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Design Challenges and Guidelines for Persuasive Technologies that Facilitate Healthy Lifestyles

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Abstract: Many diseases and health risks are the result of unhealthy lifestyles and technology could be used as an intervention. However, designing healthy lifestyle technologies is challenging, as the technology should be able to influence user behavior. In this case study, the design and evaluation process of a persuasive healthy lifestyle assistance technology was investigated. The iterative design and evaluation process included: contextual inquiry, storyboarding, concept generation, paper prototyping, video prototyping, interactive prototyping and user testing. Several design challenges are identified and guidelines are described for designing a technological intervention to encourage healthy lifestyles.

Key words: Persuasive technology, case study, lifestyle, health, wellness.

1. Introduction

1.1 Lifestyle and Persuasive Technology

Unhealthy lifestyle (such as unhealthy diets and physical inactivity) is becoming a threat to the general population and might lead to many diseases and health risks [1]. Well-designed technology can act as an intervention to unhealthy lifestyles; appropriate user interface and information design are capable of influencing behavior changes in humans [2]. Healthy living persuasive technologies can influence a user's attitude and behavior, and are a growing area of interest in research and practice [3].

According to Chatterjee and Price's [4] categorization of persuasive technologies in healthy living, current generation technologies have the following characteristics: wearable sensors to collect information from the user; awareness of the user's current status; persuasive technique and real time information exchange within the system. Future generation technologies are characterized by automated components that minimize human intervention. A design team in a large mid-western university in the United States developed a future generation persuasive healthy lifestyle assistance technology called HealthyEdge. The concept for HealthyEdge was generated through a user-centered design process. HealthyEdge monitors a person's physiological status (through wearable physiological monitoring accessories), the environment, and devices that are closely related to lifestyle (e.g., exercise equipment and television). The system also helps the user plan his/her healthy lifestyle by providing health related information and automated planning tools.

1.2 A Persuasive Healthy Lifestyle Assistance Technology

The aim of project HealthyEdge was to develop a persuasive healthy lifestyle assistance technology that is able to support the achievement of goals related to living a healthy lifestyle, while being embedded into the user's daily life. These goals include improving

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diet and increasing physical exercise.

The final outcome of this project was a prototype of the HealthyEdge system. The system includes two main modules (See Fig. 1 for visualization of the system structure): the information processing module and the user interface module. The information processing module includes a data base of user health information, monitor tags, and a physiology monitoring accessory. The monitoring tags track how long the user has been interacting with electronic devices that relate to physical inactivity, such as television and video game consoles. The information gathered from the tags is transferred to the web database for review by the individual. The physiology monitoring accessory is a wearable device which gathers physiological information from the user. It gathers information related to health, such as heart rate and blood pressure. The information stored in the accessory is then synchronized with contextual information in the database.

The main components of the user interface module are the website interface and the smart phone application. The website, which connects the user to the data base, has two main functions: to plan the diet and physical exercise schedule and to offer feedback from the information provided by the physiology monitoring accessory and the monitor tags. The fully functional website is able to create healthy meal recommendations, generate grocery lists, make exercise schedules, and track and update user health goals (e.g., weight control, body building, etc.). The website automates lifestyle planning for the users; however, users who are not satisfied with the automatic planning can customize the plan..The system also provides healthy lifestyles related information. The mobile application will have similar functionality to the website, and offers convenient access for the user.

1.3 The Case Study

This case study investigated the design and evaluation process of the HealthyEdge system. The designed process and challenges the team encountered are described. Finally, guidelines were developed for designing a persuasive healthy lifestyle assistance technology.

