

# **Event-Related Potentials preceding Emergency Braking Situations during Simulated Driving**

S. Haufe<sup>1,\*</sup>, M. Treder<sup>1</sup>, M. Sagebaum<sup>1</sup>, M.F. Gugler<sup>2</sup>,  
A. Ewald<sup>3</sup>, G. Curio<sup>2</sup>, B. Blankertz<sup>1,3</sup>

<sup>1</sup>Berlin Institute of Technology, Germany; <sup>2</sup>Charité University Medicine, Berlin, Germany; <sup>3</sup>Fraunhofer FIRST, Berlin, Germany; \*E-mail: haufe@cs.tu-berlin.de

## **INTRODUCTION**

Mental state monitoring is of particular interest in safety-critical applications such as emergency braking situations during driving, where human performance is often limited due to inattentiveness, slow cognitive processing, motor inabilities or simply hesitation. The aim of the present study was to identify typical electrophysiological and behavioural markers already occurring prior to an emergency braking situation. These results might be important for driver assistance technologies which may be able to optimize reaction times in crucial situations based on the driver's mental states.

## **METHODS**

We conducted a driving simulator study (N=20), using a customized version of the open-source racing software TORCS [1]. The experiment comprised 3 blocks (45 min each) of driving in which the subjects had to tightly follow a computer-controlled car at a speed of 100km/h. While subjects were within the desired maximal distance of 20m, the preceding car occasionally performed sudden brakes, forcing the subject to immediately brake as well in order to avoid a crash. The present EEG study focused on the analysis of event-related potentials (ERPs).

## **RESULTS**

Reaction times of EMG onset compared to the actual braking onset revealed a relatively stable delay of ~300ms due to changing from throttle to braking pedal. Various ERPs predictive of emergency braking could be observed prior to the EMG onset: an N1 related to visual processing of the preceding car's brake light and a P300 reflecting rareness and importance of the flashing brake light. Further, a readiness potential (BP) was present building up until the actual movement. This BP was shorter and stronger for emergency braking situations compared to BPs preceding occasional braking events.

## **DISCUSSION**

All the observed potentials often occur in normal driving situations. However, at least in our scenario, their co-occurrence signifies emergency brake situations. Future work will address, whether a detector using the ensemble of these neurophysiological markers can reliably predict emergency braking situations. Such a detector could then be integrated in driver assistance systems to initiate belt tightening devices and measures to optimize the car dynamic for potentially upcoming crashes. This is ongoing and previously unpublished work.

## **References**

[1] The Open Racing Car Simulator (TORCS). <http://torcs.sourceforge.net/>