Informing Design of Suggestion and Self-Monitoring Tools through Participatory Experience Prototypes

Nediyana Daskalova, Nathalie Ford, Ann Hu, Kyle Moorehead, Benjamin Wagnon, Janet Davis

> Grinnell College, Department of Computer Science, 1115 8th Avenue, Grinnell, IA 50112

{daskalov,fordnath,huann,moorehea1,wagnonbe,davisjan} @grinnell.edu

Abstract. We aim to design a persuasive technology to help college students, who are particularly susceptible to sleep deprivation, get better, longer, and more regular sleep. In order to gain the insights of our future users, we applied a participatory design approach that included experience prototypes, which aim to actively engage designers and participants with the functions that new technology might serve in the context of their daily lives. We deployed two experience prototypes: paper sleep logs and scripted reminders. We show how deploying low-technology experience prototypes as part of a participatory process can engender valuable insights into persuasive technology design.

Keywords: Experience prototypes, participatory design, persuasive technology, self-monitoring, reminders, sleep, college students.

1 Introduction

Beyond impacts on physical health, lack of sleep impairs cognitive achievement and memory [1]. College students are particularly susceptible to sleep deprivation because of the unfamiliar college environment, busy schedules, and minimal adult supervision. Over 70% of students report getting less than the average 8 hours of sleep required for young adults [2], which can cause a downward cycle of poor sleep leading to poor cognition, inefficient work and bad decisions, and even less sleep.

College students' sleep habits could be improved through persuasive technology, that is, technology intended to promote changes in users' behaviors or attitudes [3]. In particular, we aim to design technology that help college students obtain longer, better, and more regular sleep. Although several commercial technologies serve to monitor sleep quality, Choe et al. argue that sleep is under-explored in human-computer interaction [4]. They raise design questions about where, when, and how people interact with sleep technologies. We build upon these considerations in our design process aiming to support students in developing better sleep habits.

adfa, p. 1, 2011. © Springer-Verlag Berlin Heidelberg 2011 To help ensure our persuasive technology would be useful and appropriate [5], we engaged students in a participatory design process. Building on prior work [5,6], we conducted a series of design activities to engage potential users and help them think critically about their needs and values, developing directions for design.

Our contribution is to show how *experience prototypes* [7] can inform persuasive technology design. Experience prototypes are defined by Buchenau and Suri as "any kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system we are designing" [7]. Like paper prototypes [8], experience prototypes are interactive; participants engage actively rather than passively. Experience prototypes can be low-technology and low-fidelity, gaining the benefits of expedience and flexibility. However, our experience prototypes are designed for use *in situ* rather than in the laboratory. They aim to prototype not so much "look and feel" as the new roles that technologies can fulfill [7, 12]. We believe experience prototypes are well-suited to persuasive technology design because they can provide experience with persuasive strategies before investing in building new technologies.

In this work, we do not adopt a scientific approach in evaluating persuasive strategies. Rather, we propose the application of an established interaction design technique to persuasive technology. Although the technique resonates with Fogg's 8-step method for persuasive technology design [9], we are not aware of any prior work explicitly connecting Fogg's approach to experience prototyping. We address Davis's directions for future work by "selecting and tailoring [participatory] methods for each stage of persuasive technology design and reflecting on the methods' effectiveness" [6].

After an overview of our design process, we further explain our rationale for deploying experience prototypes. We then elaborate on the methods and results for two iterative deployments. We finally discuss benefits, limitations, and lessons learned.

2 Design Process Overview

We built on prior work applying a participatory design approach to persuasive technology [5,6]. Throughout our design process, we collaborated with potential future users of our technology through a series of design discussions and workshops. These activities helped us develop mutual understanding between researchers and participants. Through their partnership in the design process, participants saw their influences manifested in the form of mockups and prototypes.