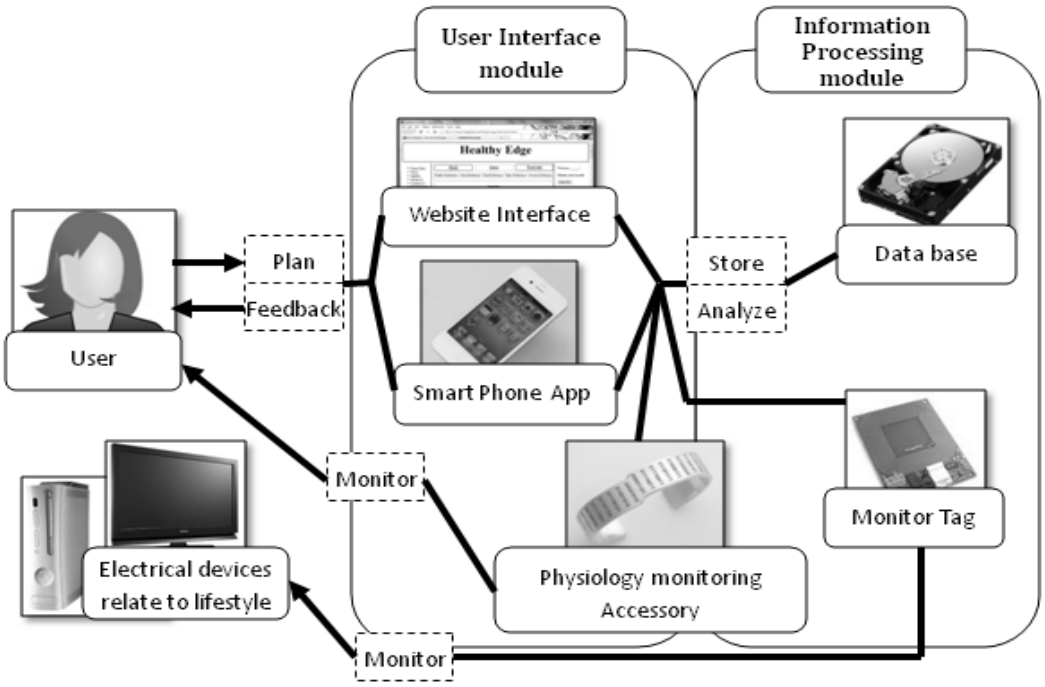

Fig. 1 The structure of a persuasive healthy lifestyle assistance system–HealthyEdge.

In the next section, the detailed design and evaluation process of HealthyEdge is presented. In section 3, three main challenges encountered in the design process and the corresponding seven guidelines are presented. In the final section, implications from this case study are discussed.

2. The Design and Evaluation Process

The design and evaluation of the HealthyEdge system followed six user-centered design and evaluation stages (Shown in Fig. 2): contextual inquiry, storyboarding, concept generation, paper prototyping, video prototyping, and user testing.

2.1 Contextual Inquiry

In the first stage–contextual inquiry, each member of the design team observed one participant interacting with technologies in a variety of contexts, such as home, work, and traveling between locations, to explore opportunities for possible design. Contextual inquiry is a participatory design process that, through working with the user in their current work or home settings, the nature of the user's needs and interaction with multiple interfaces is understood [5]. The tasks for the participants were based on the team members' goals for designing for health and wellness. By observing different users' using computer interfaces, the team gained an understanding of user's needs for interfaces in different contexts. This stage was very important because users may interact with the interface of the health lifestyle system at varied times and locations (i.e., contexts); and therefore interfaces that can be integrated into different contexts are critical. Information gathered in this stage was documented for further reference.

2.2 Storyboarding

In the second stage–storyboarding, each member created and evaluated cartoon scenarios, which displayed users performing different tasks related to interactive designs that support health and wellness.

Fig. 2 The design process of the technology.

Storyboarding can help the designer build a visualized example of the idea in mind [6]. For evaluation, all the storyboards were presented to the team. Participants were also recruited outside of the design team to provide feedback on the storyboards. During this stage, participants described their understanding of the product concepts while following the storyboard sequences. During this stage participants used think a loud techniques [7-8]. After the walk-throughs [6] participants described barriers and facilitators to using such a device. Based on storyboarding results, design requirements were proposed for a more adaptable healthy lifestyle assistance product concept.

