Evaluating Zeo and Fitbit for Tracking Sleep Behaviors

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INTRODUCTION

Sleep is one of the key aspects of good health, along with a healthy diet and regular exercise. Computing researchers have recently worked to understand how systems can support nutrition and exercise, but sleep has been relatively under-studied despite its significant health benefits. The right amount of quality sleep can improve both physical and mental health and is associated with a lower risk for heart disease, diabetes, depression, and obesity. However, sleep disorders are often undiagnosed, and many people are unaware of how their activities or environments affect sleep. Ubiquitous computing has the opportunity to help through self-monitoring, awareness, and identification of ways to promote healthy sleep behaviors [1].

This proposal outlines an evaluation to compare two off-the shelf technologies for tracking sleep behaviors: the Zeo and the Fitbit. We propose to evaluate the technologies for their accuracy in tracking sleep metrics such as sleep and wake times, sleep efficiency, and number of awakenings, as well as their overall user experience. We will also report on the ability for programmers to use the data provided for these devices for new interfaces and research projects.

DEVICE OVERVIEW

We propose to evaluate two commercially available devices for tracking sleep, the Zeo and the Fitbit, which we describe below. We chose these two devices due to their popularity and availability. In addition, both devices have mechanisms for programmatically downloading information, giving researchers the ability to use them with custom applications or as a data collection mechanism.

Zeo

Zeo (http://myzeo.com) consists of a soft sensor headband that is worn on the forehead. The sensor uses two electromagnetic probes to estimate a measure of sleep status and sleep stage and transmits the information back to a base station or to a mobile device. The application links to either a web-based application or mobile application that provides information back to the user on their sleep habits and their "sleep score," which is a proprietary measure of sleep quality.

Figure 1: The Zeo headband worn by a user and bedside appliance.

Fitbit

The Fitbit (http://fitbit.com) is an accelerometer-based device that is designed to provide a holistic view of people's physical fitness, including physical activity and sleep. For sleep, the device is put into a small, cloth sleeve and worn on the dominant wrist of the user while they are sleeping (see Figure 1, right). Fitbit then monitors physical activity and provides an estimation of the user's sleep time, wake time, number of awakenings throughout the night, and the sleep efficiency.

Figure 2: The Fitbit wristband worn by the user while sleeping.

EVALUATION

For our evaluation, we propose to evaluate both Zeo and Fitbit for their accuracy, user experience, and experience working with device for the development of custom applications or as a research tool.

Accuracy of Sleep Metrics

Although there are other sources that have attempted to validate the accuracy of the Zeo [3], we will conduct our own informal study of the accuracy of the device to confirm those findings. For this evaluation, the three researchers will each wear both devices for 1 week simultaneously and keep a manual sleep diary as ground truth. We will then compare the accuracy of the data reported from the two devices to one another, as well as the manual data reported in the sleep diary. In addition to our own metrics, we also have data from 5 participants who participated in a previous study of Lullaby, a novel application for capturing information about the sleep environment, to be presented at UbiComp 2012 [2]. The data we compare will be sleep and wake times, number of awakenings, and the calculated sleep efficiency.

User Experience

We will use the qualitative data reported from participants in the previously mentioned Lullaby study to evaluate the user experience of using both the Fitbit and the Zeo. This will include the comfort with wearing the device to bed, whether the device was cumbersome to use or activate each night, and how well the user interface worked. Also, we are interested in learning how the use of these devices affect people's sleep measures and sleep quality in return. Because our previous Lullaby study did not evaluate the user interfaces associated with Fitbit and Zeo (we had our own custom interface evaluated instead), we will supplement this data with an analysis of a random sampling of reviews left on Amazon.com for both products to report on the user's experience with the feedback systems for both.

Technical Experience

In addition to reporting on the accuracy and user experience, we will also report on the technical experience in using Fitbit and Zeo for research projects. This includes reporting on the openness of collecting data from the system, the ease at which applications can be developed on top of the Fitbit, and the quality of information obtained from the two devices. This includes how much code was needed to be able to access the data, the suitability of any APIs associated with the device, and the stability of the code over time. We have already used the Fitbit for data collection for the previously mentioned Lullaby application, so we already have data to report on that experience. We have wanted to adapt Lullaby to also work with Zeo, so we will implement that linking this summer to be able to report on the experience of developing with Zeo. This information should be useful for any developers who wish to use these two devices in research projects.

Institutional Review Board

Because the evaluation is not considered research and the only new data we will be collecting will be on ourselves, the University of Washington does not require IRB approval for this study. The data we have already collected from existing studies has already been approved by the IRB.

Resources

Our lab already owns four Fitbit devices purchased for other studies and 10 Zeo devices, which we received from an equipment grant from Zeo. Thus, we will not need any additional resources to conduct this evaluation.

AUTHOR INFORMATION

Matthew Kay is a Ph.D student in Computer Science & Engineering at the University of Washington studying persuasive technology and personal informatics. More specifically, he is developing technology to help people understand and improve their sleep habits—for example, Lullaby, which is a capture and access application that helps people track environmental factors that disturb sleep.

Eun Kyoung Choe is a Ph.D. candidate at the Information School at the University of Washington. Her research interests are in the areas of Human-Computer Interaction and Design. In particular, she is interested in designing computing applications to support people's healthy behaviors and evaluating those through real world deployment studies. Her dissertation work focuses on how technologies can promote behavior change for improving healthy sleep behaviors.

Julie Kientz is an Assistant Professor at the University of Washington in the department of Human Centered Design & Engineering. She focuses on designing, developing, and evaluating novel, future computing applications involving the capture and review of data for the domains of health and education. In particular, she has worked on designing and evaluating mobile and sensor applications for helping individuals with sleep disorders, assisting parents of young children in tracking developmental progress, and assisting special education teachers working with children with autism.

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