To begin, we facilitated an asynchronous discussion of wellness concerns on campus, and met with key stakeholders. Once we had identified sleep as our area of focus, Fogg's 8-step method for persuasive technology design suggested we proceed by identifying an audience, a technology channel, and a concrete behavior to change [9]. After committing to Grinnell College students as our audience, we designed a short survey based on National Sleep Foundation (NSF) guidelines [10] to identify what students would most like to change about their own sleep habits. The behavior change that appealed to the most students (about 57%) was to make and follow through on plans for getting enough sleep. We also asked participants about their technology use, to help us choose which technology channels to focus on.

With a direction established, we conducted participatory workshops to engage future users, promote mutual learning, and generate design ideas. Because Fogg argues that complex behavioral change is most successful when taken in small steps [9], the first workshop tasked participants with transforming NSF's sleep guidelines [10] into simple first steps for behavior change. Next, during the Mockups workshop, participants designed technologies to promote sleep and then altered them based on stakeholder and designer prompts [11]. While the Mockups workshop let participants explore one design idea in depth, the goal of the Inspiration Cards workshop was to generate diverse ideas through combinations and elaborations of cards illustrating relevant technologies and concepts [12].

From participants' designs, we identified two persuasive strategies of broad interest: self-monitoring and suggestions [3]. We designed and deployed experience prototypes to gain experience with these approaches. Participants saw their ideas embodied in these prototypes, and their experiences with the prototypes helped further our mutual understanding of the roles that new technologies could serve. After a two week deployment, we met with participants to learn about their experiences. During the fall semester, a new group of participants evaluated a revised experience prototype and mocked up new designs.

3 Why Experience Prototypes?

We decided to deploy experience prototypes because we and our participants lacked concrete experience with interventions to improve sleep. Experience prototypes help both users and designers experience what it may be like to interact with technologies that fill new roles in daily life. They emphasize "active participation to provide a relevant subjective experience," in contrast to approaches where participants must imagine the experience and give feedback from a more distant perspective [7].

We were also inspired by BJ Fogg's approach to persuasive technology design: Quickly testing many simple prototypes at low cost enables rapid exploration of persuasion tactics [9]. Experience prototypes fit Fogg's approach because they are informal, low-tech, and focus on function, lending themselves to rapid exploration, evaluation, and iteration. However, Fogg does not necessarily propose a participatory approach. Rather, designers learn from whether their experiments succeed or fail at influencing behavior. By contrast, we used experience prototypes as part of a participatory feedback loop. Prototypes communicate design ideas from the designers to the participants, who then draw on their first-hand experiences to collaborate with designers in critiquing and modifying those ideas. We created two experience prototypes: paper sleep logs for self-monitoring and scripted reminder messages. Our aim was not to explore "look and feel" or technical implementation, but rather the role of such technologies in behavior change [13].

Why a sleep log? In many of the participants' designs from the Mockups and Inspiration Cards workshops, users would monitor their own sleep hours and related information. One group's mockup explicitly involved a sleep log, and the other two groups also used self-monitoring. In the Inspiration Cards Workshop, three out of the four groups used the "YawnLog" [14] technology card. Furthermore, although keeping a sleep log is one of the NSF's recommendations for improving sleep [10], none of the researchers had used a sleep log; neither had our participants. At the same time, a paper sleep log is a good match to the experience prototype paradigm: paper forms are easy to make and use, yet provide experience with recording objective and subjective data, as well as self-reflection. We hoped to learn how participants would respond to particular questions, but also how a sleep log fit into their daily lives.

Sleep logs were not the only idea we wanted to test. Many participants remarked that they tend to lose track of time and go to bed later than they intended. Four out of the five groups at the Mockups workshop included a suggestion or reminder in their design. Moreover, all groups in the Inspiration Cards workshop used the "Reverse Alarm Clock" technology card: an alarm clock which tells you not when to wake up but when to go to bed [15]. We therefore wanted to learn whether reminders were effective, and gain insight into message content and delivery.

As Buchenau and Suri suggest [7], we took part in the experience prototypes alongside participants. We wanted to directly share in our participants' experiences. Designer engagement with experience prototypes provides a subjective lens and greater empathy for people who may be affected by future designs. Participants and designers "explore by doing" and develop a common perspective [7].

