Applying persuasive design in a diabetes mellitus application

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ABSTRACT
This paper describes persuasive design methods and compares this to an application currently under development for diabetes mellitus patients. Various elements of persuasion and a categorization of persuasion types are mentioned. Also discussed are principles of how successful persuasion should be designed, as well as the practical applications and ethics of persuasive design. This paper is not striving for completeness of theories on the topic, but uses the theories to compare it to an application intended for diabetes mellitus patients. The results of this comparison can be used for improvements of the application.

Keywords
Persuasive design, captology, diabetes mellitus, Smarcos

1. INTRODUCTION
This paper is a contribution to the Smarcos project described by (op den Akker, Lavrysen, Geleijnse, Schwietert, van der Hout, & Klaassen, 2011). Smarcos is a European project with a dozen research partners focussing on interusability of interconnected embedded systems. Multiple systems should work seamlessly together to get one consistent user experience. The authors of the article are doing research on a personal coaching service, especially devoted to diabetes type II patients.

The intention of coaching is to change behaviour of the user. Especially in the case of diabetes patients, lifestyle changes can be really important for the health of the patient. Convincing users of lifestyle changes can be done using persuasive design, which is discussed extensively in section 2.

The application being developed for diabetes patients is called Smarcos (indeed the same as the project name). Smarcos and a brief introduction to the disease diabetes mellitus are discussed in section 3.

Comparing the persuasive design theories to the functionality of the Smarcos application is done in section 4. Resulting recommendations for future developments are mentioned in section 5. Section 6 closes off with remarks about further research.

2. PERSUASIVE TECHNOLOGY DESIGN
Persuasive technology is something new. Fifteen years ago, software was more focused on increasing productivity and processing data. Nowadays, software encourages us to visit social-media sites, download the newest edition of a magazine or watch the suggested TV-program. (Fogg, 2009a) Of course, persuasion by itself is as old as humanity, but in combination with new technical possibilities, the area of persuasive technology is becoming more and more important.

Another view is that technology is not neutral and is always about persuasion. Design influences how we think and the decisions we take. There is often a proposed standard way of doing things; e.g. when it's raining, people start to use their umbrella. The design of an object can 'invite' the user "to given courses of action just by the way it presents itself to us". But people still have a choice to accept or disregard this behaviour. (Redström, 2006)

A definition of persuasive systems is that they "deliberately attempt to infuse a cognitive and/or an emotional change in the mental state of a user to transform the user's current cognitive state into another planned state. The focus of any persuasive system must be a technology-mediated transformation of either attitudes or behaviors, including a transformation by bolstering or reinforcing existing attitudes or behaviors". (Torning & Oinas-Kukkonen, 2009)

This paper mainly focuses on the area of captology. This is a combination of the field of persuasion (behaviour change, motivation, attitude change) and computers (video games, multimedia, PDA's). The word captology is thought of during the Conference on Human Factors in Computing Systems of 1997 as an acronym for Computers As Persuasive Technologies (CAPT-ology). (Fogg, 1998)

In the next sub-sections multiple models are discussed that are developed for the field of persuasive design or captology. This ranges from models that try to structure different ways of persuasion (2.1) and elements that persuasion consists of (2.2) to principles of how successful persuasion should be designed (2.3, 2.4 & 2.5). The final parts that are discussed are about ethics (2.6) and practical applications (2.7).

2.1 Categorizing persuasive design

A model of Fogg (2009c) describes a way to categorize persuasive design. This behaviour grid – as it's called – can structure the different ways of persuasion. Different types of behaviour change need different persuasion designs. The different types of behaviour change are:

A. Perform new behaviour, that is unfamiliar to the user
B. Perform existing behaviour, that is familiar to the user
C. Increase behaviour in frequency, intensity or duration
D. Decrease behaviour in frequency, intensity or duration
E. Stop behaviour that is on-going

A second important factor in persuasion design is time, i.e. the scheduling of behaviour types. There are seven time categories:

1. One time behaviour
2. One time behaviour that leads to on-going obligations or costs
3. Behaviour for a period of time
4. Behaviour on a predictable (predicted, periodically) schedule
5. Behaviour on cue (irregularly, not fixed schedule)
6. Behaviour is at will (can perform at any moment)
7. Behaviour is always performed

The five behaviour change types can be put in a table as the columns, and the seven time factors as the rows. A graphical presentation of this is showed in table 1. D6 represents in this table the intention to decrease behaviour that is at will (e.g. drink less coffee). The 35 cells in the table can be used to structure research on persuasive design or evaluating / creating a new website or other persuasive platform. (Fogg, 2009c)

Table 1: Behaviour Grid by Fogg (2009c)

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					

2.2 Persuasive Systems Design model

The Persuasive Systems Design model (or in short, the PSD model) is a way to describe elements of persuasion. The PSD model prescribes "persuasive designs and software requirements", but also "supports categorizing and mapping of persuasive elements". (Torning & Oinas-Kukkonen, 2009)

The model consists of seven components, grouped in three categories. The three categories are the intent, the event and the strategy. Figure 1 displays the model with its components graphically. The C in the figure denotes to Context.