2.3 Concept Generation

In the third stage–concept generation, through brainstorming and combining ideas and concepts from previous design stages, the design team came to a consensus regarding the final product concept. During this stage, stakeholder analysis was conducted and problem and activity scenarios were created [9]. The team discussed the results of these design activities. Through these activities the concept for a persuasive healthy lifestyle assistance system was developed.

2.4 Paper Prototyping

In the fourth stage–paper prototyping [10], low fidelity prototypes were created and tests were conducted with participants to facilitate the interface design (particularly information and interaction elements). According to Snyder [10], paper prototyping is good for testing the terminology, navigation, content, page layout, and functionality of the interface; and is helpful for finding problems in early design stages to allow for rapid changes. A low fidelity model of the HealthyEdge website using paper materials was developed by the design team. User testing of the prototype provided front-end results based on usability of the interface. Participants engaged in the think aloud method while interacting with the system. The interaction process was observed and interviews were conducted after the participants finished the tasks. Think aloud methods eliminated the time consuming activity of designer-user communication and was proved to be effective [8]. According to the feedback from the participants, an efficient website was developed. This was very important for a healthy lifestyle assistance system that will be used by individuals that have various ages, educational and income backgrounds to have a universally designed website interface.

2.5 Video Prototyping

In the fifth stage–video prototyping, a video prototype was created to simulate how the system would be used in real-world contexts. Video prototyping can help designers consider contextual elements in the design [11]. The inclusion of these contextual elements assisted the design team in anticipating barriers to use health technologies that must be used in a variety of contexts, such as in the home, the workplace, while traveling, and in health and fitness facilities. The video created by the design team simulated how the user's lifestyle is changed by using a finished HealthyEdge system. The video focused on the interaction between the user, environment, physiology monitoring accessory, and monitor tags. Through making the prototype, the design team developed new insights into questions such as, how the system would monitor user activities without disrupting daily life and how the device elements could influence healthier ways of living. The experience of creating the video prototype immersed the designers into the user's context through role-playing. This technique was particularly helpful in identifying contextual barriers to device use and adoption that might not have been thought of with more traditional user-centered design methods. The videos were then shared with participants online so that they could provide additional feedback about the device, particularly barriers and facilitators to use and adoption.

2.6 User Testing

In the sixth stage–user testing, an interactive prototype was developed for multi-stage user testing. The user test consisted of two stages: (1) using of the website, (2) simulating a day (24 hours) using HealthyEdge. In addition to observations, interviews and survey instruments were used to evaluate aspects of usability such as, learn ability, efficiency, and memorability. Data regarding user satisfaction and further suggestions for the design was also collected.

A web based interactive prototype of the website interface was developed in the first stage of user testing. The prototype was developed based on the final iteration of the paper prototype. A heuristic evaluation [12-13] for the interactive prototype was conducted before user testing. A small sample size of five participants was recruited to complete the user test, as this was the first stage of the iterative design process. It is recommended that the first iteration of user testing include a small sample of participants that are followed with additional tests if needed [14]. Also, research shows that 80% of usability problems can be captured with user tests conducted with four or five participants [15]. All the participants were college-aged students as this was the target participant group. The participants were asked to complete

multiple tasks using the interactive prototype. These tasks included: register for an account, set up food preferences and grocery list, input physical exercise preferences, and edit available times to exercise. A survey was administered after all the tasks to evaluate the ease of using the interface. The results indicate that the interface was easy to understand and easy to use in general, but had some usability problems that could be addressed in future iterations of the interface design.

Only one participant was recruited for the second stage of user testing due to resource constraints. To simulate use of HealthyEdge during an entire day, a physical accessory was used as a prototype of the physiology monitoring accessory. The participant was asked to wear the accessory continuously throughout the day during the user testing. To better simulate the communication between the user and the system, a Wizard of Oz technique [16] was used. Using the Wizard of Oz technique, one member of the design team sent text messages about the physical exercise schedule and grocery list to the participant's mobile phone, based on the information participant provided at the beginning of the user testing phase. At the end of the 24-hour simulation, a web page containing the possible information gathered by the physiology monitoring accessory and other healthy lifestyle information was shown to the participant. Finally, an interview about the participant's experience with the system was conducted. In this step of user testing, the design team gathered valuable feedback about the design of the physiology monitoring accessory and the communication between the user and the system. User feedback was documented and used in the next stage of the iterative design process.