4 Experience Prototypes: First Iteration

We deployed two iterations of experience prototypes. In the first iteration, during the summer, our main goal was to evaluate the approach and major features of sleep logs and reminders. We conducted the second iteration in the fall semester, with a new group of participants, to gain experience in the context of the academic term.

4.1 Method

We adapted a one-page sleep log from the National Sleep Foundation (NSF) [16]. As in the NSF sleep log, we asked participants for their actual bedtimes and wake times, what they were doing right before going to sleep, and if there were additional factors that might have affected their sleep. We also asked participants to retrospectively record when they had intended to go to bed and wake up, so that participants could see and reflect on any disparity in the actual and intended times. The sleep log also asked participants whether they felt tired the following day, because college students need to feel awake throughout the day to study effectively [2]. Finally, the NSF sleep log asks five specific questions about behavioral and environmental factors that might affect sleep quality, such as taking medications. Because we aimed to help participants allow enough time for sleep, we combined these questions into one, final, openended question. Based on the workshops, we suggested more college-specific factors, such as naps, alcohol, noise, and worries.

We also began thinking about ways to trigger students to go to bed. All students have access to email, and we learned from our survey that more than 98% of students have mobile phones. Thus, we explored both email and text messages, as well as desktop computing. We created an experience prototype that included email, text, and pop-up desktop messages to remind participants to go to bed. We used the UNIX cron program to automatically send emails and text messages. We also set up an AppleScript or Visual Basic script to display a pop-up reminder on participants' laptops; we scheduled the scripts using iCal for MacOS and Task Scheduler for Windows. We sent participants a different message each day to keep the reminders interesting and to experiment with a variety of persuasion tactics (Table 1).

Day	Reminder message	Rationale
1	Time to turn off your phone and computer and get ready for bed!	A basic suggestion or trigger [3,16]
2	Hello! It's time to brush your teeth and put your phone on silent! Good night!	Links new habit of silencing phone to existing habit of brushing teeth [17]
3	If you start getting ready for bed now, you will feel refreshed tomorrow!	Suggests a motivation [3,16]
4	It's time to charge your phone and get into PJ's!	Links preparation for bed to another nighttime habit [17]
5	It's time to go to bed. Listen to meditation mu- sic to relax: http://youtu.be/uRhoWQX2OF8	NSF suggests listening to relaxing music to promote sleepiness [11]. Provides a link to make this easier [3]
6	Watch these cute animals yawn and start getting ready for bed: http://youtu.be/B907 aaDw7Ec	Yawning is contagious - a social cue [3].
7	It's time to get ready for bed and listen to some relaxing white noise for a better night's rest: http://youtu.be/qorkD6n PYQM	NSF suggests that white noise helps people sleep better throughout the night [10].

Table 1. Reminder messages draw on persuasion tactics and sleep guidelines.

Of the 23 participants who came to at least one of our workshops, twelve volunteered to engage with experience prototypes alongside the researchers. We collected information regarding participants' usual bedtimes and wake times, their phone number and carrier, and which operating system they use. During the first week with the experience prototypes, participants filled out a sleep log without reminders of any kind. Each day of the second week, each participant received a different reminder 30 minutes before their stated bedtime, and continued to maintain a sleep log.

At the end of the two-week deployment, nine participants met to share their experiences with the prototypes. The remaining three we interviewed individually via email or Skype. Discussion took place in two groups, of four and five participants; each included two researchers to facilitate discussion and take notes. Facilitators encouraged participants to converse about aspects of their experience they found surprising, problematic, or compelling. Prompts involved whether the reminders triggered participants to go to bed, what barriers to sleep they encountered, what they would change or keep the same about the sleep log, how they saw the prototypes fitting in their lives during the academic year, and how their sleep habits may have changed as a result of their experiences with the prototypes. Finally, if participants were comfortable sharing with us, we took photos of their sleep logs.

4.2 Results

Participants increased their awareness of the amount of sleep they were getting each night, and also observed trends over the two weeks. Reflecting on recent behavior was helpful for identifying personal barriers to sleep. Moreover, knowing to expect a sleep reminder helped some participants be more aware of their approaching bedtimes.

