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Digital lifestyle coaches on the move[1]

1 Introduction

To introduce the topic of this paper -persuasive technologies for digital lifestyle coaching- let us present the story of Jane.

> A few months ago Jane's doctor diagnosed her with diabetes. Since one year Jane feels constantly tired. Her doctor told her that this is due to her diabetes. The doctor prescribed a medicine and advised Jane to visit a diabetes nurse. The nurse explains Jane that being active, watching her food intake, and taking her medication on time, she could control her diabetes. Jane's condition is not improving and she admits she has problems to adjust her new lifestyle. The nurse introduces a digital coaching system, which is able to coach Jane by monitoring her activity, her medication intake, and glucose levels.
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> The system gives Jane the right feedback on the right time. The system includes an activity monitor, a digital pillbox and applications on different devices. Jane is enthusiastic about the system and she would like to try it. At home she installs the different applications and enters her daily medication intake moments and moments when she measures her glucose level.
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> The next day when Jane wakes up she measures her glucose level and enters the result into the system through her smartphone and compares the current level with the values of the last five days. Because Jane is in a hurry this morning she forgot to take her medication. When Jane arrives at the office she got a medication reminder on her laptop and she takes her medication. This morning she had a meeting with her colleagues. During this meeting she receives a reminder on her mobile phone to upload her activity data. Back at the office she connects her activity monitor to her laptop to upload her activity data. In the meantime she goes for a coffee, and when she walks to the coffee machine she receive a message of her coach that tells her that her activity level is too low and that she should consider doing something physically active in the following hours. During lunch time Jane goes or a walk.
>
> After her lunch she measures her glucose level again and enters the value in the system on her laptop. After work she goes home to prepare dinner. She uses the system to find a nice and healthy dish. After her meal, Jane watches the news on television. Before turning on the TV, she connects her activity monitor to her laptop to upload her activity level. On her TV she receives a congratulatory message as she has achieved her activity goal for today. Before she goes to sleep she takes her medication from her digital pillbox. Three months later Jane visits her nurse again. After some test it becomes clear that Jane has her diabetes much better under control and the nurse advise her to take less medication.

Jane is not alone. Many people suffer from a chronic disease and better live a healthier life. One billion adults worldwide are overweight, and 300 million of these are clinically obese. Since the 1980s, obesity has spread at an alarming rate. Across OECD countries, one in 2 adults is currently overweight and 1 in 6 is obese. The rate of overweight people is projected to increase by a further 1% per year for the next 10 years in some countries.[2] These numbers demonstrate a global epidemic one whose victims suffer from heart disease, stroke, hypertension and diabetes. Many of these diseases are provoked or aggravated by lifestyle choices related to diet and physical exercise.

Many people like Jane need help from a medical coach to support them in coping with the new situation they find themselves in when they hear that they suffer from diabetes. It has been argued that technology has played a role in allowing many adults to maintain a sedentary lifestyle. Technologies can also help encourage people to live a healthier lifestyle. Persuasive technology refers to technologies that are used to persuade people of a certain opinion or to change their behavior or life style. There is a difference between the technology of persuasion and persuasive technology. The science and technology of persuasion are part of rhetoric, the classic art of persuasion and argumentation. Persuasive technology builds on social psychology in particular theories about behavior change and theories about persuasive communication.

Fogg describes seven types of persuasive technology tools, each of which employs a different strategy (or principle) to change attitudes or behaviors: reduction, tunneling, tailoring, suggestion, self-monitoring, surveillance, and conditioning [1]. He discusses their underlying principles and provides examples of each. Andrew et al. [2] explores what in this framework is referred to as a suggestion technology tools that employ the suggestion strategy. Fogg mentions that a persuasive technology product usually incorporates multiple tools, each informed by a different strategy. Andrew et al. believe that many of these strategies overlap, and they discuss how other strategies are closely related to suggestion strategies.

