ac.at
2 University of Applied Sciences Darmstadt, Germany, felix.epp@h-da.de

Abstract. This demo shows the potential of haptic sensory augmentation using a shape-changing car seat, that is meant to persuade the driver to more frequently use the mirrors in the car, especially in situations where a good awareness of the surroundings is crucial for safety, i.e., while overtaking or changing lane. The demo setup includes a simple driving scenario in the OpenDS driving simulator with simulated traffic. While the user can see traffic in front through the simulation on a computer screen, cars behind the users simulated car are haptically augmented through shape-changes of the backrest of the seat. The prototype was developed in the context of driving, but the resulting findings indicate potential for the development of non-audio-visual persuasive interfaces.

Keywords: Shape-Changing Interfaces, Haptic Interfaces, Persuasion, Car

1 Motivation and Concept

Many potentially dangerous incidents or even accidents in traffic happen because the driver is not entirely aware of his/her surroundings. Although nearly all cars provide the driver with at least two mirrors to monitor the rear surroundings, in many situations drivers only focus on the road in front. Especially in situations where the driver overtakes, yields onto the highway or changes lanes, a good awareness of the rear surroundings is crucial for road safety. Therefore, we wanted to develop an interface that persuades the driver to stay in the loop (i.e., visual scanning of car surroundings) and constantly scan the rear view mirrors. As the visual perception is mostly occupied by monitoring the traffic and road upfront the car and aural cues require an extensive amount of time to be processed and may also lead to a mind-of-the-road state. Thus, we decided making use of haptic sensations to augment the drivers perception. In order to make use of the full haptic perception not only the tactile perception (i.e., through
using vibrations) we decided to implement a shape-changing backrest, which stimulates tactile and kinesthetic perception. As the interface uses the otherwise unoccupied dorsal area, it allows continuous feedback for the driver. As we want the driver to perform a familiar behavior from now on and more often (i.e., monitor the mirrors frequently and develop a constant awareness) such an interface can be classified as a blue path or purple path according to Fogg et al.’s Behavior Wizard [1]. Our prototype shows how a shape-changing interface can be used to create an artificial sensation by using the haptic sense of the user and persuade the driver to stay in the loop (i.e., continuously scan the surroundings).

2 Technical Description and Status of the Interface

![Fig. 1. The shape-changing seat, (a) seen from front, showing the wooden plates of the push rods and (b) back revealing the 4 x 4 array of servomotors. The technology is normally hidden underneath the seat cover.](image)

2.1 Hardware

The system is based on a customary car seat, with a 4 x 4 array of standard servomotors attached to the backside of the backrest (see Fig. 1(b)). The servos are attached to plywood plates in groups of four (see Fig. 1(a)). In this way the system can easily adjust to the users back. Each of the servomotors drives a pushrod via a lever. The pushrods transfer the movement through the cushion of the seats backrest to the contact area with the users back. Here we attached circular wooden plates in order to spread the force applied to the users back. The servomotors are controlled by an Arduino microcontroller in combination with an Adafruit 16-Channel 12-bit PWM/Servo Driver, which receives the control commands via I²C. In this way the system could easily be extended with more
servos using only one Arduino board. The Arduino receives preprocessed values for each servo from a computer via USB and only compares the received values against predefined calibration data for the servos. In this way we keep the processing effort for the Arduino low and prevent the servos from running over the specific servos mechanical limits. This approach also allows us to quickly adjust the mapping of the motor, without changing the Arduino setup.

**Software** The first iteration of the computer based application for graphical representation, calibration and computation of the servo values from angle and distance was implemented in Processing. Unfortunately, this implementation is very resource consuming, presumably because of the Java based Processing framework. Also the first implementation of the computation of the servomotor values is based only on distance and angle in two dimensions and ignores the size of the approaching object. For the second iteration we therefore decided to switch to vvvv (http://vvvv.org), which should provide better performance and better flexibility. In this approach we are working with a virtual camera setup to generate the servomotor values. This approach allows us to easily test different viewports and viewing angles. Based on the 3D position and rotation of both the drivers car and the traffic cars from the OpenDS simulation, we create an additional 3D rendered scene. Hereby we aim to generate more values for the servomotors and be more flexible with the positioning and number of servo motors. Furthermore, we expect that this approach allows us to adapt the system more easily to the physiognomy and virtual haptic perception of each user by testing different camera angles and positions in the virtual scene.

### 3 Description of the Demo Setup

For the demo at the conference venue, we would like to demonstrate the dorsal haptic seat in the context of driving simulation. The setup therefore includes the car seat, which should ideally be mounted on our small car mockup (see Fig. 2) with a steering wheel, pedals and a PC with a screen attached. In order to provide the best experience and immersion, we will use an Oculus Rift Virtual Reality headset for the driving simulation software. For the proposed setup we need free space of about 2 × 2m.

### 4 Future Work

From a small exploratory study with our prototype we derived that the current approach allows most users to locate the simulated objects and name the relative position on a simulated five-lane road while conducting a five lane Lane Change Task [2] in OpenDS, based on the setup of the LCTNav study [3]. Most participants were able to tell if the object approaches or moves away. As there was no visual representation of the objects in the simulation (e.g., in the simulated mirrors), a clear mapping of the distance was not possible [4]. We also
noticed a tendency that taller participants (> 175cm) more often had problems to determine the lane of the object than smaller participants (< 165). Therefore, our next steps are to enable the system to (a) determine the users coarse physiognomy (e.g., height, weight), (b) use the visual representation of cars in the simulation software, (c) gain insights in order to adapt the viewport of the virtual camera for obstacle recognition and the haptic rendering to the users physiognomy, and (d) study the effects of sensorimotor couplings [5] on the effects of haptic persuasion.

References

The Appeal of Chance for Behavior Change: "Social Anxiety Challenge", Location-Based Gameful Application for Social Anxiety

Valentina Rao
Playful Pandas
Galgenstraat 11, 1013LT Amsterdam, Netherlands
v@playfulpandas.org

Abstract. “Social Anxiety Challenge” is a project for a mobile application to offer a self-help program for social anxiety sufferers, in the form of a gameful system that recommends homework assignments and provides psycho-educational modules. The program is based on mindfulness, Cognitive Behavioral Therapy and Emotionally Focused Therapy; the system borrows strategies from games of chance and role-playing games to make the execution of the program less emotionally challenging and to support adherence. A location-based approach situates exercises in real-life contexts, whereas elements of randomness emphasize serendipity.

Keywords. Gamification, Location-based, Social Anxiety, Randomness, Chance, Mobile Health, Self-Help, CBT, EFT

1 Background and Goals

Behavior change in social anxiety disorder is usually approached by addressing maladaptive schemas in cognitive processing, such as learning to overcome cognitive bias, read social cues, and increase self esteem [1]. Homework assignments in Cognitive Behavioral Therapy usually consist of exposure to anxiety-evoking situations and self-administered cognitive restructuring activities. In vivo exposure is considered more effective [2]. Novel approaches support the use of web and mobile technologies to reduce the costs related to direct treatment and to expand accessibility [3], both as part of a therapeutic process and as self-administered programs.

The application “Social Anxiety Challenge” is conceived both as a self-guided intervention and, when used in the context of regular therapy, as a way to enhance the experience of homework assignments. Mobile technology is more effective than web interventions in reducing the gap between cognitive engagement with the program content and active commitment in training social skills [4]. In the case of this application, the casual mode of fruition - analogue to that of casual games, games that require short bursts of involvement as opposed to immersive games - can help integrate more seamlessly this program in daily life. A main problem of self-
administered programs such as web interventions is adherence [5]; the use of gameful strategies [6] is here adopted to increase affective involvement and commitment, and consequently adherence.

2 Behavior Change Strategies and Gameful Design

In early design stages it has been useful to distinguish between persuasive design to improve user experience, and persuasive design towards behavior change (in this case, increase tolerance for social interaction and improve social skills). Such distinction helps because not always the schematic application of sound psychological theories of behavior change results in engaging interfaces: many factors like usability and perceived ease of use are involved [7]. As Deterding puts it, "gameful design has to identify the challenges already inherent in the user’s pursuit of her needs and restructure them in a motivating manner" [6], thus the design of the delivery of the program has been considered as equally important as the design of the program itself.

In the application, bite-sized psycho-education and practical exercises are proposed according to the user’s self-reported location (at home, at work, on a train), in order to prompt specific skills training according to the opportunity that is available in that moment (for example, standing in a cue as opposed to being at home reading a book).

Fig 1. A challenge and location-specific exercises support perceived serendipity

Assignments address the different layers in social anxiety disorder - physiological, emotional, cognitive and behavioral [8] - by offering different kinds of actions in the four categories of Think, Do, Write, and Learn; exercises are inspired by various sources: mindfulness-based training to control physiological reactions; EFT for emotion recognition and acceptance; CBT methods dealing with cognitive distortions, and progressive exposure protocols.
The application re-contextualizes two main game strategies:

a) an element of chance (when delegating choice by pressing a button and in the ritual randomness by which assignments are proposed), which transforms the beginning of an exercise an event [9]. The chance element acts purely at a connotative or framing level, as it doesn’t really influence progress in the self-help program.

b) role-playing mini-games: in therapeutic settings, role-playing is commonly employed as part of social skills training, although actual games are employed mostly for children and adolescents [10]. The stylistic reference to casual games hopefully can make this method appealing also to older demographics [11]. Other elements employed, commonly used in gamification but not necessarily gameful: visualization of achievements and progress, badge collection, goals statement.

3 Real and Perceived Location Awareness

A main advantage of mobile interaction is ubiquitousness, which supports persistent activation of behavior change goals [12]; such activation is reinforced when the generic motivation is situated in distinct real life experience.

Location awareness in Social Anxiety Challenge is at the moment very basic and based on self-report; in the future it is planned to expand this option, to include Google Maps location suggestions and the ability to perform check-ins. While actual context awareness is important because it provides objective data about the user and their activities [13], there are advantages also to location awareness that is just perceived. Even rudimentary location-aware technology supports a shift in the perception of space [12] and sustains the feeling of connection with the virtual system in a way that contrasts feelings of loneliness and isolation [14]. All resonance between virtual and real occurrences contributes to feelings of serendipity, the experiential quality of ‘magic, wonder, delight, and thrill’ in the user experience [15], in this case to support both usage and commitment to behavior change goals.

4 Implementation Status and Validation

An interactive version of the graphic interface is being tested online with target users for proof of concept; the survey inquires about preferences in scheduling and frequency [16], personalization, self-monitoring, reminders, praise, surface credibility [17] and if the latter is viewed as opposed to a game-like interaction style. Future work will investigate the usefulness of the "chance" element via AB testing.

5 Demo Contents

A demo of the application can be viewed on (provided) Android phone and laptop, to illustrate basic features of the user experience and persuasive principles employed:
main screen, assignments overview, a selection of exercises from the four therapeutic categories set in different locations, profile page with personal progress.

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Bon Voyage – a persuasive multimodal collectible card game

Kathrin Röderer¹, Alexandra Millonig¹, Josef Froschauer², Michael Heiml²

¹ AIT Austrian Institute of Technology GmbH, Giefinggasse 2, 1210 Vienna, Austria
kathrin.roederer@ait.ac.at
² ovos media GmbH, Schottenfeldgasse 60/36-38, 1070 Vienna, Austria

Abstract. The project Virtual Pursuit makes use of the behavior changing potential of games to foster the awareness of alternative travel modes and routes. This demo will showcase a multimodal collectible card game themed within the mobility context that aims at increasing awareness for sustainable mobility alternatives. The game is conceptualized as a persuasive smartphone application and prototypically implemented in an analog version.

1 Description and purpose of the game

Interventions aiming at changing unsustainable mobility behavior patterns often cannot motivate people to voluntarily change their lifestyles over a longer period of time. Games, however, have the potential to provide behavior-related information in an entertaining and engaging format [1]. Serious games have earlier been used in contexts, such as health behavior [1], promotion of physical exercise [2], and environmental education [3]. Within a larger project, the interactive multimodal collectible card game Bon Voyage was developed and evaluated regarding its behavior changing potential.

The main purpose of the mobility-themed game Bon Voyage was to increase awareness for unsustainable travel behavior and travel alternatives as well as to encourage behavior-changing real-life experiences. For this purpose, we implemented numerous game mechanics, all increasing the possibility of motivating players to question their individual mobility behavior. Game mechanics addressed four selected classic player types [4] well established in game design (see Table 1) to appeal a broad audience. As target group, adolescents and young adults aged between 14 and 25 years (ideally before getting their driver’s license) were identified.

