FrightLight: the Heart Rate-Controlled Smartphone Nightlight

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Abstract

FrightLight is an Android application that serves as a nightlight for those who face anxiety with falling asleep in the dark, and who would normally already have their smartphone by their bedside at night. In this paper, I discuss a the implementation of the application as well as the pilot and actual user studies performed to gather feedback on FrightLight, especially in terms of usability and experience. Overall, the feedback ranged from neutral to positive and provides a strong direction in which to further develop the application.

Introduction

As someone who has been personally afraid of the dark for most of their life, I have slept with a nightlight for the better part of the past few years. The light is usually on through the entire night unless I happen to wake up in the early morning and switch it off, sufficiently comforted by the early sunlight. Electricity is relatively inexpensive, but it is still undeniably wasteful to leave a light on through the night, especially when it is not actively necessary.

According to the Statistic Brain Research Institute, I am not alone—11% of United States citizens self-report as having a fear of the dark [1]. The fear of the dark is also referred to as *glossophobia*.

Over the past couple of years as smartphones have proliferated through the masses, I have developed the habit of keeping mine within arm's reach while asleep, either tucked between the edge of my mattress and bedframe or charging on a nearby nightstand.
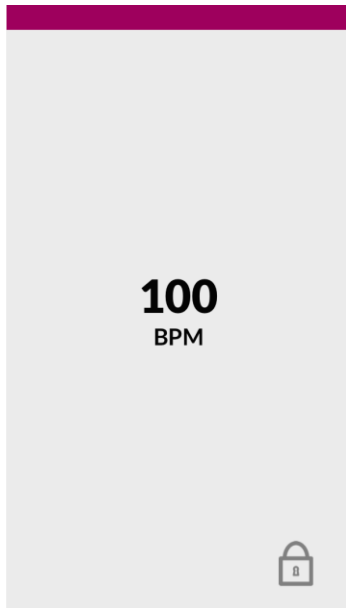
As *Fortune Magazine* has found, 71% of smartphone owners sleep with their phones [2].

Taking the combined, and quite prevalent, characteristics of fearing the dark and sleeping with a smartphone nearby into consideration, I thought to create a smart nightlight application.

Related Work
There are few existing works on the market, whether in software or hardware form. Perhaps the most closely related would be self-dimming nightlights or light bulbs that brighten or dim based on the brightness of their surrounding environment.

One notable technology that actually behaves in an opposite way is Drift Light, a self-dimming bulb. Drift Light attempts to imitate sunrise and sunset, remaining bright throughout the day for use, then dims as the evening progresses until it transitions into nightlight mode for the evening. Like a regular light bulb, Drift Light connects to a power source like any other light and can be switched on and off with a switch.

My application, however, is quite distinct from the Drift Light. First of all, it is software intended for use on mobile rather than hardware for physical installation.

Additionally, my application is more eco-friendly because it is only active for as long as the user's phone is, entering a sleep mode once the phone is inactive through the night.

The greatest distinction between my application and existing technology is that it will incorporate real-time physiological data and leverage affective computing to run.

Methodology
FrightLight is an Android application built through Android Studio. To use the application, the user must wear an Empatica E4 wristband, which collects their physiological data in real-time, focusing on their IBI data, which is converted to a heart rate value measured in beats per minute (bpm).

Heart rate is grouped into three ranges: excited, resting, and sleeping. Heart rate is grouped into three ranges: excited, resting, and sleeping. An average excited heart rate is greater than 90 bpm. An average resting heart rate falls into the range of 40-90 bpm. An average sleeping heart rate is lower than 40 bpm [3]. These values vary greatly depending on the individual; nutrition, fitness, genetics, and age are among many factors that affect heart rate.

Once heart rate is calculated, the screen brightness is modified in parallel. As heart rate increases, brightness increases; as heart rate decreases, so does brightness.

Pilot Study
To gain insight on usability and user experience for my application, I first conducted a pilot user study with one participant.

A participant was selected based on availability and convenience off premises, as the application is intended for use before and during the process of falling asleep.

Figure 1: Drift Light, a self-dimming lightbulb.

100
BPM

Figure 2: FrightLight interface, excited state

Figure 3: Each participant was asked to fill out a questionnaire the morning after the pilot and user studies.

Before going to bed, the participant was introduced to the experiment through a pre-written script. The participant then wore the Empatica E4 wristband, which was connected to a Nexus 5 running Android version 6.0.1 with FrightLight open.

The next morning, the participant was given a questionnaire presented in a five-point Likert scale with an additional free-form comment area to provide any additional notes.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
FrightLight's interface was easy to use				x	
FrightLight was distracting				x	
FrightLight was convenient			x		
FrightLight helped me feel more comfortable falling asleep			x		
FrightLight was a better alternative to my usual nightlight			x		

Additional comments:
I don't normally use a night light so this was strange. There's not much to do in the app so it's easy to use, but the changing lights were distracting.

Figure 3: Example of a questionnaire completed by the participants in the studies.

User Studies
After conducting the pilot user study and gaining insight, I conducted three additional user studies for further feedback.

Similar to the pilot study, I selected participants based on availability, proximity, and convenience off premises. Before going to bed, I read the script to the participants and had them wear the Empatica wristband, which was connected to the smartphone.

The next morning, each participant was given the same questionnaire as in the pilot study and all provided write-in comments in addition to the questionnaire questions.

Results
Based on the results of the questionnaire in the pilot study, the participant agreed that FrightLight is a helpful application to use before bedtime, rather than a traditional nightlight. The participant pointed out that the refresh rate to display heart rate on the screen could be smoother, especially since this also affects the stability of the screen brightness.

The three user studies conducted after the pilot study garnered slightly more diverse results. All three participants agreed that FrightLight proved to be a better alternative to the usual nightlight and agreed to varying degrees that the interface was easy to use and convenient overall. Two out of three participants disagreed that FrightLight was distracting, but one did indeed think it was.

Discussion
The results may have been affected by several factors, such as my relationship to the participant, participant familiarity with physiological data sensor wearable technology, and limitations of the technology used.

Because the application is intended for a bedtime setting, I received permission to conduct the pilot study outside of the Computer Science labs at the University of San Francisco. As a result, the participants in the pilot and user studies were not selected at random.

The participant who had less familiarity with wearable technology expressed discomfort with having to wear the wristband overnight, which affected the overall experience of using the application. Those who were more familiar reported more positively.

Results also may have been affected by whether a participant was a light or heavy sleeper, and whether the changing lights distracted them.

Conclusion
Based on the feedback received, I will continue to develop and improve the FrightLight interface. For future user studies, I would expand the participant selection to those chosen at random, or who at least are not as close in relation to avoid biasing the results.

FrightLight could also be developed to sooth other forms of anxiety by having the screen background change color with relaxing gradients. I could also see the concept behind FrightLight being applied to physical lights in order to decrease electricity consumption.

References
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3. Laskowski, Edward R. "Heart Rate: What's Normal?" *Mayo Clinic*. Mayo Foundation for Medical Education and Research, 22 Aug. 2015. Web. 30 Apr. 2017.