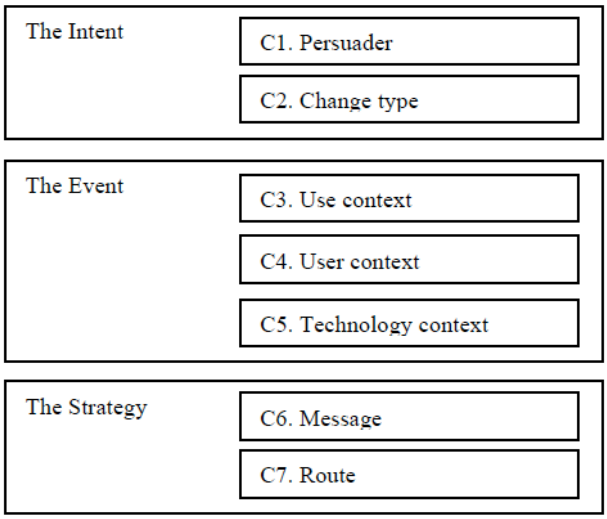

Figure 1: Components of the PSD model by Torning & Oinas-Kukkonen (2009)

The seven contexts are discussed below. (Torning & Oinas-Kukkonen, 2009)

1. Persuader: the system designer that is deliberately trying to change behaviour or attitude.
2. Change type: the target behaviour that the system is trying to achieve in the user.
3. Use context: the problem domain of the persuasion design.
4. User context: the traits of the targeted user, e.g. goals, commitment, lifestyles, and compromises.
5. Technology context: features of the technology platform, e.g. desktop computers or mobile phones.
6. Message: the form and content delivered to the user that has to be persuaded. The form is how the message is presented, e.g. as raw text, in a dialogue, or in a game. The content of the message has to fit the form.
7. Route: persuasion can be direct, indirect or both. Direct would be that the message contains only a few strong arguments, while an indirect route has many more arguments.

2.3 Eight-step design process

Fogg (2009a) describes an eight-step process for creating persuasive technology. Following these steps increases the probability of success. One of the main recommendations is to start small; novice design teams shouldn't start with ambitious plans as to let people stop smoking, but first focusing on achieving small successes and then gradually think more ambitious. The eight-step design process is mostly carried out in sequence, although two steps may be carried out in parallel and the

design team may go steps back. A graphical representation of the eight steps can be found in figure 2.

1. *Choose a simple behaviour to target:* the goal of the project should be simple, small and measurable. Convincing people to do something small often leads to a change of thinking. When the big goal is to let people be more environmental friendly, motivating them to use only one low-energy light bulb will make them start thinking about other eco-friendly choices.
2. *Choose a receptive audience:* a selection of the particular audience has to be made. Not everyone should be targeted, and to increase chances of success for a starting project, a more responsive audience should be selected. When the goal is to increase exercise time, it is better to focus first on people who already exercise once in a while. Because technology is used, it is also better to target people who are familiar with technology or (even better) enjoy using technology and trying out new things (the early adopters).
3. *Find what prevents the target behaviour:* once the appropriate behaviour and intended audience have been selected, the reasons for preventing the targeted behaviour have to be determined. There are three categories of possible answers to this: lack of motivation, lack of ability and/or lack of trigger to perform the behaviour. In the case of replacing light bulbs with low-energy ones, the user should see the advantages of it, have the money for it and be pointed out by someone/something that the user should replace his light bulbs, respectively.
4. *Choose a familiar technology channel:* trying to change the behaviour of senior people through Facebook or texting has a small chance of succeeding, because these people are not using this technology channel. The best way is to select a channel that the targeted group is already using. Selecting a channel can also be done based on the topic preventing the targeted behaviour; when the user doesn't know where to buy a energy-efficient light bulb, a digital map can show where to buy one. Or if people don't know how to replace a light bulb, a video walkthrough can make things clearer.

The order of the first four steps is not really important, as long as all steps are covered. The starting point can also be different; the designer can get the task to do something for a specific audience or use a specific technology channel (e.g. a mobile application). In that case, the remaining three steps are executed based on the preconditions. Whatever the sequence of steps, the first four steps should come before step 5.

