A Comparison of Wearable Heart Rate Sensors for HRV Biofeedback in the Wild: An Ethnographic Study

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Abstract. Biofeedback has been consistently used to manage stress and anxiety in clinical and non-clinical settings. Existing research on the use of biosignals to provide sensory feedback has been mostly limited to laboratory settings. In this study, we performed an autoethnographic study to analyze the heart rate variability (HRV) data recorded by two wearable biosignal monitors, the polar H10 heart rate monitor chest strap and Empatica E4 wristband. Data acquisition was conducted during the daily activities of two researchers in real-life settings. Data recorded during the activities and the effects of movement artifacts of each subject were compared qualitatively against each other for HRV stress management.

Keywords. Biofeedback, Heart rate variability, Polar H10, Empatica E4

1. Introduction

Psychophysiological data acquired by ubiquitous and preferably unobtrusive sensors will potentially change the role of biofeedback in psychological studies and the related clinical therapies. Many in the field of human-computer interaction (HCI) [1,2] have started to develop wearable technologies for biofeedback by using recent technological developments in biosensing technologies for the ever-rising stress-related health issues [3]. The majority of the studies conducted for the biofeedback use heart rate variability (HRV) biosignal in the laboratory environment where the settings of the experiment are highly under control and cannot be replicated in real-life settings. In contrast to lab environments, the sensory data is highly affected by the noises resulting from multiple real-life activities like movement and temperature changes [4]. Moreover, the lack of validations and comparison studies conducted in the lab vs the wild makes the validity of the readings in the wild more questionable.

In this paper, we perform an auto-ethnographic study in the wild using two wearable sensors recording HRV data of daily life activities. We analyze and compare HRV data in different activities of daily life and study the effects of movement on data quality for HRV biofeedback for stress management in real-life settings.

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2. Method

In order to collect HRV data, we used two types of biosensing wearable devices. which include an ECG device on the chest i.e. Polar H10 [5] and a PPG device on the wrist i.e. Empatica E4 [6]. Both of these biosensing devices are wearable and has been validated for heart rate data collection in the prior literature [7,8]. In order to collect data from real-life settings, two researchers wore the devices during a day and performed a series of daily life activities, which include taking part in a research meeting (18 mins), giving a research presentation in front of an audience (20 mins), walking (15 mins), having lunch (15 mins) and cycling (5 mins).

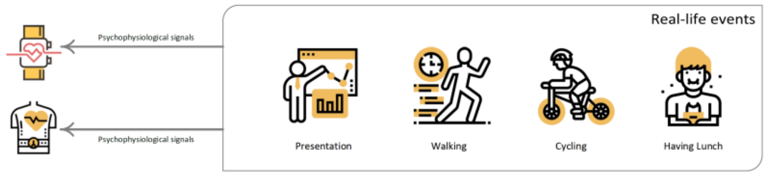

Figure 1. Data acquisition and study method.

3. Conclusion

In summary, the PPG sensor on the Empatica E4 performed nearly identical with Polar H10 chest strap during activities that require lower or near zero movements or physical activities. On the other hand, Polar H10 always responded with better accuracy and lower artifact while the task being monitored involved moderate to higher intensities of physical activities. In conclusion, while Empatica E4 brings multimodality to the table by offering PPG, EDA, Accelerometer, and Body temperature data, Polar H10 provides more accurate heart rate data in every condition. Although the issue of wearability and comfort is subjective and relative at the same time, both test subjects agree that a wristband is much more comfortable for daily usage compared to a chest strap.

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