Table 1: Examples of implemented game mechanics and related player archetypes [4]

<table>
<thead>
<tr>
<th>Player archetype</th>
<th>Game mechanics</th>
<th>Implementation within the card game</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socializer</td>
<td>Social Connection, Social Status Cooperation</td>
<td>People meet for playing and swapping cards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Players with special cards become “alpha players” Some challenges can only be solved in collaboration with other players</td>
</tr>
</tbody>
</table>
Competition: Some challenges involve a direct competition with other players. Free Spirit wants to create and explore autonomously. Content: Card decks can be individually arranged for every game. The players arrange their decks individually, based on tactics and prior gaming experiences. Unlockable: Some reward cards are harder to get (e.g., through more difficult challenges) than others. Achiever: Some cards can only be accessed at a certain level of game experience. Levels/Progression: Bonus cards for certain achievements. Rewards: Given in direct play of the card game and in some of the challenges. Branching: Choice. The players arrange their decks individually, based on tactics and prior gaming experiences. Free Spirit wants to create and explore autonomously. 

Achiever is motivated by mastery, wants to learn and improve. Levels/Progression: Some cards can only be accessed at a certain level of game experience. Rewards: Given in direct play of the card game and in some of the challenges. Free Spirit wants to create and explore autonomously. 

Philanthropist altruistically helps others, searches for purpose/meaning. Gift giving: Cards cannot only be swapped but also given to other players. Giving cards to others is rewarded later on. Collectables/Tradeables: Cards can be collected, special editions and styles are more valuable. Free Spirit wants to create and explore autonomously. 

**Game concept.** The game was conceptualized as a multimodal game, combining physical playing cards with a smartphone application. It consists of two parts, one being the direct interaction between two players when playing the card game and the other part being the collection of cards via playing challenges individually or in cooperation with others. The combination of these two game components was based on the following assumptions, which have been deducted from a comprehensive literature research on the potential of serious games in the field of transportation:

1. The mobility-related information given on the cards allows for new insights in and awareness of alternative travel options for the players.

2. The increased awareness may not have sufficient potential for actually initiating behavior changes [5], but the card game can serve as an important starting point for getting involved and staying engaged in the topic.

3. The challenges, which have to be completed in the physical world (e.g., by using alternative modes or routes) for gaining new cards, provide real live experiences that have high potential for initiating behavior change.

**Game instructions.** It is the purpose of the game to cover a distance as long as possible with limited financial resources. The app counts all the points gained and adds them up to the current score for each player. Most cards in the game (i.e., the action cards) are collected, swapped and managed digitally within the application. Also, the app allows for playing challenges and getting help and information about the game itself. The other cards needed for playing, the so called hero cards (see Figure 1), need to be present as physical representation. The game ends when all cards are played, the player with the higher score (consisting of covered distance, money left, and credit for style) wins.

It is possible to gain additional cards by taking challenges. Challenges are mobility tasks that have to be solved in real life, for example planning and following a certain route with a certain transport mode. When a challenge is successfully completed, the player receives a new and possibly rare hero or action card. Challenges can be played alone or in cooperation with others, depending on the specific task. The challenges aim at increasing the participants’ awareness for travel alternatives and allowing for positive experiences with certain transport modes. They were designed making use of
many of the design principles collected by Torning & Oinas-Kukkonen [6] (e.g., feedback/self-monitoring, (social) comparison, suggestions, and personalization).

Figure 1: Example for the hero card called “off-road vehicle” (left). The six hero cards in a deck represent different transport modes (fitness, car, public transport, medium-haul vehicle, long-distance vehicle, adventure) and have different scores for the distance they can go (left bubble) and the respective costs (right bubble). The text field below gives some general information about the respective mode of transport.

Legendary heroes as the “propeller-driven airplane” (right) can be received as rewards for successfully completed challenges. They are rare and have a third score on them (bubble on the very right), a credit for style.

2 Development and Status of implementation

The overall aim of the project was to examine the behavior changing potential of games within the mobility context. For this purpose, several game concepts and research prototypes were developed, Bon Voyage with its persuasive game mechanics and design being one of them.

Bon Voyage was developed in an iterative process comprising several consecutive feedback steps. First, the overall concept was presented and evaluated in an expert workshop, using SWOT analysis [7] to detect the game’s strengths, weaknesses, opportunities and threats. Then, we invited 18 students from an HTL1 for game design to participate in the study. Mean age was 17 years and ranged from 14 to 21 years. In a first user workshop, we focused on the evaluation of the game mechanics. Participants were asked to play the game and give detailed feedback. For the user workshop, an analog prototype of the card game was implemented, comprising not only hero but also action cards. Calculation of scores during the game was realized

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1 A HTL (Höhere technische Lehranstalt) is a secondary education school that permits students to acquire the university entry qualification and a professional training at the same time.
using a Google Spreadsheet per round of the game. Each player had to enter their score at the end of each turn.

Based on the feedback, a revised version of the card game was created and sent to the participants for open play. After several weeks, a second user workshop was held, focusing on evaluating the challenges. Participants were asked to perform one of the challenges, the *Alternate Route Challenge*, in real life. They were asked to choose one of three given alternative routes on their way to the workshop site (their school). Then, they were interviewed about advantages and disadvantages of this alternative route and why they preferred it over the other two.

A second challenge, the *Ghost Challenge*, was implemented as a click dummy for smartphones. In the *Ghost Challenges*, two virtual ghosts travelled to the same destination as the user, but used other routes and transport modes. After reaching the destination, the traveler that arrived first won the challenge. In an overview, users could then compare their travel time and route with the ones of the ghosts.

Based on the feedback gathered in the expert workshop and the user workshops, the game design and mechanics were improved several times. Since the focus of the project was to generate gaming concepts rather than developing a specific game to more than an early prototype stage, future work will include the implementation of the game as a smartphone application and its evaluation regarding long-term effects.

**Contents of the demo.** In the demo at the conference, participants are able to play analog part of the card game. Scores are calculated using a Google spreadsheet on a laptop. Moreover, a click dummy of the game interface including the *Ghost Challenge*, can be tested on a smartphone.

**Acknowledgments.** The game presented in this demo was developed as part of the project Virtual Pursuit (project no. 844071), which is partially funded by the Austrian Research Promotion Agency (FFG).

**References**

Workshops

Workshop Chairs

Maurits Kaptein  
Tilburg University, The Netherlands

Peter Fröhlich  
Austrian Institute of Technology, Austria
User Experience Design for Persuasion & Behavior Change

Thomas MacTavish¹, Jaime Rivera¹, Ryan Wynia²

¹Illinois Institute of Technology - Institute of Design, Chicago, USA
{tomm, jaime}@id.iit.edu
²higi, Chicago, USA
{ryanwynia}@gmail.com

Abstract: Many theories and models have been generated from the fields of informatics, medicine, psychology, and sociology on the topic of persuasion to describe aspects of human behavior, human/computer interaction, and information systems involved in supporting behavior change. But, what specific methods should we select to design specific user experiences? In this workshop, we will share perspectives on how to create user experiences by building on BJ Fogg’s initial description of a general user research and design method [1], draw from Harri Oinas-Kukkonen’s Persuasive Systems Design model [2], and explore pragmatic approaches for creating user experience design knowledge for aspects of healthcare.

Keywords: persuasive - design – behavior change – healthcare – user experience design – UX design

1 Workshop Topic

This First International Workshop on “User Experience Design Methods for Behavior Change” provides a forum for sharing and evaluating advances in user experience research and design methods to create engaging persuasive experiences. This workshop will be shaped by a clear focus on healthcare contexts and design methods relevant to healthcare practices, preventive healthcare and after-care medical protocols such as dosage, diet, exercise and self-managed wellness. We suggest that future workshops in this series should focus on other contexts such as environmental sustainability and personal safety.

2 Motivation

Substantial investigations and new knowledge have been published in many fields associated with persuasive technology such as human/computer interaction, informatics, medicine, psychology, and sociology. While each discovery is useful in its own domain, we seek to move from the theory and models of separate disciplines toward integrated methods and techniques that can be used to design engaging user experiences. In this workshop, we seek to capture and clarify design methods for creating
specific behavior change experiences. There are precedents from the field of persuasive technology that we would like to build on to create a more complete foundation for persuasive user experience design. Early work by BJ Fogg sought to offer pragmatic advice on designing for behavior change by identifying a modest target based on existing successes in behavior change [1]. Sunny Consolvo sought to clarify design strategies and their connection to theory [3]. Ahtinen, Aino et al proposed design approaches related to social features [4]. Shyam Sundar et al offered a more specific approach by exploring connections between Self Determination Theory and interaction design attributes [5]. From the field of multimedia learning, the work of Richard E. Mayer explores participant engagement and the need for cognitive learning [6]. Also, Dan Lockton, provides a pragmatic tool for supporting education about persuasive techniques. His “Design with Intent” toolkit card deck was released in 2010 and will be further described in this forthcoming book on the same topic [7]. And, Susan Michie has captured the perspective of the Society of Behavioral Medicine in creating a behavior change technique taxonomy [8]. From a user experience design perspective, we see a need for more clear process of using methods and tools to elicit user involvement in articulating more effective embodiments and experiences to support behavior change.

3 Organization

While workshop participants must be registered for the 11th International Conference on Persuasive Technology (2016), they are not required to submit a paper. Those who are writing papers are requested to make submissions either as position papers (2-4 pages), research-in-progress papers (2-6 pages), or full research papers (6-12 pages) in the LNCS format available at the Springer webpage. The papers will be reviewed by the workshop organizers and selected according to their significance as well as their potential to inspire discussions. Page limits do not include references or bibliographic listings. The papers do not need to be anonymous and should be submitted to the organizers at puxdworkshop@gmail.com

09:00 – 9:30 am -- Introductions and Overview of UX design methods
09:30 – 10:00am -- “Designing for Different Stages in Behavior Change,”
   by Evangelos Karapanos, Cyprus University of Technology, Limassol, Cyprus
10:00 – 10:15am -- Break
10:15 – 11:00am -- Design Issues in Mental Health Applications: Integrating Different Frameworks in the Name of the User, Valentina Rao,
   Playful Pandas, Amsterdam, Netherlands
11:00 – 12:00pm – Methods and Taxonomy workshop
12:00 – 12:30pm -- Reflections, accomplishments and potential directions
4 Expected Outcomes

a. A catalogue of methods, models, and techniques
b. An updated taxonomy of behavior change in the healthcare context
c. Identification of research areas that are newly described, need further exploration, or need re-evaluation.

5 Supporting Materials

a. Organizers

Tom MacTavish, Assistant Professor, Illinois Institute of Technology - Institute of Design, Chicago, IL, USA

Jaime Rivera, PhD Student, Illinois Institute of Technology - Institute of Design, Chicago, IL, USA

Ryan Wynia, Director of Product Design, Emmi Solutions, Chicago, IL, USA

b. References:


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Empowering Cities for Sustainable Wellbeing

Agnis Stibe1, Samir Chatterjee2, Katja Schechtner1,4, Matthias Wunsch3,5, Alexandra Millonig3, Stefan Seer3, Ryan C.C. Chin1, Kent Larson1

1 MIT Media Lab, Cambridge, MA, USA
{agnis,katjas,rchin,kll}@mit.edu
2 Claremont Graduate University, Claremont, CA, USA
samir.chatterjee@cgu.edu
3 Austrian Institute of Technology, Vienna, Austria
{Matthias.Wunsch.fl,Alexandra.Millonig,Stefan.Seer}@ait.ac.at
4 University of Applied Arts, Vienna, Austria
5 Vienna University of Technology, Human Computer Interaction, Vienna, Austria

Abstract. Quality of life in cities can be improved through reshaping and advancing urban spaces with seamless persuasive and socially influencing strategies for empowering people to succeed in achieving better lifestyles. This vision aims at helping people to acquire healthy and resource-efficient everyday routines, thus leading to prosperous and sustainable societies. Urban engineers and technology developers are oftentimes unaware of how diversely their innovations will affect lives of many people. Therefore, this research is focused on investigating and designing ways how urban environments can be retrofitted and complemented with persuasive technology and socially influencing systems to facilitate societal changes at scale. Outcomes of this research are instrumental for various contexts, including health, mobility, education, energy and water conservation, safety, emergency management, ecology, and economy. Ultimately, more refined scientific knowledge on how to design empowering cities has to be generated and translated into applicable guidelines for practice to foster their emergence.