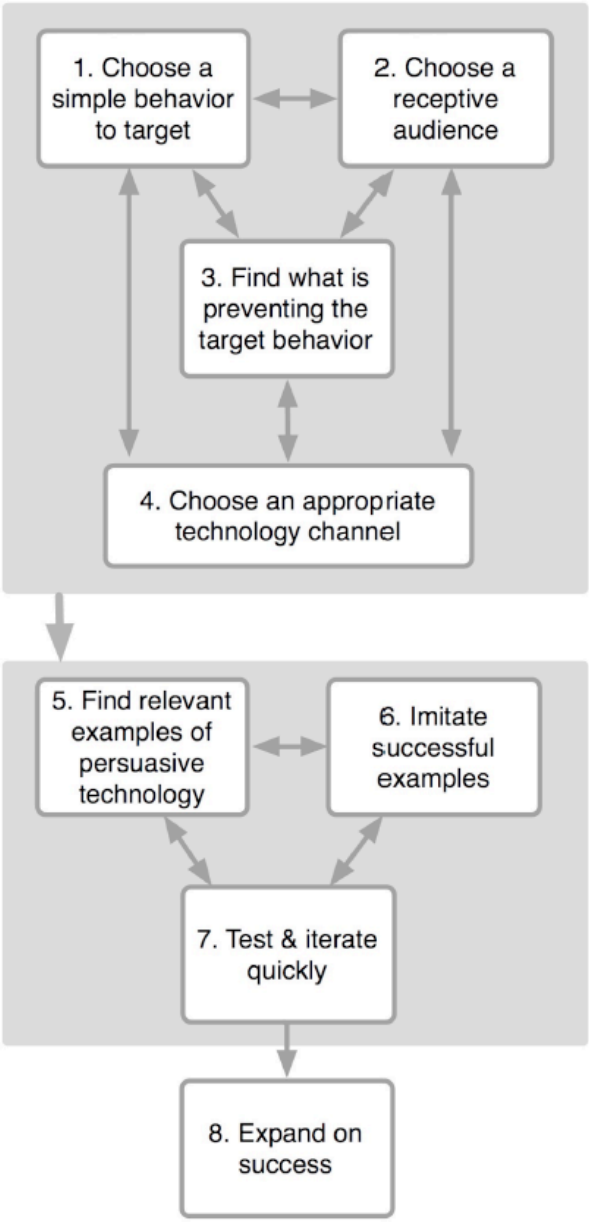

Figure 2: Eight-step design process by Fogg (2009a)

5. *Find relevant examples of persuasive technology:* the design team should study successful persuasive technologies that people are already using. The author recommends that the design team examines at least nine examples: "three that achieve a similar behavior, three that reach a similar audience, and three that use the same technology channel as the design team's."
6. *Imitate successful examples:* there's no need to reinvent the wheel. There are a lot of successful persuasive technologies, and imitating that is the fastest and surest way to create an effective persuasive technology.
7. *Test and iterate quickly:* designing for persuasion is more difficult than usability, and that's why many attempts fails. It is therefore important to test an

option and not spending more than a few hours in it. With each test, the team will get more insight in the success factors. To goal of this step is to find something that is working.

8. *Expand on success:* after reaching success on changing behaviour, the bar has to be set higher. The target behaviour can become more difficult or the target group can be different or expanded. It is important to do this as the last step, because after starting small and having success there, the design team can feel confident that the same can be achieved on a bigger scale.

2.4 Persuasion design principles

When designing a persuasive system, it is important to state the software requirements. Requirements of software can be functional (how the system should behave), non-functional (quality) and constraints on the design and development process. Having requirements is essential to design and evaluate the persuasiveness of software. The features of a persuasive system can be categorized as providing primary task, dialogue, system credibility, or social support. (Oinas-Kukkonen & Harjumaa, 2008)

The first category – primary task support – is about the primary task of the user. There are seven design principles in this category.

- Reduction: trying to reduce certain behaviour of the user.
- Tunnelling: system guides the user through a process and tries to persuade along the way.
- Tailoring: personal information about users (interests, personality, etc.) works better to persuade.
- Personalization: users like it to be able to change layout or (personalized) content.
- Self-monitoring: users must be able to see their performance and goal-achievement changing over time.
- Simulation: predicting future (e.g. before and after pictures of losing weight) increases link between cause and effect.
- Rehearsal: when the system offers possibilities to try out (e.g. flying simulator), people can change their attitudes or behaviour in the real world.

Second category of design principles is dialogue support between the computer and human. The goal is to help the user to keep moving towards their goal or target behaviour. Having these design principles increases the chance that the user changes his/her behaviour or attitude.

- Praise: giving positive feedback to the user when a (sub)goal has been reached.
- Rewards: virtual rewards (e.g. skill-level, music, trophy, unlocking maps) to give credit for reaching a (sub)goal.
- Reminders: reminding users frequently increases chances of achieving goals.
- Suggestion: offering suggestions will have greater persuasive powers.
- Similarity: imitation of users (e.g. slang language for teenagers).
- Liking: system has a nice look and feel (visually attractive) to users.
- Social role: communication between other users and possibly specialists.

Systems credibility is about the system being credible and therefore also more persuasive.