During the second week of the deployment, reminders prompted participants to go to bed 30 minutes before their intended bedtime. Some participants stopped what they were doing and started getting ready for bed, while others were distracted with people or entertainment. All participants paid less attention to their sleep reminders during the weekends. There was disagreement over the best time to send the reminders: some participants liked our default of 30 minutes before their intended bedtime, while others preferred an earlier reminder so that they could plan the rest of their evening. Participants paid the most attention to text messages, but predicted that desktop reminders would be more useful during the academic year when they are working on assignments late at night. Finally, the groups discussed the reminders' content. Reminders with links were especially problematic. For example, some were uninterested in listening to white noise (Table 1, Day 7). Others found that YouTube videos were a tempting distraction from going to sleep. As a solution, participants suggested that users should have the ability to choose or create their own reminder messages.

Reminders served as immediate prompts to go to bed, but sleep logs showed participants their sleep habits over time. Many participants found discrepancies between their actual and intended bed and wake times, which often correlated with their energy levels during the next day. Participants especially liked the question, "What were you doing/thinking before you went to bed?" because it helped them identify barriers to going to bed when they intended to. In particular, sometimes participants went to bed late because of friends who had inconsistent sleep schedules. At the same time, some participants felt social pressure to maintain a consistent schedule: they felt accountable to us and to others who may see their sleep logs. During weekends, participants often forgot to fill in their sleep log; one participant stopped logging altogether.

In reflecting on the sleep log, participants found they could easily see differences between their intended and actual sleep times and relate this to what they were doing before bed. Participants suggested that the sleep logs also ask "What would you change for tomorrow?" so that they could contemplate or commit to a behavior change in addition to reflecting on past behavior. Both groups also suggested that we address napping – based on the NSF recommendation to avoid sleeping after 4pm [10] – to help users consider napping as a reason for inconsistent sleep at night.

Overall, participants favored a quick and simple sleep log, but interaction with the sleep log varied from person to person. Some filled it in when they woke up, others in the mid-morning or afternoon, and others at night. Some started in the morning and completed the log at night. When the participants thought about their habits during the academic year, the answers changed again. "I wouldn't have time to fill it in the morning because I like to sleep as much as I can before class, but I can see myself filling it in after class," said one participant. Participants generally thought that sleep logs and reminders could help students improve their sleep habits during the academic year. Some were ready to continue sleep logging into the school year; others said they would not have started a sleep log on their own, but would use one if prompted.

A discussion of paper sleep logs versus a web or mobile app turned the conversation to privacy concerns. Although a paper log can be hidden from view, participants often found it convenient to leave it visible. We asked participants if they would feel comfortable sharing their sleep information in a web or mobile app. Several were happy to share that information and said privacy is no issue–unless we shared it with their mothers. Other participants felt this information was too private to share; they favored anonymized data. One participant explained he would feel comfortable sharing numeric data as long as his comments were kept private. Some participants felt that sharing could create positive social pressure to get enough sleep; however, several participants were concerned that sharing would perpetuate competitiveness in favor of being too busy to sleep.

5 Experience Prototypes: Second Iteration

We used participants' experiences in the summer to revise the experience prototypes for a second iteration during the fall semester.

5.1 Method

Based on participants' discussion of their experiences, we adjusted the second round of reminders in both content and delivery. We changed some messages that participants found unappealing. We also omitted any potentially distracting audio/visual links. For example, a reminder which included a link to relaxing music on YouTube (Table 1, Day 5), was replaced with, "It's time to go to bed. Take a few deep breaths and relax!" To address concerns about timing, the second iteration allowed for personalization. Participants could choose their own times for each day of the week, or retain the default of 30 minutes before their intended bedtime. This change allowed for differences between weekday and weekend schedules.

