Identifying stressful and relaxation activities using an ambulatory monitoring device

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Background and Objective:
The Autonomic Nervous System (ANS) regulates physiologic processes autonomously through the sympathetic (SNS) and parasympathetic systems (PNS) with both working in balance e.g. sympathetic input accelerates heart rate and prepares for emergencies while the parasympathetic slows the heart rate and relaxes the body. Stress can lead to imbalances in these two systems which can harm the human body. Persistent imbalances caused by chronic stress may trigger diseases such as hypertension, diabetes, asthma and depression and also lead to social problems. In this paper we discuss the effectiveness of a wearable physiological monitoring device in identifying the response of subjects to stressful and relaxation activities to monitor the long term impact of stress.

Methods:
To achieve this objective we developed a body sensor network to wirelessly monitor heart rate, respiratory rate and skin conductance. We collected data while subjects performed mental challenges, chosen to measure a range of stress responses interleaved with deep breathing activities, which they also assessed. We examined the data using several measures of heart rate variability--spectral power in the low frequency (HRV-LF) and high frequency range (HRV-HF), mean (AVNN) and standard deviation of successive RR intervals, the portion of RR interval that changes more than 25 msec (pNN25) and the root mean square of successive differences of RR (RMSSD). Respiratory effect was evaluated using normalized respiratory high and low frequency components and their ratio. To assess the impact on the skin conductance, the mean and standard deviation of the slow varying tonic skin conductance level (SCL) and rapidly varying phasic response-skin conductance response (SCR) were computed.

Results:
An analysis of the computed features indicated that not all features were able to accurately identify the impact of stress on the subjects. The HRV and skin conductance measures were more highly correlated to stress levels with best discrimination obtained using AVNN, RMSSD, PNN25, HRV-HF, SCL mean and SCR standard deviation.

Conclusions:
This study has shown that it is possible to extract features from physiological signals that can be transformed into meaningful measures of individual stress.