- Trustworthiness: system should provide truthful, fair and unbiased information.
- Expertise: a system that is viewed as knowledgeable, experienced and having competence will persuade people better.
- Surface credibility: competent look and feel of the system (e.g. not a lot of banners).
- Real-world feel: highlighting people or organization behind the content will increase credibility.
- Authority: referring to people or organizations that are credible (e.g. government health office).
- Third-party endorsements: connections with well-known and respected sources (e.g. branch certificates and guarantees) increases system credibility.
- Verifiability: claims made by the website should be verifiable on other external sources.

The last category is social support; these design principles describe how to design the system in order to motivate the user to adopt a target behaviour or attitude by using social influence.

- Social learning: when the user can see the performance of other users, the user will be more motivated.
- Social comparison: besides seeing performance of other users, the system can also offer options to compare the performance to other users.
- Normative influence: peer pressure from friends/family or other groups of people helps because it sets a norm.
- Social facilitation: when seeing other users trying to reach the (sub)goals encourages the user.
- Cooperation: working together with other users to reach a (sub)goal helps motivating.
- Competition: competing with other users is a natural drive of human beings.
- Recognition: public recognition for people who have reached their (sub)goal.

The 28 design principles of Oinas-Kukkonen & Harjumaa (2008) have been applied in a literature review.

It was researched how often the 28 design principles were mentioned or used in the 51 reviewed papers. The top 5 was: tailoring (11), social comparison (11), tunnelling (10), reduction (10) and suggestion (9). (Torning & Oinas-Kukkonen, 2009)

The 28 design principles have also been applied in practice for a mobile Internet device (Räisänen, Lehto, & Oinas-Kukkonen, 2010). Various principles can work together and reinforce each other. After suggesting something (e.g. movies to watch), the persuasive behaviour can be enhanced by a reward principle. Other synergy combinations are: suggestion & personalization, self-monitoring & reminders, similarity & liking, competition & cooperation, and simulation & rehearsal. Some combinations don't work well together, e.g. reduction and tunnelling. The third conclusion drawn is that it is unnecessary to incorporate all persuasion techniques in one case. It would be better to use a coherent set of techniques, especially if there's synergy between the applied techniques.

2.5 Ability, motivation and trigger

Fogg (2009b) describes the three factors to drive human behaviour as ability, motivation and trigger. These three factors control whether behaviour is performed, and is called the Fogg Behavior Model (FBM).

The first factors, motivation and ability can be seen as complementary. With high motivation and high ability, the target behaviour is more likely to happen. But when ability is low (e.g. it is hard to walk a marathon), increasing the motivation (e.g. giving money for reaching the goal) will increase the likelihood for the target behaviour. Also, the other way around, a low motivation (e.g. the user doesn't want to buy a car) can be compensated with a high ability (e.g. the car is very cheap).

According to the model, motivation can be increased by increasing pleasure / decreasing pain, increasing hope / decreasing fear or increasing social acceptance / decreasing rejection. Ability can be increased by simplicity, since people are by nature lazy. Simplicity consists of six elements; all elements have to work properly in order for it to be simple. Decreasing an element increases simplicity and therefore increases ability. The six elements are:

- Time: taking as less time as possible to accomplish the behaviour.
- Money: little costs, high rewards.
- Physical effort: taking car is easier than walking.
- Brain cycles: thinking at least as possible, especially when the user is thinking about something else.
- Social deviance: not going against the norm or breaking rules of society (e.g. going in normal clothing to a gala is easy, but there's a social price).
- Non-routine: routine actions are easy, and people are more likely to stick to that.

Even when both ability and motivation are high, the behaviour is still not going to happen. The missing piece is a trigger. Triggers can be an alarm that sounds, announcement, email, text message, etc. Timing of the trigger is also an important factor. When the user is busy, the behaviour is less likely to occur. Triggers are only effective when the motivation and ability is above a certain level. When the user is below this level, a trigger won't generate the desired effect and can only cause frustration (e.g. unwanted popups on a website, spam email messages).

A distinction is made between three types of triggers:

- Spark: this type of trigger has a motivation element in it. It can for example highlight fear or inspire hope, e.g. an email message that the user is on the right track with his training schedule and should continue in this way to be able to run a marathon.
- Facilitator: triggers like these are for users having high motivation but lack the ability. The trigger tells the user that the target behaviour is easy to do, i.e. that the user already has all the necessary resources. An example facilitator trigger is that the software update can be installed in just one click, or friends can be invited on the social media platform in a few simple steps.
- Signal: this trigger doesn't try to motivate or simplify the task. It only is a simple reminder, e.g. a traffic light turning red.