We also revised the sleep log based on participants' discussion. In the first iteration, the sleep log made participants more aware of their sleep habits and barriers to sleep. Our second iteration on the sleep log sought to go beyond awareness, to help participants set goals for sleep. Instead of asking "What time did you intend to go to bed?" and "What time did you intend to wake up?", the revised sleep log asks "How many hours of sleep do you want to get tonight?", "What time do you intend to go to bed tonight?" and "What time do you intend to get up in the morning?" Having participants plan their sleep and wake times gives them a goal to work toward and holds them accountable. These questions were moved to the end of the form so that participants could set goals based on their reflections about their sleep the night before.

Further, we drew on participants' experiences and reflections to add salient questions and remove uninformative questions. Because several participants suggested we address naps, we added a question: "Did you nap today? For how long? At what time of day?" To address other people as a barrier to sleep, we added the question "Who, if anyone, was with you [before going to bed]?" Some items on the sleep log were removed because they did not prove useful. We removed the question "Did you wake up before your alarm or did you need it?" because many participants always needed an alarm on weekdays or never used an alarm on weekends. We removed another question, "How did you feel when you woke up?" because some never felt refreshed in the morning regardless of how much they slept. However, the dichotomous question "Do you feel tired today?" was reworded as "Overall, how tired do you feel today?" with a scale from "not tired" (1) to "very tired" (5). We put this item first so that answers would be less influenced by questions about the previous night's sleep.

We deployed the revised experience prototypes over a two week period during the middle of the fall semester. We held two workshops with 17 new participants. In the first workshop, participants discussed barriers to sleep, as well as solutions. We also collected participants' intended bed and wake times during the week and weekends, their preferred bedtime reminder times, and their phone number and carrier. For those who brought their laptops, we set up the reminder scripts. Before leaving, participants took two copies of the sleep log, which they were to start filling out the next day. The

daily email, text message, and desktop reminders began at the start of the second week. The researchers did not participate in this second deployment.

After the two-week deployment, we held three sessions of a debrief and mockups workshop: participants discussed their experiences with the prototypes and designed a technology of their own. Of the 17 participants, seven attended the first meeting, one attended the second, and nine attended the third. All participants brought their completed sleep logs.

5.2 Results

Consistent with what we learned over the summer, the experience prototypes helped participants become more aware of their sleep habits and causes of inadequate sleep. However, we gained more reliable insights into how users might interact with reminders and sleep logs while classes are in session.

Overall, participants liked having reminders to start preparing for bed. However, there were situations where it was easier to ignore the reminders than to follow them. Participants over the summer noted that the desktop reminders may be more useful during the academic term, but experiences in the fall did not support that prediction. Although more participants saw the desktop reminders, they tended to ignore the reminders if they were doing homework. Some participants found emails unhelpful because they were not seen until long after they were sent. Thus, text messaging was still the most favored medium.

For this iteration, participants were given the option to decide when, prior to their bedtimes, they would like to receive the reminders. Several took advantage of this option; most tended toward 1-hour reminders on weekends, suggesting our design needs to adapt to weekday and weekend schedules. However, the majority of participants defaulted to the 30-minute reminder.

As over the summer, participants during the academic year found the sleep log helpful. For many, it was useful to have salient information about how tired they felt during the day and how many hours of sleep they got the night before. This allowed them to think about what they could change or maintain for the following nights. As predicted, participants valued naps more during the academic term, and many appreciated the question about napping. Again, thinking about what they were doing before bed helped them identify specific barriers to sleep. However, some participants found it unhelpful to record who they were with: the answer was always the same. In general, there were more mixed responses to the questions in the second iteration, supporting the need for flexibility in our design to account for individual differences.

As in the first iteration, many participants were made aware of the disparity between their intended and actual bed times. In the second iteration, the sleep log asked participants to commit to particular bed and wake times. Throughout their discussions, participants questioned the usefulness of the "intended" bed and wake times. Participants raised concerns about whether these questions actually encouraged accountability. In particular, some participants were unsure whether to give realistic or ideal bedtimes. This uncertainty reveals a major barrier: In the context of all the work students want to do, or feel they must do, sleep is often not highly valued.