[1] Keynote speech in this 13th International Symposium on Social Communication.
[2] http://www.hivehealthmedia.com/world-obesity-stats-2010/

A popular model is the Transtheoretical Model of Behavior Change that assesses an individual's readiness to act on a new healthier behavior, and provides strategies, or processes of change to guide the individual through the stages of change to Action and Maintenance [3]. The Transtheoretical Model is also known by the term “stages of change”, since one of the most prominent parts of the theory holds that the process of behavior change goes through a number of stages.[3] It is “arguably the dominant model of health behaviour changes, having received unprecedented research attention, yet it has simultaneously attracted criticism.” [4]. If you want to persuade someone to stop smoking, the way you achieve this depends on the stage the other is in. Is he motivated to stop? Does he know about the implications of smoking? Does he recognize the signs of deprivation and does he know how to handle this? How effective attempts are to change someone's life style also depends on his personality. In particular on the self-efficacy a personality dimension that refers to the measure of one's own competence to complete tasks and reach goals. [5].

Oinas Kukkonen [6] introduces the concept of a behavior change support system and suggests it as a key construct for research on persuasive systems design, technologies, and applications. The article suggests that a change in complying, a behavior change, and an attitude change (C-, B- or A-Change) constitute the archetypes of a behavioral change. Change in itself is either of a forming, altering or reinforcing outcome (F-, A- or R-Outcome). His research model helps in researching and designing persuasive technology.

In this paper we discuss digital coaching systems with a special focus on the way the coach presents itself to the user. According to Nass et al. [7] computers are often seen as social actors and it seems like an obvious thing to present the digital coach by means of a graphical presentation format as a talking head, a virtual human or embodied conversational agent (ECA)[8], or by some physical form, a robot (I-Cat, Nabaztaq) [9]. Research is performed to see how people assess this presentation format and how it affects the effectiveness of persuasive technology [10],[11].

Bickmore et al. [12] have researched the role of emotional and relational skills in a tool to support a health behavior change intervention for physical activity adoption. Their tool incorporated anthropomorphic avatars, which enabled them to explore the use of both verbal and nonverbal behaviors in the interface. The experiment was a 30-day trial consisting of three groups of subjects, in relational, non-relational, and control groups. They found that there wasn't a significant difference between the amounts of physical activity performed by subjects in the relational versus non-relational groups; however, the subjects interacting with the relational agent reported a significantly greater desire to continue working with the relational agent [2].

Shearer et al. [13] present synthetic embodied conversational agents, and how they can be used to explore the persuasive potential of real embodied conversational agents. Utilizing a novel Wizard-of-Oz style approach and a direct measure of behavior change they explore whether ideal embodied conversational agents have a similar persuasive impact as real people, and demonstrate the importance of visual perception for embodied conversational agents to be persuasive. According to Shearer et al.:

“A synthetic ECA appears to be a real (computer generated) ECA, but in fact it is simply a video and audio transmission of a real human transformed into the appearance of an ECA. The behavior is that of the real human, resolving the behavioral limitations of present-day ECAs.”

This paper is structured as follows: in section 2 we present requirements for digital coaches. Consolvo et al. [14] presents design requirements for digital coaches that stimulate users to be more physical active. In section 3 we present the design and architecture of a digital coaching service system. The systems is developed in an EU Artemis project Smarcos[4]. The digital coach addresses two target groups: diabetes patients and the large group of people that need to be more physical active like office workers that have a sedentary life style.

We have built "real" synthetic embodied conversational agents and we use them in experiments to see if they contribute to the acceptance of the digital coach and to see if they have a positive impact on therapy adherence. We will discuss experimental research and present some preliminary results in section 4. In section 5 we come to conclusions.

2 Requirements for Persuasive Life Style Coaching

In this section we look at the requirements that a persuasive technology should meet.

Consolvo et al. [14] proposed eight design strategies for lifestyle behavior change technologies. First of all, the data presented by the system should be abstract & reflective. The system should make use of data abstraction, rather than raw or explicit data collected from the user and sensors. The system should be unobtrusive. Feedback and data should be available when and where the user it needs. Data should be presented and collected such that the user is comfortable in the event that others may intentionally or otherwise become aware of it. The physical and virtual aspects of the technology must be comfortable and attractive to support the users personal style. The system use positive reinforcement to encourage change. Reward the user for performing the desired behavior and attaining her goal. When the desired behavior is not performed, the user should not receive a reward or a punishment. The user should be in control of her own data and should be able to access historical data to see changes in lifestyle goals over time.

