Determining dynamic cardiovascular state changes using a baro-reflex simulation model

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Abstract

Experimental data of the first part of this paper show that cardiovascular state changes may occur quite rapidly during long lasting task performance. This implies that simple pre- and post measurements will not suffice when conclusions have to be drawn about the subjects' physiological state during a working day. Furthermore, the cardiovascular patterns in the three experiments were quite different. This cannot be related to random factors or inaccurate experimentation because of the similarities between the experimental results within the same experiment. Two main types of response patterns could be distinguished: the first is comparable to a defence reaction, consisting of an increase of blood pressure and heart rate as well as a decrease of variability in both heart rate and blood pressure. This state is best visible in the initial phase (5 or 10 minutes) after the start of the working period. The second pattern can be described as an increase in blood pressure, counteracted by the baro-reflex. This state is additionally characterised by a decrease of heart rate in combination with an increase of baro-reflex sensitivity.

It is argued that these different cardiovascular states can be described in terms of autonomic control by using a baro-reflex control model. Simulation studies with such a model deliver parameters for sympathetic and vagal gain as well as vagal tone. A simple example study showed that in case of a defence type of response vagal gain was reduced with about 40%, while sympathetic gain was reduced with 20% (note: this implies an increase of sympathetic activity). Finally, an approach is outlined to use the simulation model on individual subjects in order to estimate cardiovascular state changes during task performance. In particular, this method could be fruitful when it is used in simulated work environments in which task complexity can be manipulated by designing adequate task scenarios.

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