2.6 Ethics

Persuasion is not something new; leaders, parents, salesmen and teachers are all trying to influence the behaviour of people. Technology by itself is not changing behaviour; when no one is controlling the television, it only shows static. Passive technology media does not alter its "pattern of interaction in response to the characteristics or actions of the persuaded part". People are therefore completely responsible. But with new active persuasive technologies, the system responds to the user dynamically, which makes things a bit more complicated. (Berdichevsky & Neuenschwander, 1999)

The designer of the persuasive system creates a system that tries to persuade people. For deciding whether something is ethical, it is important to look at the intention of the designer and whether the outcome was reasonable predictable. A graph showing the ethical responsibility is displayed in figure 3. (Berdichevsky & Neuenschwander, 1999)

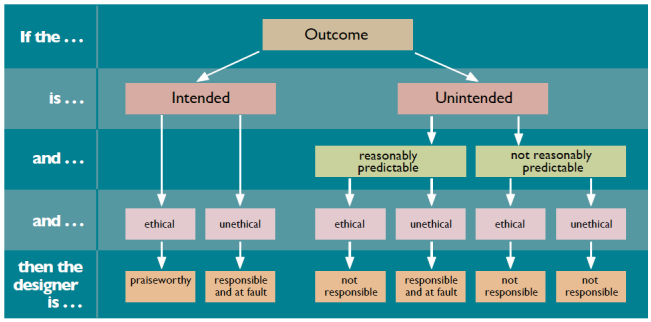

Figure 3: graphical representation of levels of ethical responsibility by Berdichevsky & Neuenschwander (1999)

A list of ethical principles of persuasive technology design has been composed by (Berdichevsky & Neuenschwander, 1999):

1. The intended outcome of any persuasive technology should never be one that would be deemed unethical if the persuasion were undertaken without the technology or if the outcome occurred independently of persuasion.
2. The motivations behind the creation of a persuasive technology should never be such that they would be deemed unethical if they led to more traditional persuasion.
3. The creators of a persuasive technology must consider, contend with, and assume responsibility for all reasonably predictable outcomes of its use.
4. The creators of a persuasive technology must ensure that it regards the privacy of users with at least as much respect as they regard their own privacy.
5. Persuasive technologies relaying personal information about a user to a third party must be closely scrutinized for privacy concerns.
6. The creators of a persuasive technology should disclose their motivations, methods, and intended outcomes, except when such disclosure would significantly undermine an otherwise ethical goal.
7. Persuasive technologies must not misinform in order to achieve their persuasive end.
8. The creators of a persuasive technology should never seek to persuade a person or persons of something they themselves would not consent to be persuaded to do.

In a study ten years later, Davis (2009) describes the use of participatory design in persuasive computing (captology). Participatory design is a combination of theories and models that involve future users during the design process. This can help increase mutual understanding between users and designer, increase user engagement in the design process and give a sense of ownership to the users. Design methods as workshops, story-telling, role-playing and making low-tech models are common in participatory design. Involving users during the design helps to avoid potential ethical issues. Especially potential vulnerable users can be involved to ensure they're not being overlooked in the design process.

Ethical consideration is an undervalued area in persuasive design. In a literature review of this area, only three of the 51 reviewed papers discussed the topic. Of the 51 reviewed papers, 32 were experimental of nature (describing existing persuasive systems), and none of these 32 experimental papers explicitly addressed ethical considerations. (Torning & Oinas-Kukkonen, 2009)

2.7 Practical applications

There are a number of case studies describing the results of bringing persuasive design theories in practice. An example of motivating people to exercise is described by Harjumaa, Segerståhl, & Oinas-Kukkonen (2009). The challenge is also to let people train properly; not too much and preventing the user to train the wrong way. To study the effect of different persuasive designs, a prototype heart rate monitor (the Polar FT60) was used to display persuasive training programs.

Over a period of three months, 12 users used the hearth rate monitor. These 12 users filled in four questionnaires, participated in four semi-structured group-interviews, had an individual interview and kept a diary. It should be noted that all users were already active in sports and only two of the participants were motivated by weight loss. Techniques that were considered useful and users were positive about, were:

- Self-monitoring: track performance during and after exercise.
- Reduction: system gives exact schedules how much user should train.
- Reminders: because feedback was regularly, users begun to get expecting it and get excited about it.
- Trustworthiness: the brand Polar was considered a trustworthy brand.
- Tailoring: because the trainings were tailored to the users, the system was perceived credible.
- Social role: users saw the device as a personal coach, exercise buddy or sparring partner.
- Expertise: although users questioned the advise of the device in the beginning, they accepted it because it is determined by experts.

Interestingly, praises and other verbal feedback of the device were motivating for some of the users, but the effect wore out after time. Also, virtual rewards were not considered very positive, because this was not the main reason for users to sport. Nevertheless, some users pushed themselves to get the virtual trophy. Rewards can also be seen as a way to give feedback to users. (Harjumaa, Segerståhl, & Oinas-Kukkonen, 2009)

Another area to apply persuasive design is decreasing dentist anxiety with children. (Salam, Yahaya, & Ali, 2010) A multimedia learning environment prototype did indeed show successful results in decreasing fear. Six multimedia design principles were used that enhances

and encourages learning for children. It should be remarked that these principles are specifically applied to children, and results for adults are unknown.