According to Noar [15] interventions of behavior change support systems with several contact points are expected to be more effective in stimulating change in health behaviour than those that use a single contact points.

[3] http://www.prochange.com/transtheoretical-model-of-behavior-change
[4] 3www.smarcos-project.eu

Feedback by the coach must be targeted, personalised, timely, context-aware, and well-informed. The type of feedback and the information presented to the user should fit the stage [3] the client is in.

The unique capabilities of mobile, context-aware, networked devices make them an interesting platform for applying suggestion in persuasive technologies. Because these devices are nearly always with their owners, can sense relevant information about the context of their use, and nearly always have Internet access, they are able to provide relevant information at the right time and place, and may help encourage opportunistic activities [1].

Relatively little work has examined providing opportunistic, right-time, right-place suggestions or notifications that encourage people to change their behavior. Andrew et al. [2] discusses some of the challenges facing designers incorporating suggestions into their persuasive technologies. They review a set of relevant persuasive technologies, focusing primarily on technologies in the health domain. They identify a design space that represents tactics for building persuasive technologies, particularly suggestion technologies. They explore how this design space of suggestion tactics can be used to evaluate, compare, and inform the design of new persuasive technologies [2].

3 A Digital Coach for Diabetes Patients

Diabetes is a metabolic disease characterized by higher than normal blood sugar levels. Two main types of diabetes can be distinguished: Type I and Type II. In type I diabetes, the body fails to produce sufficient levels of insulin. In type II diabetes, the body shows an insulin resistance, which means the cells fail to respond properly to insulin, sometimes with reduced levels of insulin production. Type II diabetes is far more common than Type I diabetes, affecting 90 to 95% of the diabetes population in the Netherlands.

The development of type II diabetes is related to lifestyle, in particular physical activity, diet, smoking, and alcohol consumption. Obesity is widely believed to be an important contributor to the development of type II diabetes. Specifically, increasing levels of physical activity and decreasing the intake of saturated fats and transfatty acids and replacing these with unsaturated fats reduces the risk of diabetes type II and can be effective for lowering body weight and improving insulin sensitivity in diabetes type II patients. Several interventions that have been developed to promote a healthy diet and an increase in physical activity have shown promising results. Nevertheless, many intervention studies show that the achievement of long-lasting behavior change remains a challenge [16] [17].

This section will discuss the digital coaching system that was described in the introduction scenario. The coaching system should be able to support Jane during a normal day and in different situations. Subsection 3.1 will introduce the two different target groups of our coaching system followed by Section 3.2 that will discuss the different devices that will be used in the coaching system. The feedback that will be presented to the user of the system will be presented in subsection 3.3. This part will present more details about the content of the feedback messages, the timing of the messages and the modality in which the feedback is presented to the user.

3.1 Target Groups

The goal of the system is to motivate and support diabetes type II patients to live a healthier lifestyle to get better control over their diabetes. The system will focus on behaviors that are known to affect blood glucose levels and are therefore important for managing diabetes type II. These behaviours include physical activity, food intake and medication intake.

3.2 Input and Output Devices of the Coaching System

The digital coaching system uses different input and output devices in order to support their users in living a healthy life style. People will be in different situations during a day, they will be at work, on-the-go, and at home. In all these situations and contexts the system should be able to monitor the user and finally provide the right feedback at the right moment to the user. Users will have access to different devices in these different situations. When the user is at home the system can interact with the user via the desktop computer, television or mobile phone. When the user is on-the-go they will only have access to their mobile phone to interact with the coaching system. Mobile phones have full Internet access, are able to receive the GPS signals and capture the context of the user by using an accelerometer, compass, and gyroscope.

In order to provide useful feedback the system should measure the amount of physical activity, the medication intake of the user and the system should know were the user is. To measure the amount of physical activity the system makes use of an activity monitor. To keep track of medication intake the system uses a digital pillbox.

Activity monitor: An activity monitor, see Figure 1, measures the amount of physical activity all day long. The activity monitor uses an accelerometer that measures acceleration on three directions. These results can be transformed into calories. The user has to dock the activity monitor to his computer to upload the activity data to the coaching system.

Figure 1: An example of an activity monitor that provides the system with activity data of the user.

