Dynamical Heart Beat Correlations during Complex Tasks – A Case Study in Automobile Driving

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Aims: We study dynamical alterations in the heart beat correlations during automobile driving, a complex cognitive task that is known to elicit stress responses with high individual variability. In this exploratory analysis we assess whether dynamical heart rate variability (HRV) analysis yields additional insights over conventional methods.

Methods: We utilize the publicly available database *"Stress Recognition in Automobile Drivers"* from PhysioNet in our study. The experimental protocol consists of 15 min relaxation periods prior to and after driving a predetermined route on public roads. We apply dynamical detrended fluctuation analysis (DDFA) to RR intervals and obtain continuous scaling exponents $\alpha(t, s)$ as the function of both time t and scale s. The temporal fidelity of the method permits accurate determination of distributions of $\alpha(t, s)$ in relatively short segments of data.

Employing the distributions as features, we evaluate the benefits of DDFA by attempting to classify whether the subjects are relaxing or driving in the segments. The analysis is complemented by conventional HRV measures including nonlinear, and both time- and frequency domain measures. For comparison, the classification is also performed with this ensemble of HRV measures as features.

Results: The subjects exhibit highly individual cardiac responses to the experiment, and 20 % of the subjects do not show significant differences in HRV between driving and relaxing. In the remaining cases an average classification accuracy of > 95 % is achieved, and the DDFA-based features outperform the ensemble of conventional HRV features in 55 % of these subjects. This suggests that there may be intricate local patterns in the heart beat correlations that are overlooked by the cruder methods, but their significance requires further study.

Conclusion: Dynamic heart beat correlation analysis is a promising tool that complements other methods in situations where transient changes in HRV could be important.