Keywords: persuasion, empowerment, socially influencing systems, wellbeing, mobility, behavior change, sustainability, gamification, persuasive technology

1 Motivation

Future cities will reshape human behavior in countless ways. Persuasive urban systems will play an important role in making cities more livable and resource-efficient by addressing current environmental problems and enabling healthier routines. Therefore, future research should be directed towards exploring how urban design might be combined with persuasive technology [3] and socially influencing systems [4-5] to encourage healthy behaviors at scale.

More effort has to be put into studying how quality of life and the health of the individual and communities might be improved through the creation of empowering
cities, streets, buildings, homes, and vehicles. Information technology and computer systems are increasingly designed to support everyday routines and advance user experience in multiple ways [2]. Novel computer systems can be also intentionally designed to influence how users think and behave. Theories of persuasion and social influence provide various strategies for the developers of such systems to facilitate desired effects on users.

Research on empowering cities seeks to advance urban spaces to facilitate societal changes. This research is primarily focused on socially engaging environments for supporting entrepreneurship and innovation, reshaping routines and behavioral patterns in dense urban districts, intelligent outdoor sensing for shifting mobility modes, enhancing environmentally friendly behaviors through social norms, interactive public feedback channels for affecting attitudes, engaging residents through socially influencing systems [4-5], exploring methods for designing persuasive neighborhoods, testing agent-based models and simulations of persuasive interventions, and fostering adoption of novel urban systems.

2 Importance

The proposed research direction is highly important, as it will directly influence everyone living in future cities. Environmental, personal, and behavioral factors are locked into triadic reciprocal determinism [1], meaning that all three are strongly interconnected and continuously reshaping each other. Thus, environmental design is strong influencer on human behavior and attitude. In other words, quite often it is merely sufficient to improve urban spaces to help people become healthier and to create sustainable communities. This is very powerful vision as it encompasses transformation of human behavior and urban environments at scale. Moreover, since persuasion sometimes has a negative connotation, we will explore new ways to empower communities and cities.

The proposed research will reflect on novel ways of how socially influencing systems [4-5] enable perpetual mechanisms to foster user motivation as compared to conventional methods, such as those that are based on the principle of carrots and sticks. Earlier research on motivation discusses methods that have substantial limitations. For example, monetary incentives are mostly effective only as long they are provided, so people tend returning to their earlier behavior after the motivators are taken away. Instead, persuasive urban systems harness social influence from crowd behavior to craft influential messaging aimed at shifting behavior and attitude of an individual, who naturally is an integral part of the same crowd. Such continuous interplay can ultimately result in an ongoing process that reshapes communities and societies without any other incentives.

3 Agenda

The empowering cities research agenda is focused on reshaping and redesigning three main urban areas: outdoor environments, indoor environments, and mobility in cities.
Public spaces can be advanced in many ways, e.g., supermarkets can project a portion of how many healthy products have been purchased that day, week, or month. Responsive environments can use ambient lights to provide feedback about behavioral patterns of crowds. For example, streetlights can change color depending on how many joggers have been on that street on that morning. The window frames of residential buildings can be illuminated for those apartments, which have changed regular light bulbs to energy-efficient ones.

Computer-supported strategies [4] can be implemented indoors to motivate using stairs instead of an elevator. For example, a situated display that represents various comparisons of what can happen when stairs or an elevator is chosen. Strategies can be introduced to increase water intake in offices. For example, a situated display can present an increase of water consumption, which can be used to compete with other offices. New ways can be designed for office workers to increase socializing among individuals from various groups and departments. For example, specific game-like activities can be set up for employees to promote socializing.

Mobility within dense urban districts can be reshaped in multiple ways, for example, by introducing influential strategies to facilitate bicycle commuting. Street signage can be used to display how many bicyclists have ridden over a bridge today, for instance. Mobile apps can be developed to engage bicycle riders in reporting experiences with bike lanes and their quality in a selected urban area. Electric bicycles can be complemented with influential strategies to attract more riders and persuade them to pedal.

4 Application

There are various ways how the concepts of empowering cities can be designed and applied in urban contexts to support wellbeing. For example, it is necessary to design interventions for promoting bicycling and walking, because these mobility modes are carbon neutral, provide major health and financial benefits, and require less space for parking. Besides investing in infrastructure, cities can work on shifting mobility patterns towards bicycling and walking through publicly engaging urban interventions, especially designed leveraging persuasive technology [3] and socially influencing systems [4-5].

Earlier research traditionally reports how various interventions to promote modal shift can be effective. However, most of them rather follow one of the traditional approaches like publicity campaigns, engineering measures, or financial incentives. Therefore, more research should be done with regards to how behavioral and attitudinal changes can be achieved through persuasion and social influence [6]. Empowering cities have potential to significantly contribute to this effort, for example, through publicly displayed street signage with interactive computer-supported [4] social comparisons of cars versus bicycles.

To promote walking, city planners can potentially make many modifications to the urban environment. Besides meeting the requirements of safe walking pathways, there are other proven methods of fostering behavioral and attitudinal changes through
social influence [5]. Persuasive urban systems can leverage the principles of normative influence, social learning, and social facilitation to affect the way people think about walking, which might presumably lead to increased physical activity. The principles of recognition, competition, and cooperation can be incorporated to build on the initial levels of walking and promote sustainable adoption.

Empowering cities can make walking experience more engaging, for example, by combining a mobile phone app that interacts with retrofitted traffic light junctions. So, when waiting at traffic light junctions, people would be invited to do certain meaningful activities. To represent the level of activity at each junction, each traffic light can be overlaid with an interactive color strip, which would display rankings on a particular day or week.

5 Future

Fundamentally new strategies must be found for creating the places where people live and work, and the mobility systems that connect these places, in order to meet the profound challenges of the future. Novel models for urban architecture and personal vehicles should be more responsive to the unique needs and values of individuals though the application of disentangled systems and smart customization technology. Technology has to be designed to understand and respond to human activity, environmental conditions, and market dynamics. The design of future cities requires optimal combinations of automated systems, just-in-time information for personal control, and interfaces to persuade people to adopt sustainable behaviors.

Drawing on socio-psychological theories [1] and integrating them with new concepts for urban design and technology [3], the proposed empowering cities research aims at advancing livability in future cities.

6 Literature

The Challenge of Device Overload: Using the Persuasive Framework to Effectively Use Modern Technologies to Encourage Health-Promoting Behaviors

Sriram M. Iyengar
iyengar@medicine.tamhsc.edu

Abstract. The current explosion of devices and technologies such as smart mobiles, sensors, smart watches, augmented/virtual reality comprises both opportunities and challenges. The challenge is how to use this overload of devices and technologies to support health promoting behaviors among the sick and among healthy individuals. The theory of Persuasive Technology and Behavior Change Support Systems can be a solution. This workshop will bring participants together interested parties to develop strategies and a framework for optimal use of these exciting technologies for health promotion.

Keywords: Health promotion, rich media, smart mobiles, sensors, augmented/virtual reality, health promotion, Persuasive Technology, Behavior Change

1 Introduction

Currently we are witnessing an exciting explosion of computing-based technologies. Smart mobile devices, including phones, tablets, smart watches, wearable sensors, beacons, augmented reality, Virtual reality, ubiquitous social network access, Internet of Things, are becoming rapidly more affordable. Among other benefits, this means that sophisticated computing, communications, display, immersive, and sensing devices potentially capable of providing real-time highly relevant assistance to humans, are becoming pervasive and ubiquitous. However the ready availability and rapid advancement in the capabilities of these technologies raises a challenge of overload: How can we make the most effective use of the bewildering array of these devices/technologies to improve outcomes and enhance the quality of life among those afflicted with medical conditions, decrease health disparities, enhance patient engagement, promote healthful behaviors and continued wellness of those who are healthy.

The disciplines of Persuasive Technology and Behavior Change Support Systems offer a potentially effective theoretical foundation for addressing this challenge. In particular, PT could be a framework for translational science, specifically for converting health research and evidence-based guidelines into actionable, easy-to-use mobile and pervasive tools that include, among others, anytime-anywhere media-rich
advice, augmented/virtual reality gamifications, social networks, and simulations [1-7]. A related development is in the area of ambient/environmental persuasion [8-9], in which empirical research and published literature confirm that the design of cities, suburbs, neighborhoods, and workplaces can improve or deteriorate population health [10-11, 26-28]. Recent research and analyses regarding mobile technologies for both patients and health workers [12 – 24] provide intriguing evidence to support the notion that PT and modern technologies can be synergistic for both healthworkers and patients in both developed and developing countries.

2 Workshop Proposal

The proposed half-day (four hour) workshop will bring together interested participants to share their collective knowledge and experience. The Proposal author has identified and will recruit at least 5 participants prior to Persuasive2016. The workshop will be highly interactive. It will be moderated by the author of this proposal but his role will be limited to encouraging discussion and interaction. Participants will be encouraged to bring examples of the devices mentioned above. The workshop will be organized according to the following outline. The proposal author will recruit another participant to help with documenting the discussions and major points.

<table>
<thead>
<tr>
<th>Time</th>
<th>Participants</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>First half hour</td>
<td>Workshop organizers</td>
<td>Introduce the topic, provide a brief literature review, describe the challenge</td>
</tr>
<tr>
<td>Next hour</td>
<td>All</td>
<td>Each participant will present their ideas, views, experiences. Device demonstrations, papers.</td>
</tr>
<tr>
<td>Next half hour</td>
<td>Proposal Author leads</td>
<td>Summary of the ideas, thoughts so far written out as, e.g., bullet points</td>
</tr>
<tr>
<td>Next hour</td>
<td>All</td>
<td>Hopefully, more focused discussions. Where do each of these devices (or class of devices) fit within the theoretical principles of PT and BCSS?</td>
</tr>
<tr>
<td>Next half hour</td>
<td>All</td>
<td>Identification of specific application areas of these devices, combined with principles of PT &amp; BCSS, in health, both for those who are afflicted and also the healthy.</td>
</tr>
<tr>
<td>Last half-hour</td>
<td>Proposal Author leads</td>
<td>Final summary of the workshop, formation of working group to ensure continued discussion and research</td>
</tr>
</tbody>
</table>

3 Specific Topics to Initiate Discussion

The topics of Diabetes, Obesity, rural/global health, depression, will be introduced by the moderator merely as starting points for discussions and interactions. Discussion will not be limited to these application areas.
4. Conclusion

The current explosion in mobile devices, augmented and virtual reality offers both opportunities and challenges to enable adherence to health promoting behaviors for both sick and well individuals. This workshop will result in a shared understanding of both opportunities and challenges and the design of systems based on principles of Persuasive Technology and Behavior Change Support Systems. Participants will comprise a core working group which will continue fruitful discussions and collaboration even after the conclusion of Persuasive 2016.

References


Where are We Bound for?
Persuasion in Transport Applications

Andreas Riener\textsuperscript{1}, Myounghoon Jeon\textsuperscript{2}, Peter Fröhlich\textsuperscript{3}, and Alexander Meschtscherjakov\textsuperscript{4}

\textsuperscript{1} Ingolstadt University of Applied Sciences, Germany
\texttt{andreas.riener@thi.de}
\textsuperscript{2} Michigan Technological University, USA
\texttt{mjeon@mtu.edu}
\textsuperscript{3} Austrian Institute for Technology, Vienna, Austria
\texttt{peter.froehlich@ait.ac.at}
\textsuperscript{4} Center for Human-Computer Interaction, University Salzburg, Austria
\texttt{alexander.meschtscherjakov@sbg.ac.at}

Abstract. Due to its interdisciplinary nature, research on persuasion in transport applications is fairly scattered across communities as diverse as psychology, transportation science, computer science and automotive user interfaces. We would like to take this workshop as an opportunity to achieve a first step towards a systematic overview of the field of persuasion in transport applications. The aim of this workshop is thus to bring together people with interest in persuasion and/or automotive research and to discuss, share knowledge, and take away insights, strategies, and tips of how to use persuasive technology to improve the driver-vehicle interaction loop. We are covering both i) theoretical work focusing on theories and models, modalities, and strategies and ii) practical work/design studies toward optimal applications for vehicle environments (behavior change, social interaction, cooperative self organization, gamification approaches/serious games, incentives, etc.).

Keywords: Persuasion, Multi-modal transport chains, Future transport, Serious games, Behavior change.

