Short-term heart rate measures as indices of momentary changes in invested mental effort

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Abstract

Laboratory research on invested mental effort in demanding mental tasks has given evidence for an increase in heart rate (HR) and decreased heart rate variability (HRV) as a function of task load. In particular the HRV effects are very consistent in short lasting tasks (e.g. 5 minutes) in which working memory is heavily involved. Using this concept in more practical workload situations evokes two types of problems: 1. Generally HRV increases as a function of time due to baroreflex related regulatory processes; 2. workload and mental effort change continuously as a function of time. This latter point is directly related to the reliability of the estimated HRV measures. According to published standards, in many cases time segments of steady workload would be too short to apply spectral techniques for HRV measures.

In this paper a simple time-frequency approach, called spectral profiles, for this type of problems is outlined that is suitable for many (semi-)realistic working conditions. This is illustrated in two studies using two different types of task, i.e. the SON IQ-test for children and a simulated flight for candidate pilots.

The results show that in both experiments HR and HRV effects based on short segment analysis can be related to task demands. It is concluded that the described short segment spectral profile approach is promising for use in (semi-)realistic working situations. The important pre-requisite is that on the basis of simple task analysis relevant segments have to be detected that do not overlap too much (in time or in effect) with respect of the HRV patterns.

Introduction

In several laboratory experiments it has been shown that heart rate variability (HRV) decreases with increasing task demands, while heart increases (Boucsein & Backs, 2000). In general a diminished HRV is interpreted as additional effort invested in the task to be performed (Mulder, 1986). On this basis HRV was proposed to be an index of invested mental effort. Many of these studies, however, can be characterised by short task duration (e.g. 5 minutes), while in most cases working memory load was manipulated specifically. Longer lasting tasks, in general, show a quite different

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