

# 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 ( $2\beta$ ,  $3\beta$ ) and the states with no struggle were coded with alpha ( $2\alpha$ ,  $3\alpha$ ). ECG (for HRV spectral analysis), respiration, and Skin Potential Level were recorded. Respiration was significantly deeper in  $3\beta$  than in  $3\alpha$ . 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

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