1 Introduction and Motivation

We can expect a very exciting time for the transport field, with two main areas of research: First, the application of cooperative strategies between the various entities involved in traffic (technology and non-technology enabled), and second, the transition from manual to automated driving. Persuasive technology has the potential to push the field forward, e.g., by applying methods to lessen selfish behavior and thus, to establish cooperative self organization. Furthermore, using gamification approaches or incentives, it is expected that the transition between different levels of control in partial automation and the co-existence of manual and automated cars can be made smoother and safer.
The safety, efficiency and ecological impact of transportation systems is dependent on the attitudes and behaviors of their users. People often have the choice between different routes and transportation modalities, they have certain driving styles, and they will have various attitudes towards concepts like car sharing and semi-autonomous driving. Persuasive Technology, that is, interactive information technology designed for changing users attitudes or behavior [1], has shown to be effective also in many areas of transport, demonstrated for example by a large EU FP7 project “MyWay” (http://myway-project.eu, last accessed November 29, 2015) or many other related works, e.g., [5], [4], [2], [6].

Due to its interdisciplinary nature, research on persuasion in transport applications is fairly scattered across communities as diverse as psychology, transportation science, computer science and automotive user interfaces. We would like to take the Persuasive Technology 2016 conference as an opportunity to achieve a first step towards a systematic overview of the field of persuasion in transport applications.

To this end, we need to have a general consensus on (1) what to persuade (the goal state), and (2) how to persuade (methodologies, modalities, and strategies), and thus we can design (3) optimal applications for vehicle environments. To achieve (1) what to persuade, more data need to be systematically archived from across multiple disciplines. To better know (2) how to persuade, we may need to go beyond the traditional conceptualization about the relationship between driver and vehicle. One of the directions could include making computers (in our case, “vehicles”) more social. For example, Salah et al. [3] shows that the role of pervasive systems is “(to support) change from a passive observer to a socially active participant that influences people’s attitudes and behaviors, by providing support in goal selection and acquisition”. Even under this assumption, we can think of different strategies (e.g., social interaction between a driver and an intelligent transportation system, extension of the driver’s social interactions with other “people” by utilizing a car’s networking and other capabilities, etc.). To design (3) optimal in-vehicle applications, these efforts can evolve with the rapidly changing situations of the transport industry (e.g., intelligent transportation systems, instrumented road infrastructure, connected vehicles, semi/full autonomous vehicles, etc.).

2 Topics of Interest

To discuss all these aspects in the workshop, we have qualified topics of interest as follows.

I. Theories and Models
(a) Theories and models in Psychological, Cognitive, and Affective Sciences about i) motives, rewards, incentives, reinforcements and ii) behavior modification
(b) Theories and models in Affective Computing
(c) Theories and models in Positive Design/Technology/Computing
(d) Direction: Persuasion for long-term vs. short-term behavior adaptation
(e) Ethical issues: What is the direction of persuasion, who decides it?, etc.
(f) Trust: Persuasive technology or manipulative technology

II. Modalities and Strategies
(a) Speech-based dialogue between driver and car
(b) Implicit/subliminal/unobtrusive/ambient driver-car communication
(c) Multimodal interactions (visual, auditory, haptic, gesture; combinations)
(d) Reminder and preventive strategies
(e) Gamification of behavior modification technologies

III. Applications in Vehicle Environments
(a) Intelligent means of transportation
   i. Promote fuel efficient driving
   ii. Detect and prevent or mitigate i) fatigue driving, ii) emotional driving, iii) use of mobile phone while driving
(b) Social cars
   i. Provide collective knowledge about driving skills and traffic pattern
   ii. Promote car pooling
(c) Autonomous vehicles
   i. Persuade the driver based on social networks (other people’s opinion), rather than a car
   ii. Expand the driver’s social abilities by initiating a contact with other real people, by using a car
   iii. Persuasive technology to support the transition between different levels of control in partial automation
   iv. Application of persuasive technology (serious games) to establish cooperative self organization (i.e., lessen selfish behavior)

3 Organizers

Andreas Riener is a professor for Human-Machine Interface and Virtual Reality at Ingolstadt University of Applied Sciences, Germany with more than 10 years of experience in automotive UI’s and novel in-car applications and more than 100 publications in the field. His current interest is in the future of mobility and he is the main organizer of a prestigious Dagstuhl seminar on “Automotive User Interfaces in the Age of Automation” (June 2016).

Myounghoon “Philart” Jeon is an assistant professor of Cognitive Science and Computer Science at Michigan Tech. He directs the Cyber-Human Systems Center at Tech. His Mind Music Machine Lab conducts research on automotive interfaces, affective computing, auditory displays, and assistive technologies, which has led to more than 130 publications and numerous awards. He was a professional automotive UX designer and led many industry projects.
Peter Fröhlich is a senior scientist at AIT, where he leads a team of researchers dealing with Personal Value-enhancing Experiences. His research interests include user experience and mobile spatial interaction, as well as persuasive technologies for sustainable and privacy-aware behavior. He has contributed as organizer and committee member to renowned conferences and journals, such as the Journal of Personal and Ubiquitous Computing, Mobile HCI, Automotive UI, and CHI.

Alexander Meschtscherjakov is an assistant professor at the Center for HCI at the Computer Sciences Department of the University of Salzburg. In his research he deals with automotive interaction design and persuasive technologies in various domains. He was co-chair of conferences (e.g., AutoUI’11) and organizer of workshops (e.g., AutoUI’13-15, CHI’15, PT’14).

References

Abstract: Both in theory and in practice, learning has been argued to hold significant potential in relation to persuasive technologies. Particularly when persuasive initiatives strive to motivate sustainable behavior changes. Correspondingly, the notion of persuasive design may constitute a valuable perspective in the development of technology-based learning designs, ensuring that learning technologies not only facilitate learning, but also motivate the students to engage in the learning process. As a result, this workshop invites researchers and practitioners from both learning and persuasive technologies, to participate in exploring how the cross field between persuasive technology and technology-based learning may advance.

1 Introduction

In this first workshop on Persuasive Designs for Learning, we wish to explore the potential of creating a network for researchers and practitioners to discuss and share knowledge on the impacts of applying persuasive design principles in learning, or combining theories and methods of learning and persuasion in technology design. The organizers are all based at Aalborg University, Denmark, as members of E-Learning Lab, Center for User Driven Innovation, Learning and Design.

1.1 Organizers background

**Sandra Burri Gram-Hansen** is Teaching Assistant Professor and PhD Fellow at Aalborg University in Denmark. Her primary research interests are within the field of Persuasive Design, which she approaches from a humanistic perspective, placing particular attention on the rhetorical notion of Kairos, and on applied ethics in relation to persuasive design. She was a contributing member of the project consortium of the EU funded EuroPLot project (*http://www.eplot.eu/*). Current research focuses on designing persuasive learning technologies for climate communication within the Danish Army. In particular, she is interested in Participatory Design, Value Sensitive Design, Applied Ethics and Persuasive Technologies.

**Lykke Brogaard Bertel** is a PhD Fellow at the Danish Technological Institute and Aalborg University. She is exploring the cross fields between Human-Robot Interaction, Persuasive Design and didactics, particularly focusing on robots’ ability...
to facilitate motivation for learning through social interaction in real-world learning environments. Research interests include persuasive technologies in special needs education, motivation in human-robot relationships and design-based educational research.

Thomas Ryberg is Professor mso (MA, PhD) in the Department of Communication and Psychology at Aalborg University (AAU), Denmark. His primary research interests are within the fields of Networked Learning, Problem Based Learning (PBL), Computer Supported Collaborative Learning (CSCL) and Technology Enhanced Learning (TEL). He is co-chair of the International Networked Learning Conference (http://networkedlearningconference.org.uk/) and editor of the Journal of Problem Based Learning in Higher Education (http://journals.aau.dk/index.php/pbl). He has participated in European and international research projects and networks (EQUEL, Kaledioscope, COMBLE, PlaceMe, EATrain2), and in development projects in South East Asia and Latin America (VISCA, VO@NET, ELAC). In particular, he is interested in Problem Based Learning, and how new media and technologies transform our ways of thinking about and designing for Networked and Hybrid Learning.

2 Motivation

The literature on both learning design and persuasion is vast, yet these areas have not been combined in a systematic manner. Initial steps taken towards defining and exploring the areas in which persuasion and learning may complement each other, indicates that both persuasion and learning are highly contextual phenomena where intentions of the designs and the users and the negotiation of intentions are equally important to the applied technology.

From a learning perspective, it has been argued that, that which separates teaching from other similar activities, is the particular intention of the teacher – namely that the students are to learn something specific. The distinctive characteristic of the intended learning scenario is that the teacher wishes to motivate and encourage students to relate to and reflect upon the subject in a specific way. The aim is to make the students gain a deliberate and positive impression of the content of the subject, and to motivate an aspiration within the students to learn more. However, much learning also occurs without a teacher, such as informal learning or learning in communities of practice, and how can such learning theories and perspective inform persuasive design thinking? [1,2]

As initially stated, persuasive technologies - in our view – should strive towards not only designing for superficial changes of behaviour, but to facilitate deeper rooted sustainable changes of perspective and identity of the learner or user. Learning theories have for decades sought to understand how such personal as well as collective transformative learning processes occur. For example Mezirow’s notion of transformational learning or Engeström’s ideas of collective expansive learning [2] both provide us with concepts of radical personal and collective transformation and learning processes.

With learning and persuasion clearly overlapping in significant areas, distinguishing between persuasive learning technologies and simply well designed
learning technologies can be challenging. Consequently, establishing a claim for persuasive technologies in learning contexts may be equally difficult. None the less, as technologies are playing an increasingly large role in teaching and learning, both in organizational matters and in learning designs, it may be safe to argue that the field of persuasive design principles may hold potential with regards to motivating learners to engage in learning activities. While the field of learning games, serious games, gamification and edutainment is vast, we would argue that the theories of persuasion bring in a more holistic perspective and could be employed to initiate learning processes resulting in more fundamental change of perspective and identity, rather than merely the acquisition of simple skills (or what is at times referred to as chocolate-covered broccoli within learning games [3]).

In addition, the field of technology-enhanced learning may have something to offer in relation to the methodological approach to design and development of persuasive technologies, particularly its attention to contextual factors affecting implementation and application of technologies as well as its tradition for including users at an early stage through user-centered innovation processes and Design-Based Research.

The Persuasive Learning Design workshop will bring together experts and stakeholders in the realm of technology-based teaching and learning and persuasive technologies, who are interested in discussing persuasive principles and methodological approaches in the development and application of technology-enhanced learning.

The workshop aims to include researchers and practitioners from both traditional and untraditional learning domains, thereby broadening the scope of this workshop from state of the art approaches to digital learning in education and organizations, to also include novel approaches to learning technologies such as social robots, games for learning and apps for active learning. As such we take a broad approach to the notion of learning, and strive towards creating a venue for networking and sharing experiences as we explore the potential of persuasive design in learning contexts.

3 Workshop format

The workshop is designed to cover one afternoon of presentations, discussions and creative learning design activities. Interested participants were invited to submit papers describing their current reflections on or practice in areas such as:

- The role of persuasive design in learning
- Persuasive Technology as basis for new learning designs
- Methods for persuasive learning designs
- Ethics of persuasion and learning
- Context aware learning designs
- Practical exemplifications of persuasive learning designs

Depending on the received submission, the workshop is expected to focus primarily on two themes, divided into two individual sessions:

1. The theoretical and practical potential of persuasive design in relation to learning
2. Persuasive Learning Designs in practice – areas of application, methodological approaches, evaluation methods and results
Finally, the results of the workshop discussions and activities will be summarized and distributed amongst the participants.

4 References

Fourth International Workshop on Behavior Change Support Systems (BCSS’16):

Epic for Change, the Pillars for Persuasive Technology for Smart Societies

Olga Kulyk¹, Liseth Siemons¹, Harri Oinas-Kukkonen², Lisette van Gemert-Pijnen¹

¹ Psychology, Health & Technology, University of Twente, Enschede, The Netherlands
{o.a.kulyk, l.siemons, j.vangemert-pijnen}@utwente.nl
² OASIS Research Group, Faculty of Information Technology and Electrical Engineering,
University of Oulu, Oulu, Finland
harri.oinas-kukkonen@oulu.fi

1 New Avenues for Research: EPIC for Change

Our everyday life is impossible to imagine without modern technology. Humanizing technology is embedded in our daily environment, measuring our activities 24/7 via smart sensors, activity trackers, and various wearable devices [1,2,3]. Checking health status, tracking and managing our stocks, and controlling the temperature of our house via a mobile app have become a daily routine.

