Struggle against sleepiness - estimation of Driver State

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Abstract

At times, drivers may struggle against sleepiness while driving. This drowsy state is different from a non-driving low arousal state because drivers should make a great effort to keep their arousal level high. Twenty-one middle-aged male adults and ten male university students participated in an experiment in which they were asked to perform a monotonous one-dimensional tracking task using a steering wheel for sixty minutes and to report their sleepiness level (1 to 5) verbally when it changed. Their faces were video recorded to evaluate their sleepiness level (1: awake, 2: slightly sleepy, 3: very sleepy, 4: almost asleep) according to their facial expression. A struggle may occur in levels 2 and 3. The states with struggle were coded with beta (2β, 3β) and the states with no struggle were coded with alpha (2α, 3α). ECG (for HRV spectral analysis), respiration, and Skin Potential Level were recorded. Respiration was significantly deeper in 3β than in 3α. The coefficient of variation of inter-beat-intervals (CV-RR) was higher in the struggle states than in the non-struggle states in both levels 2 and 3. The results indicated that physiological parameters such as respiration depth and CV-RR in the struggle states are different from those in the non-struggle states at the same sleepiness level.

Introduction

It is important to detect drivers’ state of drowsiness and to avoid falling asleep-at-the-wheel accidents. Ohsuga, et al (2008) and Nopsuwanchai, et al (2008) proposed a two-dimensional model of arousal-drowsiness. A struggle (large effort) - non struggle (small effort) axis is orthogonally set on the high arousal - low arousal axis in this model. In the struggle state, drivers have noticed their low arousal level and are making a large effort to keep their arousal state high. However, their state is not active and their performance may be inferior to that in a normal arousal state (Figure 1). The struggle state may change to the non-struggle state soon. From the perspective of an active-safety concept, it is necessary to awaken them using an alert