- Principle of multimedia design: adding pictures to words (rather than words alone).
- Principle of spatial contiguity: presenting words and pictures near to each other builds a mental connection.
- Principle of temporal: presenting words and corresponding words simultaneously (rather than successively).
- Principle of coherence: irrelevant (for the main message) words, pictures, and sounds are excluded rather than included.
- Principle of modality: children remember spoken text better than printed text.
- Principle of redundancy: avoid redundant text and graphics.

That persuasive design can have drastic effects is demonstrated by de Kort, McCalley, & Midden (2008). Through carefully designing a trash can, the amount of litter on the street could be reduced by up to 50%. Both explicit (direct, verbal statements) and implicit (indirect, trash can design) strategies were almost even successful. Remarkable in the study was that in the implicit situation, where a mirror was assembled to the trash can to appeal to the social norms of the person, less people trashed their given flyer and more people kept the flyer with them. In the explicit situation, where the trash can addressed the people verbally, more people trashed their given flyer and less people kept the flyer with them. But in both situations, the amount of litter was reduced. (de Kort, McCalley, & Midden, 2008)

3. REAL-LIFE DIABETES SYSTEM

The theories of persuasive design discussed in the previous section can be applied to a real-life system. This comparison is done in section 4. The description of the real-life system by itself is topic of this section. Smarcos is a system that is specifically meant for diabetes patients. Section 3.1 will describe the disease diabetes briefly and section 3.2 will discuss the Smarcos system.

3.1 Diabetes mellitus

There are two most common types of diabetes mellitus patients. Type 1 patients can't produce insulin; it's a disease that expresses itself at a random moment in life for unknown reasons (a combination of genetic and environment factors is believed to be the trigger) and take up about 10% of the diabetes patients. Type 2 patients take up about 90% of the diabetes patients and they have a problem producing the insulin or absorbing the insulin from the blood. In the latter case, the receptor cells have reduced sensitivity to insulin. Insulin is a hormone produced by the pancreas that stimulates the body to take up glucose from the blood and transforming the glucose to glycogen. (Wikipedia , 2012)

The Dutch General Practitioner Society mentions a number of factors that increase the chance to get diabetes mellitus type 2. Age (older than 45 years), overweight, too little exercise and heredity play a role in getting a too high glucose level. A too high glucose level by itself doesn't need to give any complications, but after years the eyes, kidneys, nervous system and blood vessels can sustain damage. Is also increases the chance on cardiovascular diseases. The advice is to exercise more and eat healthier. The exercise doesn't need to be really intense, but can be small things as taking the stairs (instead of elevator), biking and walking, for in total 30 minutes a day (not necessarily at once). Other advises to decrease the blood pressure, pay attention to the cholesterol level and stop smoking don't decrease the chance of diabetes directly, but help to prevent cardiovascular diseases. (NHG, 2006)

Besides reducing weight, taking the right nutrition is also important to prevent diabetes and (for patients already diagnosed with diabetes) to control the disease. Food advises given by (NHG, 2011) are:

- One glass of alcohol can't do much harm, but more or drinking every day can disrupt the glucose level.
- Do not use too much salt or sugar. A bit is allowed, and using completely sugar-free product isn't necessary, but using it moderately is advised.
- Eating frequently is important. Three main dishes and some snacks in between help to maintain a constant glucose level instead of unwanted spikes.
- Take skimmed products and prefer unsaturated fats instead of saturated.
- Snacks as fruit, rice waffles, toast, cherry tomato's, carrots and nuts are a lot better than pie or cookies.

3.2 Smarcos system

In the Smarcos project, a personal digital health coach was developed. This is done by "giving timely, context-aware feedback about daily activities through a range of interconnected devices". Diabetes type 2 patients are the target user group, as well as normal office workers. The difference between the user groups is that with office workers feedback is given on activity level and food intake, while for diabetics also glucoses level are taken into account. (Lavrysen, van der Hout, Klaassen, & op den Akker, 2012)

A difference with other existing digital coaching systems is that the Smarcos system uses multiple feedback devices. This makes it possible to give feedback to the user on the right time and take the context of the user into account. The different contexts being used are: at home, at work, outside and on the go. Feedback devices are a smartphone (Android or iOS), desktop or laptop and a television. Input devices for measurements are a pill dispenser, an activity monitor and GPS (from the phone). Changes in the input device causes the coaching rules being checked; if one of the rules returns true, a suitable message will be send.

A participatory design method (as discussed in section 2.6) was used; users and stakeholders were actively involved during the design process. Over a period of 3 to 5 days, users had to keep a diary to describe their daily activities (e.g. lunch and physical activities).