Persuasive technology reveals an interdisciplinary research and education area transcending the traditional use of technology as helpful to merely improve the accessibility, affordability, and efficiency of services within the institutional contexts. Technology has the capacity to create smart (virtual) persuasive environments that provide simultaneously multimodal cues and psycho-physiological feedback for personal change by strengthening emotional, social, and physical presence. Besides, smart environments collect and analyze sensor data by self-tracking behaviors, emotions, and thoughts; presenting a quantified holistic self-concept that will shed new lights on how technology integrates in our lives, and how people engage each other and their environments using unobtrusive and pervasive technologies. An array of persuasive applications has been developed over the past decade with an aim to induce desirable behavior change. A Behavior Change Support System (BCSS) can be defined as “a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception” [4]. Persuasive applications have shown promising results in motivating and supporting people to change or adopt new behaviors and attitudes, in various domains such as health and wellbeing, sustainable energy, education, and marketing.

During this workshop we would like to set the first stage in defining the pillars for persuasive technology by introducing a new holistic concept: EPIC for Change. EPIC refers here to:

- **Engagement**: Creating experience, flow using persuasive strategies and triggers in development, using positive psychology concepts.
- **Personalization**: How to personalize technologies to personalities and to differences in cultures?

- **Integration**: How to create technologies which are implementable in practice, environments [geo-informatics] and that are adaptable to people [humanizing environments]?

- **Connectivity**: How to develop social networks for self-organizing communities?

**Change**: Refers to individuals, communities and society, creating smart environments with persuasive technology for solving societal challenges.

### 1.1 Workshop Topics

Topics for submissions include, but are not limited to:

**Design & Development**
- Engagement, Personalization, Integration, Connectivity, and Changes in Persuasive Technology.
- Smart communication and information systems.
- Interactive visualizations for personalization and social support.
- High tech, human touch / humanizing technology.
- Persuasive prompts to create engagement and involvement: Virtual environments, ambient visualizations, etc.
- Developing just-in-time persuasive feedback to support activities real-time and offline (e.g., triggers and alerts), using data generated by smart sensors, self-tracking devices, wearable’s, etc.
- Connectivity designs for social support, e.g. for lifestyle change & wellbeing.
- Persuasive profiling to personalize interventions.
- Ethical issues of persuasive technology, big data and BCSSs.
- Value proposition design to create BCSSs that have value in practice for all stakeholders, implementation issues.
- Persuasive strategies related to different outcomes (engagement/resilience/attitudes/compliance/behaviors) and levels (individual/community/society) of change.

**Evaluation**
- Measuring the impact of BCSSs and smart persuasive environments on individuals, community, and society.
- Evaluation methods for measuring various aspects of BCSSs; process and product measurements.
- Advanced big data analytics for measuring and interpreting self-tracking data from wearables, multi-sensor data, etc.
- Adequate design for measuring the effect of persuasive strategies on task adherence during usage and long-term effects (fractional factorial designs).
- Frameworks and methodologies to measure A/B/C-Changes (attitude, behavior or compliance).
- Profiling personalities and matching them with persuasive strategies.
- Multimodal cues and the effects on adherence and outcomes.
• Advanced analytics to predict adherence, and to identify usage patterns and its effects on adherence.
• Evaluation of persuasiveness of different BCSSs (mobile, ubiquitous, ambient technologies, virtual environments, sensor-based, etc.).
• Design guidelines for practice, based on evaluation studies.

1.2 Important Dates
Submission deadline: February 2, 2016  ➔ Notification to authors: February 26, 2016
Final version due: March 18, 2016  ➔ Workshop date: April 5, 2016

1.3 Organizers
General Co-Chairs: Harri Oinas-Kukkonen, University of Oulu, Finland; and Lisette van Gemert-Pijnen, University of Twente, the Netherlands
Program Chair: Olga Kulyk, University of Twente, the Netherlands
Organizing Chair: Liseth Tjin-Kam-Jet - Siemons, University of Twente, the Netherlands

2 Workshop’s Way of Working
This interactive workshop will act as a multidisciplinary forum where researchers, practitioners and experts from a variety of scientific domains (such as information sciences, psychology, human-computer interaction, industrial design and medicine) will: a) present their work, b) discuss and pitch ideas on how to develop a mutual and broader understanding of behavior change models using the BCSSs, and c) set the first stage in defining the pillars for persuasive technology. The results of this workshop are planned to be presented as a vision paper at the Persuasive 2017 conference in Amsterdam, the Netherlands. This edition of the workshop will build upon the insights and research topics of last year’s workshop of which the proceedings have been published online and which has led to a special issue on “Persuasive technology for Behaviour Change” in the International Journal of Medical Informatics.

3 Challenges
The use of technologies as persuaders may shed a new light on the interaction process of persuasion, influencing attitudes and behaviors. Yet although human-computer interactions are social in nature and people often see computers as social actors, it remains unknown how these interactions re-shape attitude, beliefs, and emotions; how they change behavior; and what the drawbacks are for persuasion via technologies. Humans re-shape technology, changing their goals during usage, making persuasion not a static ad-hoc event but an ongoing process.
The capacities of technologies to change behaviors and to continuously monitor the progress and effects of interventions are not yet being used to its full potential. Specific aspects of the intervention contributing to the results and user adherence often remain unknown, known as the ‘black box’ phenomenon [5].

Validated and suitable evaluation methods are needed, as well as mixed-methods approaches to measure engagement, emotions, and social influence of persuasive technologies in smart environments. BCSSs pose a number of specific challenges as well, such as personal goal-setting, personalized feedback, support for computer-mediated communication, 24/7 availability, feasible business models, as well as suitable methods and processes to develop scalable software platforms and architectures for these systems. Where the focus was on small, exact datasets and causal connections in the past (i.e. knowing “why”); we now focus on gathering or linking large amounts of (noisy) data to demonstrate the presence of (unexpected) correlational connections (i.e. knowing “what”) [6]. New technologies allow us to gather larger amounts of data from multiple sources, e.g., multi-sensor data and self-tracking data, that can be used for customization and personalization purposes. Though this opens new exciting frontiers of research, important concerns have been raised as well concerning issues like safety, profiling, purpose limitation, liability, data ownership, and (above all) privacy [6,7,8]. Such issues should be dealt with appropriately, to enhance the public’s trust in technological advancements.

4 References

Personalization in Persuasive Technology

Rita Orji\textsuperscript{1}, Marc Busch\textsuperscript{2}, Arie Dijkstra\textsuperscript{3}, Michaela Reisinger\textsuperscript{2}, Agnis Stibe\textsuperscript{4}, Manfred Tscheligi\textsuperscript{5}

\textsuperscript{1}McGill University, Canada; \textsuperscript{2}Austrian Institute of Technology, Austria; \textsuperscript{3}University of Groningen, Netherlands; \textsuperscript{4}Massachusetts Institute of Technology, USA; \textsuperscript{5}University of Salzburg, Austria.

Abstract. The goal of the Personalization in Persuasive Technology Workshop is to connect diverse groups of persuasive technology and behavior change researchers and practitioners interested in personalization and tailoring of persuasive technology to share their experiences, ideas, discuss key challenges facing the area, and how to move the field forward. The workshop will cover broad areas of personalization and tailoring, including but not limited to personalization models, design and evaluation methods, and personalized persuasive technologies. We welcome submissions and ideas from any domain of persuasive technology and HCI including, but not limited to health, sustainability, games, safety and security, marketing, eCommerce, entertainment and education. Workshop papers and ideas will be archived online to be accessible to the general public.

Keywords: Personalization, tailoring persuasive technology, captology, persuasion

Introduction

Given the evidence that interactive systems can strategically be designed to promote desirable behavior or motivate a change of undesirable behavior, how to design and use technology to motivate desirable behavior change have attracted the attention of researchers and practitioners alike. Over the past two decades, several persuasive technologies and behavior change support systems aimed at promoting change in different domains, including health, safety and security, environmental sustainability, energy conservation, marketing, and education have been developed. These technologies come in various forms, including games, mobile and wearable devices, web and desktop applications, robots, and other dedicated devices.

The major problem is that most existing persuasive technologies adopt the so called one-size-fits-all approach in their design and evaluation, which has been shown to be far less effective at motivating behavior change. For example, Orji et. al. in their study of the persuasiveness of various persuasive strategies show that the persuasiveness of the strategies vary depending on the gamer personality type under consideration [14, 15].
Kaptein et al. [8] in their comparative study of the effect of tailored and contra-tailored strategies, discovered that the contra-tailored strategies (inappropriate strategies) led to strong adverse reactions that tended to increase the adoption of the unhealthy behavior that the intervention had intended to decrease. Similarly, Orji et al. [15] in their investigation of the influence of theoretical determinants on gamer types, discovered that manipulating certain determinants in persuasive technology design can demotivate behaviour in some people depending on their dominant gamer type.

The realization that the one-size-fits-all approach may not be sufficient to motivate behavioral change has led to a growing interest in finding ways of personalizing and tailoring persuasive technology to various user characteristics. In line with this, research has shown that personalizing or tailoring persuasive technologies will increase their effectiveness [8, 10, 11]. So far, few attempts have been made toward personalizing persuasive technologies or developing approaches for personalizing persuasive technology. For example, research has suggested that individual characteristics such as personality type [1, 2, 6], age [13], gender [12, 17], gamer type [3, 14, 15], and culture [10, 16] as well as individual’s susceptibility to persuasive attempts [8, 9] can be useful dimensions for tailoring. Research has also explored how various psychological processes can be used to explain the persuasive effect of tailoring [4, 5, 7]. However, there are still many unexplored issues pertaining to creating, evaluating and implementing personalized persuasion and to the effects and conceptual foundations of personalized persuasion in different areas.

**Goals and Core Questions**

To advance the state of the art in this field, this half-day workshop aims at bringing together the academic and industrial community interested in personalization of persuasive technology to brainstorm and jointly explore these topics and define a roadmap for future research in this area.

In this context, we want to explore the following topics and questions:

- What do we personalize (for example, do we personalize the persuasive strategies, approaches, or end-goals)?
- How do we personalize (e.g., subjective and objective personalization methods)?
- Who do we personalize for (e.g., personality, gender, age, persuadability, player types, emotional states, contextual/situational variables)?
- Where do we personalize? - domain and context dependency of personalization approaches
Why do we personalize (e.g., increase overall effectiveness, attitude vs. behavior change)?

How do we evaluate the effectiveness of personalized persuasive technology over the one-size-fits-all, and what variables constitute contextual effectiveness (e.g., number of encounters and short or long-term effects)?

Challenges and limitations of implementing personalized persuasive technology and possible solutions.

Case studies and examples of personalized persuasive technologies

Success and failure stories with regard to personalized persuasive technology

Benefit and trade-offs of personalizing persuasive technology

Studies on the return of investment and costs benefits analyses of personalized persuasive technology

Effect of personalization on user experience

Explorations of the differences and commonalities between personalization, customization, adaptation and tailoring.

Other areas of personalized persuasive technologies

We invite you to participate in the workshop by submitting position and research papers that cover any of the topics listed above or other relevant topics.

Workshop Outcomes

Through critical reflection, presentations, and brainstorming, the workshop will outline a roadmap for personalization in persuasive technology research with a focus on improving relevance and overall effectiveness of persuasive technology. It will contribute an overview of the state of the art in persuasive technology research addressing the issue of personalization, and outline challenges and opportunities. It is planned to establish a working group that will continue to discuss and collaborate on issues personalization in persuasive technology.

References


Doctoral Consortium

Doctoral Consortium Chairs

Jaap Ham
Eindhoven University of Technology,
The Netherlands

Cees Midden
Eindhoven University of Technology,
The Netherlands

Luciano Gamberini
University of Padua, Italy
Personalized persuasion for sustainable mobility

Evangelia Anagnostopoulou

1 Institute of Communication and Computer Systems, National Technical University of Athens, Athens, Greece
eanagn@mail.ntua.gr

Abstract. The idea of using technology to motivate desirable behaviors has recently become a popular topic. Researchers have previously worked on developing guidelines and models for persuasive technologies. My PhD research focus on the implementation of personalized persuasive services for sustainable mobility.

Contribution statement. My PhD dissertation aims to fill in the research gap between the fields of personalization and persuasive technology.

Keywords: behavior change, personalization, sustainability, transportation.

1 Research questions

My PhD research will address the following questions: What are the theoretical and practical implementations of applying persuasive principles in order to encourage increasingly sustainable travel behavior? Which of the implemented techniques are more successful? How personalized persuasive strategies can motivate for more sustainable mobility solutions?

2 Background

My PhD research examines the application of personalized persuasive strategies in the domain of transportation. The focus is placed on the implementation of personalized persuasive services in order to motivate and create more eco-friendly habits to travelers.