Digital pillbox: A digital pillbox is a pillbox where users can store their medication. The pillbox is connected to the coaching system via the GSM network. Every time the user opens the pill dispenser it sends a message to the server and the coaching system know that a user has taken their medication. An example of a digital pillbox is given in Figure 2.

Figure 2: An example of an activity monitor that provides the system with activity data of the user.

Based on the information provided by the input devices the coaching system should present feedback to the users of the system. The system can provide feedback via the mobile phone of the user, his desktop and laptop computer or his television.

All the input and output devices are connected to the coaching system by using the internet. One central server keeps track of all the users, their devices and the data that is provided by the input devices. Figure 3 provides an overview of the complete digital coaching system. Based on the data on the central server system is able to support their users. The coaching program will be discussed in the next section.

3.3 Coaching Program

The input devices provide the system with information about medication use, physical activity and location. Users provide the coaching system with information about their medication moments, the number of pills and the time when they should take the pills, and their personal and daily activity goal. Based on the available information the coaching system will present feedback to the user.

Content of feedback messages: The content of the feedback can differ based on the context information of the user. Feedback messages can be a regular (daily or weekly) report about physical activity, calories, or medication intake. Or it can be a reminder, warning, an advice, an assessment, or maybe a message that asks for specific information from the user. It is also important not to send too many messages to the user. It can be possible that the same feedback should be presented to the user several times a day; in this case the system should send only a maximum number of messages.

Timing of the feedback messages: When the system decides that it is time to send a feedback message to the user, it should decide when to send the message. The timing of the message is dependent on the context of the user and the content of the message. Warnings about medication intake should be send as quick as possible, but a presentation of the weekly report of physical activity can wait until the user is at home (and the television is on, so the system can present the overview on a large screen).

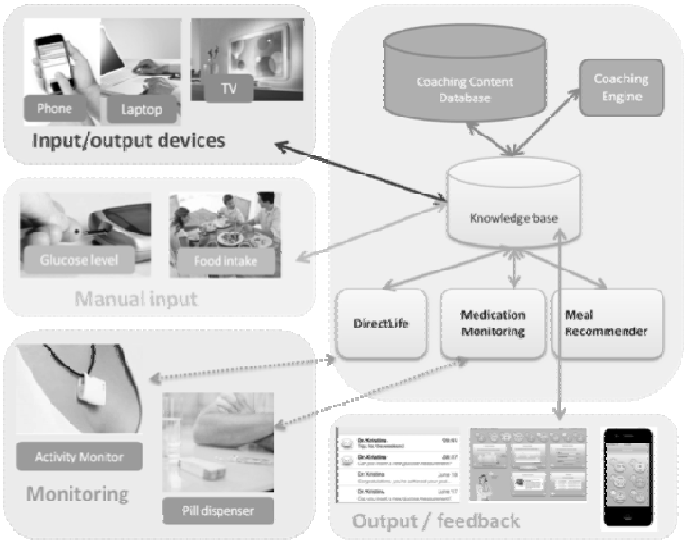

Figure 3: The complete overview of input and output devices of the digital coaching system.

Presentation of feedback messages: Feedback can be presented using different modalities. The possible formats in which the system can present feedback to the user are an embodied conversational agent that presents the message to the user by spoken text and animated graphical user interface, simple text messages, a graph showing an overview, text that refers to a picture or sound or a tune that signals the user that he has forgotten to take his pills. These modalities are available on desktop, mobile phones and television. The selection of modality is currently based on the type of message, e.g. a medication reminder is presented as a simple text message, feedback to be more physical active is presented by an ECA and an overview of physical activity is presented in a graph.

Overview and history of progress: All the devices in the coaching system are able to present an overview of progress to the user. On a dashboard, see Figure 4 an example is shown. The dashboard presents the overview of that day. By clicking on the icons that user can access more details and history about their progress for that specific behaviour.