Because we added a mockup exercise to the debriefing session, participants were able to use their experiences and discussions to inform their own designs. Here, privacy manifested not so much as a concern but as a preference. To make the prototype more persuasive, several groups incorporated social sharing, so that others can strengthen the user's accountability in going to bed at the intended time.

6 Discussion

Experience prototypes provided important design insights in the context of our participatory design process. Our prototypes let participants (and designers) directly experience the potential functions of new technologies. Although participants incorporated self-monitoring and suggestion strategies in their workshop designs, they could speak only hypothetically about how effective these strategies might be. Experience prototypes changed that. When participants understand not just the purpose of a new technology, but the experience of using it in the context of their own lives, they can more aptly address concerns about practicality, meaning, and ethics. For example, participants told us that text messages were by far the most effective technology channel for reminders, contrary to their predictions. Participants found that some reminder messages were not effective, or even counterproductive. We worked with participants to develop sleep log questions that help them meaningfully reflect on their behavior; participants challenged our ideas about goal setting and identified other questions that were simply not useful. Through our discussions with participants, we learned that variability in how and when people use sleep reminders and sleep logs means that personalization is important to both strategies. And finally, participants varied widely in their views about how private sleep log data should be and what it would mean to share that information. Without directly engaging our participants in conversation and reflection, and without our own use of the experience prototypes, we would not have gained such a rich understanding of the potential range of experiences with the proposed technology.

We found that experience prototypes fit well into the middle stage of our participatory design process. Rather than eliciting values and generating ideas (as in the Inspiration Card and Mockup Workshops) or refining elements of more concrete designs (as in implementation or look-and-feel prototypes [13]), experience prototypes allowed us to evaluate persuasive strategies and tactics in the context of use. Workshops conducted beforehand allowed us to incorporate values and ideas put forward by participants, and the results allowed future workshops to be tailored around ideas which provoked participant response. Like many prototyping techniques, experience prototyping enables low-cost testing and rapid iteration. In keeping with Fogg's [9] advice to build on success, we were able to incorporate feedback from the first deployment in the second deployment, while maintaining elements that participants liked and found effective. However, we remained focused on the role the technology would serve. We were able to revise sleep log questions, reminder messages, and reminder delivery times. Because our prototypes were relatively simple to assemble, we were able to easily move between iterations, and also test multiple strategies at once. Although participants interacted with our prototypes over multiple weeks–a much longer time than required for other design activities like storyboarding–our prototypes were much faster to produce than a software system prototype that would provide comparable experiences.

Given the limited capabilities of paper forms and computer scripts, we did not delve deeply into look and feel, usability, personalization, information displays, or sharing. Although there is much design left to do, we do not plan to conduct a third iteration of experience prototypes. After our second iteration, we believed a third iteration would have diminishing returns. We were starting to find more differences between people's experiences than similarities. The features we would have added to our experience prototypes, such as personalizing reminder messages, would have added too much complexity without much additional insight. Further design will require us to move forward with other kinds of prototypes.

7 Conclusion

Our work suggests that experience prototypes can fill a valuable niche for informing the design of persuasive technology. In contrast to more abstract prototypes, where designers and participants must imagine how new technologies will fit into everyday life, experience prototypes provide concrete, lived experience with the roles that persuasive technologies can serve. Beyond the implications for design discussed above, our process provides some support for the use of suggestion and self-monitoring strategies to improve sleep habits: reminders helped some participants go to bed on time, and sleep logs helped all of our participants reflect on their behavior. We learned all these valuable lessons at a relatively low cost. Iterating on the experience prototypes let us evaluate our proposed revisions in the real context of use.

Extending Fogg's 8-step method for designing persuasive technology [9], we recommend a participatory approach when applying experience prototypes of persuasive technology. Close interactions with our participants helped us gain better insight into their needs, values, and preferences regarding the final product, going beyond assessing the effectiveness of our prototypes in changing behavior. When both designers and participants engage with experience prototypes, they develop a shared perspective on the role that new technologies can play in shaping behavior. Acknowledgments. We thank our participants for their time, enthusiasm, and insights. We thank Grinnell College for its support of this research through the Mentored Advanced Projects program.

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