A range of persuasive strategies have been identified. The most common are proposed by Fogg [1], Cialdini [2] and Oinas-Kukkonen [3]. People differ in their susceptibility to different persuasive strategies. This leads to the assumption that personalized persuasive technology is more successful than persuasive technology that is intended to “fit to all”. Many persuasive applications have implemented in the domain of transport which motivate all the users using the same strategy. Persuasive sustainability systems aim to change behavior related to sustainability typically by raising individuals’ awareness of their choices, behavior patterns and the consequences of their activities [4]. Often, these systems measure human activity related to resource usage, and provide information to the user in order to motivate
change. A relevant example is the Peacox application [5], which proposes plan routes considering the environmentally friendliest travel mode and aims to persuade users make more sustainable choices. Personalized persuasive technologies can be used to create effective persuasive applications [6]. However, the use of personalized persuasion should be studied more.

3 Research plan

For the purpose of my PhD, a personalized persuasive system will be implemented. First, a large survey to examine the most appropriate personalized persuasive approach will be conducted. Following that, an application will be developed, based both on results from state-of-the-art analysis as well as survey feedback. Finally, user experience experiments are planned in order to study the degree of persuasion, the usability, and overall reaction of individuals to such a new, personalized service.

4 Advancement state

My PhD research has been running for almost 6 months. A great deal of literature has been examined and a state-of-the-art analysis has been completed. Planning for the system implementation has already started. I will rely on previous study [5] and I will build on it. Feedback and ideas from the Doctoral Consortium in regards personalized persuasive systems would be of extreme value to the development of the study. The research is funded by OPTIMUM project. This project has received funding from the European Union's Horizon 2020 research and innovation program. My advisor is Prof. Gregoris Mentzas from the Electrical and Computer Engineering department of the National Technical University of Athens.

References

Persuasive self-experiences with virtual cognitions:  
Advanced social skills training simulator  

Ding Ding, Willem-Paul Brinkman, and Mark A. Neerincx  
Delft University of Technology, Delft, The Netherlands  
{d.ding-1, w.p.brinkman, m.a.neerincx}@tudelft.nl  

Abstract. Self-efficacy is a key belief people hold about their capability to execute a certain task. It influences whether persons feel comfortable in specific social interactions where it is essential that they take initiative and draw attention to themselves. We intend to develop an advanced virtual reality social skills training system that exposes trainees to virtual cognitions to persuade them of their capability to perform this social behaviour. To study the effectiveness of this idea, a series of empirical experiments are planned to explore how virtual cognitions influence people’s self-efficacy and knowledge of social skills.  

Keywords: Virtual reality · Social skills training · Virtual cognitions · Self-efficacy  

1 Introduction  

A vital part of human life relies on social interactions. Besides the competence needed, Bandura’s work [1] shows that people’s belief about their own capability is a key factor in determining the engagement in social behaviour. Therefore, a key challenge for any social skills training system is to persuade people about their own abilities to perform a certain task, e.g. their self-efficacy. According to Bandura, self-efficacy can be influenced by two kinds of experiences: mastery experience (accomplishing tasks successfully) and vicarious experience (seeing someone else succeeding). Recently the concept of self-efficacy has become a research hotspot in virtual reality. For example, Fox and Bailenson [2] demonstrated that a mixture of these two experiences by exposing people to their virtual-self influenced their decisions and behaviours. Besides exposing people to their own virtual behaviours, a next step would be to expose people to virtual cognitions to alter their beliefs. Like virtual reality aims at replicating an environment by artificially creating sensory experiences, virtual cognitions aim at replicating thoughts by artificially creating cognitive experiences. For example, while experiencing a negotiation scenario in virtual reality, an individual would hear on his/her earphone well-adapted cognitions as a kind of inner voice or voiceover about the nego-
tiation at hand. Besides improving negotiation skills, we intend persuading people of their own negotiating capability, i.e. improve their self-efficacy.

2 Method

In our project we will first develop a virtual reality social skills training system to offer users a passive self-experience in the context of a negotiation scenario. While passively observing from a first person perspective oneself interacting with virtual humans, individuals will simultaneously hear reflecting thoughts about the negotiation. These cognitions both explain underlying negotiation strategies as well as evaluate one’s own negotiation ability to motivate the person. As the social judgment theory [3] postulates, the most optimal persuasive messages are not too extreme that people ignore them or cause a boomerang effect strengthening exciting beliefs. Therefore, reflective cognitions designed to alter people’s self-efficacy beliefs should be personalised to the beliefs a person holds. Consequently, the project will also work on establishing an instrument to measure these beliefs, which allows the virtual cognitions to be personalised. We will design a series of empirical experiments to explore how virtual cognitions influence people’s self-efficacy and establish or alter cognitive schemas about social interaction.

3 Future work

Until now most research into the effect of social interaction in virtual reality only focuses on short-term effect. However, for training to be practically relevant, it also needs to elicit long-term attitude or behaviour change. Establishing empirically grounded understanding of such a training system, that also considers relapse prevention to old habits or attitudes, would therefore be very welcome. In addition, we envision also more work on adaptive control strategies to provide effective virtual cognitions tailored to the individual which optimizes cognitions for personal relevance with the continuous persuasive aim of strengthening people’s beliefs about their social abilities, a prerequisite for people to actually engage effectively into social interactions.

4 References

Using Personalized Persuasive Strategies to Increase Acceptance and Use of HCI Technology

Sofia Fountoukidou, Jaap Ham, Peter Ruijten, and Uwe Matzat
Human-Technology Interaction, Eindhoven University of Technology
{s.fountou,J.R.C.Ham,P.A.M.Ruijten,U.Matzat}@tue.nl
http://www.tue.nl

Abstract

Loss of voluntary muscular control while preserving cognitive functions is a common symptom of neuromuscular disorders. This leads to a variety of functional deficits, including the ability to operate software tools that require the use of conventional interfaces like mouse, key-board or touch-screens. As a result, the affected individuals are marginalized and unable to keep up with the rest of the society in a digitized world [1]. In recent years, new technologies have been developed for this purpose, such as joy-sticks for the hand or the chin, suck-and-puff control and voice control. However, for those seriously affected by neuromuscular conditions, assistive devices are in general very limited and may not work with a sufficient level of performance over an extended period of time [11].

Motivated by this fact, the European project Multimedia Authoring and Management using your Eyes and Mind (MAMEM) set the overarching goal to facilitate the social integration of individuals with muscular disabilities (i.e. Parkinsons disease, neuromuscular diseases and spinal cord injury disease) by stimulating their use of social media. To achieve this, the MAMEM project aims to deliver the technology that will allow them to operate software applications and execute multimedia tasks, using novel and more natural interface channels. These channels will be controlled by eye-movement and brain commands, and thus have the potential to significantly stimulate communication and exchange in both social and workplace contexts.

Within the MAMEM project, it is acknowledged that the adoption of a certain technology is not only an issue of technological excellence. Simply providing the technology is not enough, since people can be reluctant to adhere in practicing a new technology, even though they may be fully aware of its benefits.

Personalized persuasive technology could be a key to successful adoption of the technology used in the MAMEM project. Previous research has identified various persuasive strategies, such as goal setting and encouraging feedback, which can motivate the desired behavior and/or attitude change [4,9,2].

Although persuasion can be effective to change a behavior and/or attitude, there are individual differences in the way that people are motivated. Thus, a strategy that influences the behavior of one type of person may not have
the same effect on another type of person or even to prevent him/her from such an accomplishment. It is only recently that researchers started to examine the moderating role of users characteristics and individual differences in the persuasiveness of the strategies and the essential role of tailoring to reinforce its effectiveness [10].

Kaptein and colleagues [6] examined the effectiveness of personalized short messages in reducing snacking behavior. For this, they developed a questionnaire that predicts individuals susceptibility to different social influence strategies identified by [2], called Susceptibility to Persuasion Scale (STPS), and adapted the messages according to participants scores. The results suggested that tailored-to-the-individual messages result in a stronger decrease of snacking behavior, compared to randomized messages or non-tailored messages. In addition, [5] investigated whether there is an escalation of the effectiveness of a persuasive appeal when the message framing is aligned with the recipients personality profile. Thus, they framed persuasive messages based on a users score on Big Five personality traits. The findings revealed that adjusting the persuasive messages to the peoples personality traits can increase their effectiveness.

Nonetheless, despite their remarkable efforts, it is still unclear which persuasive strategies are most effective for which type of person [10,8,7].

In the current research project, our aim is to adapt persuasive technology interventions to our target group characteristics, in order to increase their effectiveness. Therefore, our first step is to create user profiles of our target population based on relevant characteristics. The user profiles will, then, be used as an input to increase our understanding of which persuasive strategies can influence which type of user.

Next, in order to come to the selection of the most effective persuasive strategies, it is intended that the Intervention Mapping (IM) approach, a theoretical framework for developing and implementing interventions, will be used [3]. Different iterative steps will be taken to select theoretical foundations and persuasive strategies, for the MAMEM target audience.

Driven by this theoretical approach within the MAMEM project, our objective is to investigate individual differences in effective methods to increase compliance to a persuasion request. In the above sentence, one can identify three aspects that could lead to compliance. Firstly, the users relevant characteristics, the relevant persuasive methods and lastly the specific request. Therefore, our research questions, although quite broad at this initial stage of research, are:

– What is the role of user characteristics and individual differences in selecting effective persuasive strategies?
– What is the moderating role of the persuasion request in the effectiveness of persuasive strategies?

This area of research would contribute to the current state of the art of designing persuasive technologies taking into consideration both the user characteristics and the behavior in request. The output of this research project will be relevant for increasing acceptance and usage of assistive technology by the
MAMEM target groups, but also for the scientific insights in personalization of persuasion.

References

Persuasive Technology for Disaster Management

Christoph Kotthaus

University of Siegen, Siegen, Germany

christoph.kotthaus@uni-siegen.de

Abstract. Especially during large-scale disasters like floods, earthquakes or storms, authorities and organizations with security responsibilities are often not able to cover all recovery tasks in a timely manner. This has always led citizens to take voluntary recovery actions on their own, nowadays also conducted and organized via information technology [1]. Due to this fact, authorities aim at warning citizens before and during such emergencies to prevent them from harm and not to endanger themselves through misbehavior. Usually this was done by sirens or loudspeakers announcements, but nowadays digital technologies are available to inform citizens even at an individual level. Hence, these technologies allow authorities to contact citizens throughout all phases of the resilience cycle (mitigation, preparedness, response, recovery) and even to get feedback from them. In contrast to the well-established and organized actions and communication done by authorities, communication and cooperation amongst citizens is poorly structured and usually emerges in social media during disasters. These types of communication, coordination or even collaboration bear potential for engaging with persuasive technology [2].

My research mainly takes place within the project KOKOS (http://kokos_projekt.de/) that started in May 2015 and is funded by the Federal Ministry of Education and Research in Germany. Within this project we try to find out novel IT-based approached for cooperation between officials and volunteers and also how cooperation amongst citizens can be improved. To approach this application area with regard to persuasive technology, I first want to find approaches derived from common biases or discrepancies between behavior and attitude. One typical characteristic of disasters is that decisions have to be made for low-probability, high-consequence events [3]. This causes well-known biases in human decision making like “[…] the tendency to learn by excessively focusing on short-term feedback, […] poor insights into future consequences, […] and poor inter-temporal tradeoffs between short-term costs and long-term benefits”. Disaster warnings, for example, often prove to be false alarms, as impact zones mostly are much smaller than warning zones, reducing beliefs in related warning messages. Misjudgments regarding future consequences, amongst others, are caused by the subjective assessment of the likelihood that i.e. a hazard will occur and the subjective consideration whether taking mitigation actions will probably prevent future losses. Within these considerations, biases like the availability bias (mental availability of i.e. losses due to a flood or fire), representativeness bias (taking recent history as an implication for long-term likelihoods), optimistic bias (belief that dangerous events will more likely happen to other people than oneself) and projection bias (inability to imagine i.e. one’s
home to be destroyed, leading to refuse to evacuate) are well known cognitive dissonances in the application area of emergencies. Further, discrepancies regarding tradeoffs (short-term costs and long-term benefits) underlie biases as well, like the status quo bias (default or no action at all are preferred) or the tendency to procrastinate mitigation investments against low-probability events. Due to these biases citizens are i.e. usually often not familiar with concepts of risk communication or warning.

