Monitoring cardiovascular state changes in a simulated ambulance dispatch task for use in adaptive automation

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Abstract

A simulated ambulance dispatch task was used to induce variations in mental workload in a semi-realistic laboratory setting in order to study cardiovascular state changes during several hours of task performance. The main aim was to find out whether it is possible to classify physiological state changes due to increased workload at an individual participant level in order to use such an approach for future studies in adaptive automation. Twelve participants took part in three experimental sessions after two training sessions of about 2.5 hours each. Task load was varied by manipulating the number of ambulance rides to be planned as well as the number of emergency rides, while task complexity was increased by evoking planning problems in specific regions. Blood pressure, heart rate, baroreflex sensitivity as well as variability measures of heart rate and blood pressure were determined to derive cardiovascular state changes.

During the working period blood pressure, heart rate, baroreflex sensitivity increased as a function of time on task. At the same time heart rate variability increased, while blood pressure variability decreased. Differences between periods of high and low task load were only visible in the variability measures. In order to distinguish individual participant's cardiovascular response patterns in respect of varying task load, a linear multiple regression model was used, with task load (2 levels) as the dependent variable and the mentioned cardiovascular measures as the independent variables. Acceptable classification results were found, ranging between 67 and 83%. As a mean over all participants and using the "voting neighbours principle", about 75% of the individual data segments could be correctly classified as whether belonging to the easy or the heavy task load condition. In respect to the relative small differences in task load as obtained in the present experiment it is concluded that the proposed method gives hopeful results for future on-line applications in adaptive automation.

General introduction

The main drive to study physiological state changes in long lasting tasks in laboratory is to know how people can cope with heavy mental workload during several hours in normal daily life. More specifically, we want to know the cardiovascular reaction patterns of operators such as air traffic controllers and operators in a control room in industry in relation to momentary workload. It is well known that in such work situations at some moments in time the work may be easy or