3. Challenges and Guidelines

3.1 User's Acceptance and Actual Use of Technology

In the early stages of the design process, the biggest challenge was designing the user interface and integrating technologies to increase user's acceptance and technology usage. Two of main design outcomes were, user acceptance and integration with daily living, as they are both needed to influence health living. One important aspect of this problem was that the technology might not be well integrated into the user's normal daily life; therefore additional work is needed for the user to interact with the technology (e.g., set up the program for first time use, look for internet access while updating the information is needed, etc.).Under these constraints, the user may not work with the technology in the way the designer expects [17].

Another aspect of this challenge emerged during the video prototyping, in which the design team tested how the system could be embedded in the users' daily life. The question was how to influence the user's behavior without interfering with the user's normal daily activities.

Guideline 1: Designs should be compatible with other technologies. In the design of a system that is to be embedded into user's daily life, it is necessary that the system be compatible with other devices or programs that are currently used by the user (for example, email or online calendar).It is important to minimize the efforts required to begin using the new system, as this can create a barrier to adoption. This design guideline informed three HealthyEdge features. First, in HealthyEdge, the communication between the user and the system takes various channels, for example, the system could be set up to send information to the user through email or mobile phone text messages. If the system sends text-based messages through the mobile phone, the messages should be sent when the user is available, to avoid disturbing the user, Therefore, the system should work with the calendar program, which is currently used by the user to check the user's availability. Second, the system's mobile phone application has different versions to work with different operating systems. Finally, the monitor tags are compatible with different types of electronic devices.

Guideline 2: Create a "player experience". The

system should have a high level of usability as well as a player experience [18] to make sure the user can have fun while interacting with the system. A literature review showed that video games are increasingly used to change health related behaviors [19]. Two kinds of player experience are related to this project–"people fun" and "serious fun" [18]. "People fun" refers to the emotions created by enjoyment of social interaction [18], and this kind of player experience maybe used by healthy lifestyle persuasive technologies. For example, social support from an online community could have an impact on health related attitude and behavior change [4]. Some multi-user games (for example, games involved in competing or collaborating with other users in losing weight) can be designed for use in the online community to motivate the user. Other than games, "player experience" can also be created in the product design [18]. A goal setting module of health status (e.g., setting a weight goal and visualizing weight changed over time and achieving the goal) could offer the user "serious fun", which is related to the enjoyment of real-world benefits from interacting with the system [18].

3.2 Adapting the System to the User

Through paper prototyping, the design team investigated efficient methods for the user to understand and control a system. During video prototyping efforts, the question of how to make the system adaptable to a user's need and daily life was considered. The main challenge that the design team encountered in these two stages was how to make the interface adaptable to users with different levels of health and healthy lifestyle literacy. That is, the user of the system may be a user who is not aware of healthier lifestyles, or a user who is knowledgeable and would like assistance creating a customized health plan. An example of user with high health and wellness literacy may be an athlete who understands terms like caloric intake and has fitness activities that they currently enjoy.

Guideline 3: Design an understandable interface. A survey based research study showed that about one third of the respondents did not understand calorie labeling and about half of the respondents would not use the calorie information in restaurants [20]. This implies that designer cannot assume that the user will understand or use all of the information necessary to make healthy decisions. In the design process, the design team made efforts to group concepts related to healthy lifestyle in an understandable manner to help the user learn, navigate and explore the system more efficiently. To achieve this, user tests were conducted in different design stages, including the paper prototyping and user testing stages. The outcome of the effort was that health information in the system is presented to the user in an easy way that is understandable to most people while more detailed information is also made available for advanced users. For example, for novice users, nutrition information could be presented using food categories like "grain", "oil", "vegetable", etc.; for more advanced users, the same information could be presented as "calorie", "protein", "fiber", etc. Future designs may explore adaptive designs that grow with the user as their health and wellness literacy improves.