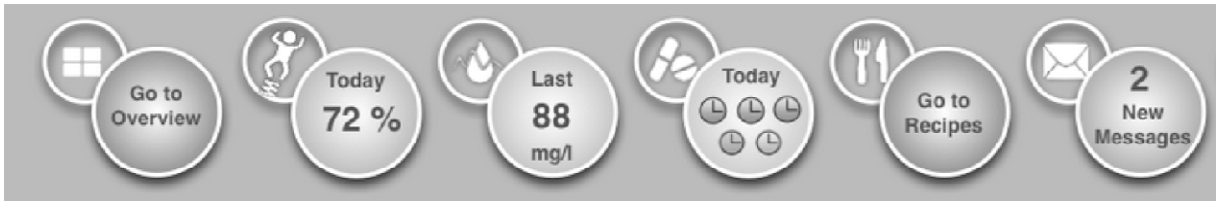

Figure 4: The overview of progress for a day presented on a dashboard.

4 Embodied Conversational Agents as Interface for Digital Coaching Systems

This section describes how the feedback is presented by an Embodied Conversational Agent (ECA). In particular we focus on the PictureEngine, a light-weight engine that allows animated presentation on mobile devices. We also discuss some experiments to see how users assess this format of presentation and if this makes the digital coach more persuasive.

4.1 The PictureEngine

To take advantage of the known benefits of personification of the user interface of service systems as described by Bickmore and Shearer the PictureEngine was developed [18]. The PictureEngine is able to present embodied conversation agents in user interfaces and is based on the Elckerlyc platform [19]. The PictureEngine makes it possible to use the Elckerlyc system on a mobile platform and generate real-time animations of embodied conversational agents. The PictureEngine is used in the coaching application as a mobile embodied coach. Figure 5 presents an example of the mobile embodied coach.

Figure 5: The mobile embodied coach.

The Elckerlyc platform is a Behavior Markup Language (BML) realizer for real-time generation of behaviours of virtual humans (VHs). The verbal and nonverbal behaviour of the ECA will be specified in BML and realized by the Elckerlyc platform. In Figure 6 an example of a BML specification can be found.

```
<bml id="bml1" xmlns:pe="http://hmi.ewi.utwente.nl/pictureengine" xmlns:bmlt="http://hmi.ewi.utwente.nl/bmlt">
    <pe:setImage filePath="pictures/" fileName="neutral-open.png" layer="1" start="0" end="s4:end" id="0"/>
    <speech id="s1" start="1.0">
        <text>Hello, my name is Brenda, I will be your coach for the coming weeks.</text>
    </speech>
</bml>
```

Figure 6: Example of a BML specification for the embodied coach.

During a six-week user evaluation of a physical activity coaching application two alternatives were compared for providing digital coaching feedback to users of the system. Sixteen participants received personalized feedback on their physical activity levels for a period of six weeks. Feedback was provided weekly either by e-mail or

through an embodied conversational agent (ECA). User's perception of the digital coaching was assessed by means of validated questionnaires after three weeks and at the end of the study. Results show significantly higher attractiveness, intelligence [20] and perceived quality of coaching [21] for the ECA.

5 Discussion and Conclusion

We have seen that multiple contact points between coach and client and timely context-aware feedback is a factor that has positive impact of the effect of the life style coaching. In our digital coach these needs are met by the use of multiple devices and mobile devices and other platforms so that clients can be given feedback where ever they are and at any time. The feedback is based on context-aware data that is monitored by multiple devices.

Our digital coaching system meets most of the requirements discussed in Section 2. The coaching system presents sensor data in a visual way and presents timely and context-aware feedback in text or presented by an ECA when the user is performing well according to his personal goal. The system monitors the user in an unobtrusive way by using personal devices. The users of the system can control their own data and can access details and history overviews of their own progress.

The multiple devices in our coaching system are a challenge for user interface design. In the first place it is a challenge to present information on a small screen of a mobile device and secondly, all the devices in the system should interact and support the user in a same way.

The inter-usability is the main theme of the EU Smarcos project and the personal digital multi-device coaching systems is an application in which we demonstrate the inter-usability. Inter-usability entails a seamless user experience across a range of devices and situations. We think that aspects of inter-usability, for example the identification of the system, are improved by the use of an ECA as user interface. Further experiments need to be carried out to see if inter-usability and persuasiveness of the digital coach are improved by using ECA as interface.

Acknowledgements This work was funded by the European Commission, within the framework of the ARTEMIS JU SP8 SMARCOS project 100249 - (www.smarcos-project.eu).

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