In a questionnaire send out to 15 diabetes patients and 49 office workers, they were given five scenarios what the system could do for them. The respondents indicated that their smartphone was the most preferred device for giving feedback, and when they were at home the computer/laptop or television would be. Other devices as a digital photo frame, on-board car system, or colour-changing lamp were not desirable. (Lavrysen, van der Hout, Klaassen, & op den Akker, 2012)

The Smarcos system is currently under development and a prototype version is expected to be finished several weeks after writing this paper. A number of graphical designs of the system are therefore used to assess the functionality of the system.

4. COMPARISON OF PERSASION THEORIES TO SMARCOS SYSTEM

Section 2 mentioned several persuasion theories that can be applied to the Smarcos system introduced in section 3.2. The order of persuasion theories discussed in section 2 is maintained for the comparison to the Smarcos system. Recommendations for improvements of the system can be found in section 5.

4.1 Categorizing persuasive design

The behaviour grid of (Fogg, 2009c) is a useful way of categorizing persuasive design. Unfortunately in the Smarcos system, there are too many distinctive persuasion goals. The goal of having a balanced glucose level is completely different than eating healthy and moving enough. Overall, the time factor that is reached with the Smarcos system is of the highest category, behaviour that is always performed. To do this, the user should first carry out behaviour for a period of time, and step-by-step go to behaviour that is always performed.

The different types of behaviour change that are mentioned by (Fogg, 2009c) cannot be strictly applied to the Smarcos system. It depends on the user whether the intended behaviour is familiar or unfamiliar. A clear-cut answer which persuasion methods are used in the Smarcos system and putting them in a Behaviour Grid is impossible. This is because the behaviour types and time factors are too diverse.

4.2 Persuasive Systems Design Model

Seven components are important in this model:

1. Persuader: the Smarcos system that is being developed.
2. Change type: using a virtual coach, the system is trying to improve "physical activity and medicine compliance" (op den Akker, Lavrysen, Geleijnse, Schwietert, van der Hout, & Klaassen, 2011).
3. Use context: diabetes patients and also office workers (although to a lesser extent).
4. User context: lifestyle changes in activity and medicine intake.
5. Technology context: a system is developed for Android, iPhone, desktop and television.
6. Message: are delivered through the phone standard notification centre or with a popup in the computer's operating system.
7. Route: the exact content of the persuasion message has not been decided upon.

4.3 Eight-step design process

There are two phases in this design process. The first four steps have to be completed before the fifth step can start.

1. Simple behaviour to target: the goal should be simple, small and measurable. The Smarcos system stimulates balancing glucose levels, regular medicine intake, eating healthy by providing recipes and regular exercising.
2. Receptive audience: diabetes mellitus type 2 patients and office workers (although to a lesser extent) are targeted.
3. Investigating preventing behaviour: it is unclear whether research has been done on this. Three causes are mentioned by the theory: lack of motivation, ability or trigger. Ability is not really a factor here, and the system tries to increase motivation by providing a reminder (trigger). But motivation alone is also increased by giving insight into the glucose levels or an activity overview of last week.
4. Familiar channel: in a questionnaire with potential users, it turned out that a digital photo frame, on-board car system, or colour-changing lamp were not desirable. These systems are also less common, and therefore (according to the theory) a less successful way of changing behaviour.
5. Finding relevant examples: no (found) efforts have been made in this area.
6. Imitate successful examples: not carried out.
7. Test and iterate quickly: not yet in this stadium. The first prototype is not yet completed.
8. Expand on success: for the future.

It is clear that the process is half-way. It remains to be seen whether the foundation set in the first four steps are stable enough for iterative improvements in the last four steps.

4.4 Persuasion design principles

There are 28 design principles described by Oinas-Kukkonen & Harjumaa (2008). Principles that are found in the Smarcos system are mentioned below:

- Reduction: not really a reduction, but more an increase of activity is one of the goals of the system.
- Tailoring: there is a configuration screen to set up notifications, privacy settings and devices that are used.

- Personalization: there is a screen where personal information (name and address) can be entered. This name is sometimes used in reminder messages.
- Self-monitoring: glucose level, medication intake and activity level can be seen in a generated diagram and goals can be set.
- Praise: when a goal is reached, a message will be displayed.
- Reminders: for e.g. pill intake or entering a glucose measurement, a reminder message can be displayed.
- Suggestion: there are recipes available that can help improve the diet of the diabetes patient.
- Social role: friends can be invited/accepted and can comment on messages or reached targets.
- Social learning: the screenshots only discloses that users can see that friends have achieved their target. What this target exactly was, is not displayed.
- Recognition: users can comment on achieved goals of other users.

4.5 Ability, motivation and trigger

Ability, motivation and a trigger are the main components to persuasion, according to (Fogg, 2009b). Ability is not really the core problem of the Smarcos system; all users can live without the system and take their medication or eat healthy. But the Smarcos system can improve this. The behaviour change ability can be improved by making one of the six elements (time, money, physical effort, brain cycles, social deviance and non-routine) simpler. The system does this for example by making it easy to find good recipes for cooking.

