Inter-usability and the Presentation of Multi-modal Feedback for Physical Activity and Diabetic Type II Patients

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Context

In the EU Artemis project Smarcos we developed a personal behaviour change support system that supports users in attaining a healthy lifestyle. The coach sends timely, context-aware feedback about daily activities through a range of interconnected devices. The system is designed for two targeted user groups: Diabetics Type 2 patients and office workers. The Diabetics group gets feedback about their medication intake, activity level, glucose level and food intake. The office workers receive feedback about physical activity and food intake. The feedback to the users of the system consists of personalized reminders, advice and tips, or learn more about why healthy behaviour is important.

The prototype system combines two existing (single-device) behaviour change support systems. The multi-device service system we present here extends the single device feedback systems bringing them on one integrated service platform. It allows multiple contact points with users in various contexts: at home, at work, on the road and the system is able to gather more context information of the user. Interventions with several contact points are expected to be more effective in stimulating change in health behaviour than those that use a single contact points [5]. The input devices in the prototype are a smart pill dispenser and a 3D accelerometer. The pill dispenser is connected to a server via the GSM network. Every time the user opens the pill dispenser it sends a message to the server. The accelerometer is measuring the amount of physical activity all day long. The user must connect the accelerometer to his computer to upload the data to the server. The output devices of the prototype system are smartphones (Android and iOS), desktop/laptop computers and (smart) TV's. Smartphones can act as an input and output device. Smartphones can gather information about location of the user, can ask for self-report and are able to receive feedback messages from the system.

Feedback

The input devices provide the system with context information of the user about medication use, physical activity and (semantic) location. The system knows for all users their medication moments, the number of pills and the time when they should take the pills. The system also knows the personal and daily activity goal of all the users. Smartphones provide the system with location information and self-report. The user can connect his devices to the coaching system so the system knows what kind of input and output devices the user can use.

The system receives and evaluates updates on the user context and compares the new data with the conditions of the coaching rules. When one of the rules is fired, the system should send feedback to the user. When a message should be presented four aspects are important; the selection of the device, the timing of the message, the content of the message and the modality in which the message is presented to the user.

Device selection. The system should select the best available device on which it can present the feedback. Based on the available devices and the location of the user the best device can be selected. If the user is at home, the television is maybe the best available device. When the user is on the road the only available device can be the mobile phone of the user.

Content. 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. Variation of feedback messages is important in order to prevent annoyance. Bickmore et al. reports: "One surprising finding from the interviews was that, even though the dialogue scripts had been

authored to provide significant variability in each days' interaction, most participants found the conversations repetitive at some point during the month. This repetitiveness annoyed subjects, and a few subjects even indicated that it negatively impacted their motivation to exercise..." [2]. It is also important not to send too many messages to the user. It can be possible that some coaching rules can fire several times a day; in this case the system should send only a maximum number of messages.

Timing. 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).

Modality of presentation. Feedback can be presented using different modalities. The possible formats in which the system can present feedback to the user are a spoken animated graphical user, 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.

User centered design

The coaching system as described in this paper is designed in a user centered design process. In order to provide feedback at the right time and using the right modality it is necessary to take into account the context of the user. Feedback models define the interactions between system and the user. To capture the requirements for the system, two context-mapping studies have been conducted. Context mapping is a procedure for conducting in-depth research with users. The objective of this procedure is to gain knowledge about the use of products from implied and implicit information that is provided by prospective users during an intensive process [6]. Through active participation by users and stakeholders during the design process, it informs and inspires design teams and ensures a good fit between the design and the use of a product. These qualitative studies consisted of a diary booklet with exercises and a semi-structured interview. Over a period five days, users were probed to describe their daily activities and reflect on their behaviours relevant for the system based on small assignments. The study provides insights in the actual behaviour of the users, awareness of the importance of healthy behaviour and their barriers to a desired behaviour. The requirements collected with this approach were further refined by a role-playing exercise during a workshop.

When the initial requirements were defined two online questionnaires were provided to find out in which situations users would like to receive what kind of feedback on which device. The questionnaires were also used to assess the clarity of the icons that were used in the interface, and to get an idea of how the participants perceived the presented concept.

During a six-week user evaluation of a physical activity coaching application two alternatives were compared for providing digital coaching to users of a physical activity promotion service. 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 and perceived quality of coaching for the ECA.

The results of the previous studies were incorporated into the first prototype of the coaching system. New, long term user evaluations are planned to investigate the overall user experience of the coaching program and the effectiveness of the coaching program when feedback is presented using different presentation modalities and output devices. The effectiveness of the coaching system will be measures by logging the actual behaviour of the participants (the level of physical activity, the medication intake and the progress toward the personal goal of the user, therapy adherence and retention rate). The overall user experience [1,4] and quality of coaching [3] will be measured using validated questionnaire before, halfway and at the end of the user evaluation.

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