Based on this first foundation I want to design and evaluate different persuasive technologies for different situations within the application area of (large-scale) emergencies. One demonstrator we are actually working on is a public display to coordinate supply and demand of voluntary help [4]. Other planned activities are mobile apps for head mounted displays to support similar tasks as well as (social) navigation and neighborhood awareness. We tried to engage the application area with regard to persuasive technology by analyzing the two most important mobile warning apps in Germany using the persuasive system design model (PSD model) by Oinas-Kukkonen and Harjumaa [5].

Methodologically projects are conducted as design case studies as proposed by Wulf et al. [6] at the group of Computer Supported Cooperative Work and Social Media at the University of Siegen. My interest is in how to embed design methods like Oinas-Kukkonen’s and Harjumaa’s PSD model [5], Stibe’s framework for socially influencing systems [7] or other approaches within design case studies and how to derive design implications for persuasive technologies based on qualitative methods. Some questions I would like to answer during my research are:

- How could objectives for behavior or attitude change be determined collaboratively by the users (endogenous intent)?
- How could behavior change collaboratively be supported by technology?
- Which routes and persuasive features [5] and combinations of them are particularly suitable for the application field of large-scale disasters?
- Which kinds technologies are suitable as persuasive technologies especially in large-scale emergencies and in different application contexts within?

Immersion states a key factor in this context. Fusing immersive virtual environments with persuasive technology (PT) in a game setting paves the way for creating interactive platforms aiming at user-oriented behavioral change. This work outlines important aspects for designing an immersive VR game platform for persuasion. Our future research aims at investigating how and to which extent recent advances in intelligent user interfaces (IUIs) can benefit immersion and persuasion. In particular, this includes how interactions with a persuasive VR game platform are influenced by contextual or individual conditions and how associated designs can be adapted to target audiences in specific, like medical or educational contexts.

Keywords: Virtual reality; persuasive technology; serious games; intelligent user interfaces.

1 Introduction

Recent advances in head-mounted display technology with integrated eye tracking and mountable vision sensors render virtual and mixed reality promising platforms for creating new interactive environments and visualizations in various fields ranging from pure entertainment over assisting technology in medical environments (Sonntag, 2014) to industrial simulation. While persuasive technology is focused on the design, development and evaluation of interactive computing systems aimed at changing users’ attitudes or behaviors without coercion or deception, leveraging the “addictiveness” of video games for this purpose seems natural: players are encouraged to achieve a certain goal while following a set of rules and receiving system feedback under voluntary participation (McGonigal, 2011). The goal of persuasive games can hence be identified as a behavioral change, which might be hard to achieve but seems eased in a gameful setting where individual abilities, motivation and trigger models are accounted for. When entering the VR realm, immersion, i.e. the feeling of perceiving a physical presence in a non-physical simulated environment, can be identified as

2 http://ovrvision.com/entop/
a critical factor in persuasive systems since it largely determines their credibility. In this respect, graphics, physics, sound, controls and personalized system feedback by means of an artificial intelligence component have to match a user’s expectations. Since persuasive VR games constitute a part of human computer interaction (HCI) and incorporate intelligent automated capabilities for improving performance or usability in critical ways, several scientific challenges arise in the context of intelligent user interface design [2], which are described and contextualized in the following.

2 Position Statement and Research Plans

Immersive VR has been successfully used for persuasion in terms of aversive feedback for simulated risk experiences (Chittaro, 2010). Moreover, design principles for persuasive games have been formulated (Khaled, 2007) and aligned with general PT strategies [1] in the context of a gameful smoke cessation. Based on these results, we aim to address the following UI-related research questions in the context of current projects:

1. How are interactions with a persuasive VR game platform influenced by contextual or individual conditions?
2. How can immersive VR games for persuasion be designed from the perspective of modern UIs incorporating collaborative multimodality [2]?

Aiming at task-related training and assessment games in medical and educational contexts, we opt for VR as technology channel in combination with new multimodal sensory input and output methods. Our technical infrastructure consists of an Oculus Rift DK2 with SMI’s eye tracking HMD upgrade in combination with an attached vision sensory for immersive hand tracking as well as implementations realized in the Unity game engine. In this respect, dedicated plug-ins allow for a seamless integration of multimodal multisensor frameworks to incorporate real-time monitoring and evaluation of user-specific input. This information can then be used to generate personalized system triggers aimed at increasing individual abilities and for providing users with a continuous self-monitoring and customized feedback. Concerning the tracking of gaze data, planned user studies will benefit from a very robust tracking functionality, which even works uncalibrated for a wide range of users whenever an easy and on-the-fly in-game calibration functionality exists.

References


3 http://www.dfki.de/MedicalCPS/?page_id=463
Interactive tools for self-improvement under the lens of User Experience

Jasmin Niess
Ludwig-Maximilians-University, Munich, Germany
jasmin.niess@lmu.de

1 Background

Technologies for self-improvement offer many possibilities to enrich people’s lives. However, the linkage between psychological knowledge and technological expertise in the field of persuasive technology and especially in the product category of self-improvement technologies is still improvable [4], [7]. To exploit the potential of this product category, it is inevitable to explore these products under the lens of user experience (UX). As suggested, there has to be a profound understanding of the product to create enriching experiences for the user [5]. The hedonic-pragmatic model [6], a well-established UX model focuses on the presence of positive emotions and on the absence of negative emotions. However, the process of change seems to be consisted not only of bitter but also of sweet facets [2]. In addition, the way to self-improvement and, therefore, to enhanced well-being seems to be characterized through eudaimonic well-being (i.e. life satisfaction) and not through hedonic well-being (i.e. fleeting moments of happiness) [1]. Thus, it can be concluded that the hedonic-pragmatic model does not represent the right fit to classify self-improvement technologies.

2 Research Questions

In order to gain a better understanding of this challenging thematic, aim is to focus on the following research questions: 1.) Which aspects need to be included in an extended user experience model to be able to classify self-improvement tools. 2.) Does the communication between product and user represent a central factor for the user experience of self-improvement technologies? If so, which are the critical facets that define this communication?

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The results of a first explorative study [3] indicate, that the dialogue between product and user seems to be a relevant psychological factor for a positive UX. Moreover, different communication styles are related to particular emotional consequences, and therefore, can possibly contribute to a successful process of change.

3 Outlook

Main goal of the above and of the following research studies is to gain a better understanding of self-improvement tools, mainly by classifying technologies for self-improvement in an extended UX model. At the moment, a concrete research plan so as to achieve the aim described above is being developed. As the next steps are really critical, concerning my research progress, I strongly believe that I could extremely benefit by participating in the doctoral consortium of the Persuasive 2016.

References


Use of machine-learning techniques and standardized data definition in serious games for health

Konrad Peters

University of Vienna, Entertainment Computing

Abstract. Recognition and definition of physical exercise using low-cost motion capturing systems is one of the most challenging tasks when implementing a serious health game involving skeletal tracking. The use of machine-learning methods to classify data can be used to facilitate this, both during definition of exercises as well when interpreting the results. Health originating from serious games often lacks the use of data standards, not only for the transfer and storage of data, but even for basic definition. The proposed dissertation should on one side clarify whether machine learning methods can be used in serious health game applications, and on the other side investigate the possibilities to use strong, standardized data definition for evaluating results.

1 Introduction

In the recent years, smart devices have boomed, as well as services used through them - including social media as well as entertainment applications and health-related apps. The use of entertainment elements to encourage users to comply with treatment plans, such as in physiotherapy, has shown improved results [4] [1].

The use of machine learning techniques (like ADABOOST) is an obvious approach to tackle the challenge of recognizing and evaluating skeletal movements as physiotherapy exercises. Yet it is crucial to produce data with high semantic value, which complies with existing ehealth data standards such as HL7. Therefore, solutions to classify data produced by health-related apps in entertainment computing should be evaluated. Once produced data has strong semantic context, also clinical evaluation of this data can be facilitated by using machine learning algorithms in form of decision-support systems.

The proposed dissertation should therefore cover the question, whether machine-learning approaches can enhance and facilitate the development of health-related apps using low-cost technologies like a Microsoft Kinect 2. Further, existing nomenclatures and ontologies of physical exercises should be evaluated and eventually be implemented to experiment with exchanging data using state-of-the-art medical data standards.

1.1 Related Work - State of the Art

Serious games with health relation were researched in [3], where various positive aspects like education in health matters, motivation during difficult episodes, enhancing treatment compliance as well as therapy support through physical exercises were covered. In 2014, Zhao et al. were investigating the technical capability of a Microsoft
Kinect Sensor, evaluating 5 different rehabilitation exercises using a rule-based approach [5]. A system for paediatric patients doing physiotherapy exercises with NAO robots¹ was implemented in [2].

2 Research Plan

In Interacct², a platform for fostering communication with young and adolescent cancer patients was implemented. Main components of this platform are a smartphone app for patients, where they can report health data directly to their physician, with the look and feel of a game, and a physician web-frontend to evaluate the reported data. The patient app can be extended by further game projects, serving the purpose of specific issues like promoting fluid intake, motivating the patient to do physical exercise etc.. In another sub-project, physiotherapy exercises are tracked and evaluated using a Microsoft Kinect 2 sensor, recognizing a couple of exercises and reporting them to the platform for evaluation.

Using Interacct as a first base, the issues regarding semantic richness of health data reported through app and sub-projects (such as physiotherapy) should be implemented and tested in a real-life environment. A fitting ontology should be either used, adapted or created, a first analysis should define the requirements for such an ontology. Further, to facilitate the process of clinically interpreting the reported data, a decision support system will be developed by creating a knowledge base for a defined set of clinical topics and using training data collected during evaluation phases of Interacct.

References


² https://www.interacct.at/ (accessed February 10th 2016)
Understanding Effective Coaching on Healthy Lifestyle by Combining Theory- and Data-driven Approaches

Heleen Rutjes
Human-Technology Interaction, Eindhoven University of Technology
h.rutjes@tue.nl

1 Background and Research Questions

Behavior and health are strongly linked as maintaining a healthy lifestyle can prevent many diseases [1]. E-coaching can play a role in supporting people to achieve their health goals and changing or maintaining their healthy behavior.

New wearable technologies such as health watches and smartphones create new opportunities to learn more about a user’s preference, psychological state, personality and environment [2]. Insights about variances on these aspects between and within users are easier to obtain now the trend is to have bigger and richer data.

Our research aim is to uncover principles of effective coaching and to deliver personalized e-coaching applications in the domain of healthy lifestyle. We expect to find synergy in combining the fields of psychological theory and data science, resulting in more and deeper insights in effective coaching.

Many psychological theories are formulated on a high level of abstraction, which makes the transfer to application domains, e.g. behavior change interventions, not trivial. However, these theories do provide plausibility criteria and ‘behavioral templates’ which help to interpret big data sets consisting of large N, multi-sensor and/or longitudinal traces of behavior. Theory can inform the relevant frameworks and constraints needed to formulate working hypotheses that may direct the data mining process and help separate relevant from irrelevant information. Tailoring to users also follows from understanding data, for example by recognizing habits and teachable moments.

This brings us to our research questions: (1) What are the critical parameters for effective (e-)coaching? And (2) what aspects are most important to tailor to, in order to improve the effectiveness of (e-)coaching?

Tailored behavior change interventions are proven to be more effective than standard interventions [3,4]. It should be noted that tailoring can be manifested on many levels [5]. Although tailoring is shown to be effective, the mechanisms underlying this increased effectiveness are still ill-understood, and require further exploration. Several models have indicated determinants of behavior (e.g. awareness, social support, attitude, perceived barriers, self-efficacy) that are recognized as important aspects for tailoring (e.g. [6]). Still, the quantification and validation of these models is limited. Having rich data sets, data science can help to overcome this problem.

The ever growing presence of smartphones allows us to collect ecological valid data, since it brings the lab into our lives, as stated in Millers’ [7] ‘Smartphone Psychology
Manifesto’ and IJsselsteijn’s ‘Psychology 2.0’. Seizing this opportunity is inevitable to bring the psychology of coaching and behavior change to the next level.

To conclude, data can help to fine tune theory, a practical application provides a good test for the value of the theory. But, looking at data only can also burden us with spurious correlations or other flaws. For this, good theory can offer a solution. By combining both theory and data, we aim to understand the critical parameters in coaching, including the important tailoring aspects.

2 Research Plans and Methodology

First, we explore the literature for the current state of the art. We interview health coaches and perform a thematic analysis on this data. To complete, real life coaching data will be used for further inspiration. By those means, hypotheses will be formulated about effective coaching.

