# Heart Rate Variability and Respiratory Sinus Arrhythmia Assessment of Affective States by Bivariate Autoregressive Spectral Analysis

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The impact of computational devices in modern everyday life has raised an increasing interest on the study of emotions elicited by human-computer interactions. Our motivating research hypothesis is that an automated system for affective states detection can rely on non-invasive acquisition and processing of biological signals, such as the Electrocardiogram and Respiration. In this study we evaluate the autonomic nervous system response and the mechanical and autonomic effect of respiration on heart rate during PC-mediated stimuli eliciting targeted affective states. To this extent, we use multivariate autoregressive (AR) spectral methods to estimate standard heart rate variability (HRV) measures, as well as the interaction between R-R interval and respiration time series, a measure of respiratory sinus arrhythmia (RSA). We further assess significance of the linear cardio-respiratory coupling by use of surrogate series. A group of 35 young healthy volunteers is considered. Each subject was monitored during four experimental conditions: Baseline (stare at a white screen, 3 minutes), Relaxation (sequence of panoramas, 10 minutes), Stress (perform a Stroop task, 4 minutes), and Engagement (read a detective tale, 10-15 minutes). In order to account for possible effects due to the sequential order of the emotion-induced conditions, the sample was split into two groups: half of the subjects (RES group) were exposed to Engagement before Stress, the other half (RSE group) to Stress before Engagement. Resulting HRV measures clearly separate the autonomic nervous system response among all three conditions. Of note, less significant differences are found between Engagement and Stress in the RSE group, suggesting that Stress stimuli may cause a lasting response possibly affecting the following Engagement period. Results from bivariate analysis further indicate a substantial disruption of the cardio-respiratory coupling during non-relaxing conditions, as corroborated by significantly lower levels of coherence (although still above the surrogate zero threshold) and RSA gain.