Guideline 4: Support special needs. Individual user needs may vary. For example, generic diets may not work well for the users with specific health concerns, such as diabetes. Therefore, the customized information concerning the user's health condition should be collected by the system. This additional information will be critical to system success, if the system is automated. In HealthyEdge, the designers contemplated design features where the system automatically assigned diet, activity and planning activities. However, the designers realized that it is important the information offered by the automated system not to conflict with the individual's physician's advice. In some cases, physician's advice could be input by the user; but more likely, the system

will need to work with other information sources to acquire more detailed and accurate information. One possible way to accomplish this goal may be to integrate data from personal or clinical health records [4]. However, more research is needed to understand the social, institutional, financial, and ethical implications of the integration between consumer health technologies and the medical record. Another option may be to work with the individuals care providers, to acquire information needed. However, more research is needed to determine the feasibility of integrating consumer tools into the care provision process.

Guideline 5: Ensure that automated features are adaptable to "novice users" and "expert users". In the design of HealthyEdge, a prototype with an automatic meal and exercise planning feature was developed to help the novice user; meanwhile, different levels of automated meal / physical activity planning and health information were also provided to the users with different levels of health and wellness literacy. Offering more information to advanced users can lead to a better understanding of the underlying mechanism of the automation and may help calibrate the user's adoption of the system. Targeted information also serves as a mechanism for educating novice users: as usage increases, the system can offer more detailed information to the user (e.g., more detailed nutrition intake recommendation for a day); in this way a novice user could learn and eventually become an advanced user.

3.3 Usefulness and User Satisfaction

In the user testing stage, the design team explored factors associated with user satisfaction and perception of the system's usefulness. The main design challenges included designing system functionality that fulfill users' needs and designing a comfortable physiology monitoring accessory.

Guideline 6: The design should capture the full scope of user's lifestyle. It is possible to design systems that are both usable and rich in functionality as human-computer interaction (HCI) guidelines are established for balancing ease of use and complexity in design process [21]. There are four healthy lifestyle characteristics (HLCs) frequently cited in the literature–smoking cessation, weight control, health diet, and physical activity [22]. In the design of a healthy lifestyle assistance system, functions should capture the full scope of the user's lifestyle. Previous research shows that persuasive technologies could be effective in helping users with those HLCs [4]. A system that could offer assistance with all four aspects would be helpful.

Guideline 7: Ensure wearable technologies are well-designed and customizable. The physiology monitoring accessories in the HealthyEdge system are available in various shapes and are customizable, since it is the device that the user will be wearing continuously. However, there are still other issues that may discourage the user from wearing the accessory. In the user testing stage of this experiment, a participant spent an entire day interacting with HealthyEdge. The participant chose a metal bracelet when multiple choices regarding material and types of accessories were offered. In the interview after the simulation, when asked if the bracelet was comfortable to wear, the participant answered "No. It was too heavy and I always noticed it. I took it off to sleep even though I knew I was supposed to keep it on at all times. I also took it off to shower." Therefore, it is necessary to find a material that is comfortable to wear at all times, including sleeping time. More importantly, a return/exchange policy should be adopted for physiology monitoring accessory; since even when offered the choice for different accessories, the user may find that the device they have chosen is uncomfortable to wear.

4. Conclusions

A future generation persuasive technology like HealthyEdge is possible given advances in wireless

networks, mobile computing, and physiology monitoring technologies. This paper studied the design and evaluation process of such a system, discussed challenges, and presented seven design guidelines developed by the design team for overcoming the obstacles. However, challenges outside of the design of the technology may exist. For example, ethical and policy related challenges to monitoring user behavior and use of health information should be considered and studied.

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