After this exploration field trials will be used to test the hypotheses on real data. When using adaptive tools to influence behavior, both data-driven and theory-driven approaches can be combined. Possible future research questions are:

— If certain user characteristics or context aspects happen to be important to tailor the coaching on, how can those be measured? Which sensors are needed? What kind of data processing (e.g. affective computing) is needed?
— What is the optimal balance between asking questions to the user versus making inferences from data? How can the uncertainty of predictions be used explicitly in data science techniques, to prompt questions at the right moment?

3 References

Using Personalised Argumentation to Persuade Healthy Eating Patterns

Rosemary Josekutty Thomas

Department of Computing Sciences
University of Aberdeen, Aberdeen, United Kingdom
r02r15@abdn.ac.uk

Abstract. This research aims to analyse how healthy eating can be encouraged by using persuasion and argumentation in a digital system.

1 Research Questions and State of the Art

Obesity is an growing problem due to poor diets and the increasing availability of high energy density food, and leads to a variety of health problems [2],[4]. In this work, we seek to create a persuasive system to help individuals eat a more balanced diet.

Given its importance, it is no surprise that a large body of work on persuasion with regards to healthy eating exists. Some of this existing work uses argumentation. For example, Grasso et al. [3] had developed 'Daphne' that uses argumentative dialogues to reason and persuade people to incorporate wholesome foods in their meals. 'Portia' was created by Mazzotta et al. [5] that persuades individuals to modify unhealthy eating patterns by adapting both intellectual and psychological arguments.

To use argumentation effectively, user characteristics need to be taken into account. For example, the effectiveness of persuasive messages depends on user involvement. Additionally, when a message is received that is too far away from the individual’s opinion, the message may fall within the latitude of rejection [6], and therefore be ignored. Therefore, when attempting to persuade, arguments must be selected which instead fall within the latitude of acceptance. In addition, there are people apprehensive about the impressions they create on others and are more resistant to behavioural modifications. Fogg’s Behaviour Model illustrates how the different levels, motivation and abilities along with various triggers stimulate alternations in behaviours [1].

Within my PhD, I intend to create a persuasive system for healthy eating by exploiting the state of the art in formal argument theory. This theory investigates what conclusions can be drawn from a set of arguments; how arguments are formed; and how arguments should be introduced into a dialogue in pursuit of some dialogical goal [7].

Using formal argument theory, I will investigate the following research questions, which I will situate in the healthy eating domain.

– How can formal argument and dialogue games drive the persuasion process?
How effective is this approach compared to the state of art?
How can a persuasion algorithm using argumentation be personalised to user characteristics?

2 Research Plans and Methodologies

The research will use the following steps:

1. Identify appropriate argument schemes for the healthy eating domain.
2. Determine how biases, preferences, and personality effect the argument evaluation process in humans.
3. Produce and instantiate algorithm for persuading people to eat more healthily based on the findings.
4. Perform user studies to inform and investigate the effectiveness of the algorithm.

We will use qualitative methods (such as interviews, focus groups, corpus analysis) to find out what argument schemes to use and what user characteristics to take into account. We will use controlled experiments to inspire the algorithms and to investigate the perceived and actual effectiveness of the algorithms.

References

Persuasive Technology in Education: Motivating Individuals to Enter Higher Education

Aamna Toor
Centre for Human Computer Interaction Design, City University London, Northampton Square, EC1V 0HB, London, United Kingdom
Aamna.Toor@city.ac.uk

Abstract. In this research I aim to explore how Persuasive Technology is used within the educational context. The use of technology to aid teaching and encourage skills development and learning has been applied in various educational settings, targeting students who are already in education and learning. The purpose of this research, however, is addressed to individuals who are not involved in any education: Persuasive Technology will be used to motivate these individuals to enter higher education if it is the best career option for them.

Keywords: Persuasive Technology (PT) • Higher Education (HE) • Low Participating Neighbourhood (LPN)

1 Introduction

As persuasive technology (PT) evolved through the years, it has been applied within a number of sectors including the area of education, where PT is designed to aid teaching and learning. Examples of such technologies include a software designed to develop a reading habit in children [1], a mobile persuasive application developed for the HANDS Project [2] aimed to improve social skills development in young people with Autistic Spectrum Disorders, and the EuroPLOT Project [3] which introduced new concepts in teaching such as the use of robotic dolls to help Autism therapy.

These projects are aimed at students who are already in education, motivating and enabling them to learn more effectively. My research involves targeting individuals who are not in education at all, encouraging them to think about higher education as an option for them. Some individuals who fall into this category are those who come from a socially deprived background and/or Low Participating Neighbourhood (LPN, neighborhoods in England where the number of students enrolling for university is low) and have not given much attention and thought to higher education due to their circumstance and lifestyle. This research will develop PT to inspire and encourage individuals to understand that higher education is an option for them to help them grow.
2 Research Plans and Methodology

Two studies have been carried out for this research. The first involved interviewing 10 participants who come from a LPN to find out what barriers/constraints they faced which led them to make the decision to not enter HE. The second study involved interviewing 10 participants who also came from a LPN, but had recently enrolled into university (first year undergraduate students) to find out what motivated them to make the decision to enter HE and what could have restrained them. Participants from both studies came from similar backgrounds and life styles, thus it was easier to make a comparison between the two groups.

3 Results Achieved So Far

The qualitative analyses were done with NVivo Software where the transcribed interviews were coded to look for emerging themes. The most popular reason for not entering HE amongst the first study participants was their claim that a job after completing their degree is not guaranteed. Whereas, for the second study, the most popular theme that emerged from the interviews was ‘help and guidance’. All the participants said that they needed help and advise to make a decision about entering HE and would have been able to apply without help and advise. A pattern evolved when both the studies were compared. Study 2 participants took the initiative to look for guidance if it was not available to them, however, Study 1 participants were not concerned about seeking help and information themselves; they wanted help to come to them. As they were unable to get help, this could have resulted in them leaving the HE pathway.

4 Ideas

Develop a mobile persuasive application that allows individuals to be able to retrieve enough information to make an informed decision about entering HE. This information will be tailored to suit individuals’ needs, just how a careers advisor would guide them with what career options are available to them. PT could be applied to change the attitude of individuals regarding higher education.

References

Improvement of communication and relationships through technology

Stefan Andre Tretter
LMU Munich, Germany

1 Background

Communication in all its verbal and non-verbal facets is the backbone of human development as well as the soundtrack to our everyday lives. Thereby it serves two purposes: a functional purpose of information transmission and a social purpose of interpersonal connection (Light, 1988). The effect of communication is eminently dependent of not only what is communicated, but also who communicates and how. Technology is capable of shaping the way we communicate and provides the chance to strengthen relationships in the long term.

Now imagine lacking some crucial social capabilities, e.g. the ability to express yourself in ordinary communication, a phenomenon often found in autistic people. This is where interactive products come into play (Ganz et al., 2012). To compensate for minor social capabilities, the unique opportunities of technology are exploited and adapted to special needs in form of augmentative and alternative communication-devices which allow, for instance, communication with the help of pictures. Thereby, interactive products serve as a means to enable but also to enrich communication behaviour.

Recurring communication builds up reciprocal relationships that can come along benefits for both parties involved. This benefit is usually more or less balanced out but there is also an idealistic component of trust and loyalty. Corporations try to leverage this by means of a remarkable customer relationship management (CRM). Technologies, that is CRM-systems, help to keep track of relevant information which are subsequently used to show the customer that he or she (allegedly) matters. However, this kind of communication with the customer is often superficial and unidirectional, so that the CRM-system ends up to be a customer organization system, increasing efficiency in communication (quantity) rather than establishing a relationship (quality).

2 Research idea

When we think of technologies in terms of communication, we often think of it as a passive medium to deliver some kind of information across distance. However, there are also instances of augmentative communication where technologies compensate for a lack of expressive capabilities in a supporting way (Light, 1988). Furthermore, CRM usually takes advantage of technology to intentionally strengthen customer loyalty, although, as argued above, its full potential is
not exploited yet. Users can fall back on customer information or, occasionally, automatic processes are initiated, but the system rarely encourages action in terms of persuasive technology.

Persuasive technologies can play an important role in this context since the feasibility of communication is basically given but we often tend to forget or postpone relevant actions. Therefore, I aim to apply paradigms of persuasive technologies to encourage, improve and enrich communication behaviour in different realms with an additional focus on intentional relationship building.

3 Outlook

The research project Kommunikado aims to enhance communication and customer relationships in small to moderate B2B-businesses through an interactive product. Since the projects participating partners have to work in close contact with their customers, communication with their clients is a core aspect of a lasting assignments and the business success in the long run since they have to account for a lack of opportunities in marketing, i.e. the acquisition of new customers. In addition to that, I intend to adopt emerging findings to individual use in private life. Analogously to health apps, persuasive technology could raise awareness to important social interactions that you tend to postpone or forget regularly. Accordingly, I initially explore expectations, possibilities and challenges concerning the enrichment of communication and relationships through interactive products. Subsequently, potential solutions for addressing these issues will be developed and transposed into prototypes. Lastly, an evaluation of the technology will be conducted. The initial requirements analysis for business-applied tools is concluded at this point in time and waits to be implemented in the following prototyping process.

References


Acknowledgments. This work was supported by the BMBF project Kommunikado (Grant: 01IS15040D).
Exploring Technologies that Encourage the Adoption of Biking as a Sustainable Urban Mobility Practice

Matthias Wunsch

AIT Austrian Institute of Technology / Vienna University of Technology, HCI
Giefinggasse 2, 1210 / Argentinierstraße 8, 1040, Vienna, Austria
Matthias.Wunsch.fl@ait.ac.at

Abstract. This PhD research explores how human-centered information technology can encourage citizens to bike within urban areas. By using technology as a channel for feedback and social influence, one set of case studies focuses on changing the daily transportation mode choices of citizens. A second set of case studies reaches to the group of potential bikers. It investigates a behavior change strategy based on using technologies for supporting the development of urban cycling skills.

There is a worldwide trend towards urbanization with cities growing at an unprecedented pace. It is of importance to meet the resulting demand for transportation within these urban areas with a transportation system that fosters the sustainability and livability of a city. The use of bicycles can be a key part of such a system. But while most research on promoting bike use is focused on aspects of the built infrastructure and (information) campaigning, information and communication technologies (ICT) have only sparingly been applied in this field. For that reason, this research designs, evaluates and deploys ICT that helps people to integrate bike-riding in their daily routines and subsequently curbs the use of single passenger motorized vehicles.

Background and related work

Biking is viewed as social practice consisting of meanings, competences and materials. [1] As cities are places that usually offer multiple options for personal transport, a second theoretical perspective on individual transportation mode choices is necessary. Much of the existing literature in this regard is based on the assumption of a rational agent acting based on attitudes or social norms. Technologies include e.g. mobile phone applications that reveal information about transportation behavior and try to engage users in the goal of increasing green transportation choices (e.g. walking, biking, public transport). [2] However, multiple findings from the field of psychology suggest that cognitive processes can be distinguished in fast and intuitive (System 1) and slow and effortful (System 2) processes. [3] Persuasion and persuasive technologies do rely to some extend on the use or exploitation of System 1 processes.

The first set of studies for this PhD work focuses on altering daily transportation mode choices. A prototype of a smartphone app designed around a challenge including triggering messages, social comparison, information provision and competition to facilitate more frequent biking has been developed and evaluated, showing promising
first results. [4] An evaluation study on an Austrian bike promoting initiative has been conducted. [5] There, teams of 2 to 4 are build within companies and they try to bike to work as often as possible during one month. Although tangible incentives could be won, most of the observable behavior changes within this campaign could be attributed to the social dynamics introduced by its design. Building upon that, a comparable campaign was design for this research as a medium sized study with 14 companies and 239 employees participating. Throughout this set of studies evaluation results pointed to an increase in biking due to the introduced (persuasive) technologies. However, these are primarily attractive to existing bikers and tend to increase their level of biking. In order to reach the group of urban dwellers that might consider cycling for utilitarian purposes but lack some of the necessary skills in order to do so another set of studies is part of this PhD research. A conducted study therefore provided participants with a virtual bike tutorial. [4] Based on the coaching of an experiences bike instructor it should provide an interactive training and skill development within an overall safe setting. Similar approaches are planned for future studies, thereby drawing on multiple theoretical backgrounds for learning and skill development [e.g. 6] as a means of behavior change.

Methods and Expected Contributions
The methods used in this thesis will vary depending on the stage, the particular questions and size of the studied interventions. Studies on everyday mobility practices, small-scale design evaluations and user studies will be evaluated based on qualitative methods. Large-scale deployments of bike encouraging technologies will be evaluated in a primarily quantitative way by analyzing trip-data of study participants.

References