Motivation is increased by the system trough increasing pleasure (e.g. seeing the glucose level decreasing) and increasing social acceptance (e.g. the friends updates). The triggers found in the designs of the Smarcos system are mainly signal triggers. The notifications ask the user to e.g. enter a glucose value or whether the user has taken his/her pill. This is by itself not really motivation (a spark trigger) or increasing ability (a facilitator trigger).

4.6 Ethics

Checking for ethical omissions can be an important consideration when dealing with persuasive design. When looking at the list of eight ethical attention points from (Berdichevsky & Neuenschwander, 1999) the Smarcos project comes out pretty good. At least, as far as the designs are concerned; during the implementation later on ethical issues can arise. Trying the same as the Smarcos project without using technology would not be a problem, there is no intention of misinforming users and there would be no reason not to use the system due to ethical concerns.

Another aspect is that users were involved during the development of the Smarcos system. This participatory design is advised by (Davis, 2009) to help avoiding potential ethical issues. Therefore the chances that ethical problems arise in later phases of the system development are slim.

5. RECOMMENDATIONS FOR THE SMARCOS SYSTEM

Possible future improvements of the Smarcos system are discussed here. It should be noted that Smarcos system is currently in the prototype phase, and therefore it is logical that a lot of functionality is not yet implemented. Also, there can be reasons not to implement improvements mentioned here. This paper only looked to persuasion theories, but e.g. usability or privacy issues can be of higher importance for which persuasion has to give in.

The goal of the system is not completely clear. Improving physical activity and medicine compliance is not explicit enough. Also, it is advised that the goal should be simple, small and measurable (Fogg, 2009a). The Smarcos system has a broad range of functionality (glucose levels, medicine intake, eating healthy and exercising). Although most is measurable, having such diverse target behaviour reduces the chances of success.

The target group of the application is not clearly defined. In a first article, diabetes type 2 patients were mentioned as the target group (op den Akker, Lavrysen, Geleijnse, Schwietert, van der Hout, & Klaassen, 2011). In another article, office workers were added as target group (Lavrysen, van der Hout, Klaassen, & op den Akker, 2012). Besides defining the target group better, selecting a receptive group is also advisable. The chances of success increase when the users are familiar with the devices (smartphone, desktop and TV) and like using it. An option would be to start focussing on diabetes patients that like using new technology and social media as a target audience first. When the users are becoming receptive to the persuasion, the project can be expanded to other diabetes patients and/or office workers.

From the available documentation of the Smarcos system it was unclear whether efforts were made to look for comparative systems and borrow some successful elements out of it. Imitation can help decreasing the development time. After the first successful persuasion techniques are implemented, more innovative and perhaps effective methods can be introduced. An example of this is the friends activity design, which offer similar (but less) functionality than e.g. Facebook. Using a Facebook plugin instead of developing something in-house, saves development time and probably works better.

When the first prototype is ready, it should (according to the theory of Fogg, 2009a) be improved iteratively in a short time span. The goal is to find something that is working to change behaviour. This should be done by implementing a function and testing it, not spending more than a few hours per option. Instead of creating a fully working application at once, it would probably be better to spend most of the time to the core components and gradually expend the application with other functionality.

When looking at the 28 design principles of Oinas-Kukkonen & Harjumaa (2008), some of them are used by the system. Because the system is in a starting stadium, not too much functionality should be implemented now, but for later stages, some suggestions can be:

- Simulation: the user could for example ask the system what would happen if he/she would sport once a week extra, how that would affect the glucose level or weight. This would help to give the user a sense of cause and effect between activity and health issues.
- The trustworthiness of the system can be improved. This can be done by e.g. giving the source of recipes, referring to credible organizations (e.g. governmental nutrition centres) and make verifiable claims by referring to health organizations.
- Social possibilities are there, but can be extended. Seeing performance of friends, comparing with them and setting goals together can help. Teaming up or create a small competition can also increase motivation and/or results.

When looking at ethical issues, especially privacy must be safeguarded during further development. For instance, other people using the same TV or computer must not be able to see personal messages. The involvement of users during the first phases of the Smarcos project will probably help avoiding ethical issues in the future.

6. FURTHER RESEARCH

Almost no research has been found on long-term effects of persuasive design. In the practical research of a sports training program, praises and other verbal feedback wore out over time. (Harjumaa, Segerståhl, & Oinas-Kukkonen, 2009) It is unclear which persuasion design principles work better in the long run, and which better as short-term incentive.

This leads to the second unfamiliar field, which is measuring behaviour change. No mention of a standardized way of this has been found in the studied literature. Especially on long-term research of behaviour change, external factors can have influence on the persuasion goal. For example, positive or negative responses from friends/family can have a great impact on behaviour, while it is outside the persuasion application. External factors should therefore be ruled out as much as possible and a standardized way of measuring behaviour change is necessary for a comparison of persuasive design principles.

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