Effects of a driving assistance system on the driver's functional near-infrared spectroscopy

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Abstract

In this study driver's brain activity was measured by using functional near-infrared spectroscopy (fNIRS) when using driving assistance systems such as Adaptive Cruise Control (ACC) system and Lane Keeping Assistance (LKA) system. The fNIRS measurement system detects the radiated near-infrared rays, and measures relative variations of oxygenated hemoglobin (oxy-Hb) and deoxygenated hemoglobin (deoxy-Hb) based on those absorbencies.

Subjects followed a leading vehicle, which had a certain speed pattern including stop and go situations, with and without ACC system. The activity in the dorsolateral pre-frontal cortex (DLPFC) of the drivers without the ACC was modulated by accelerating and decelerating the car, whereas this was not the case for the drivers using the ACC. Also, the overall DLPFC as measured by fNIRS was lower when drivers were using the ACC compared to when they were not using ACC. These results may reflect a difference in mental workload between the two conditions.

Introduction

In recent years, various driving assistance systems have been developed to ensure safety by giving support and reducing driver workload. Examples include the Adaptive Cruise Control (ACC) system, which maintains a safe distance between the driver's vehicle and the vehicle ahead of it, and the lane-keeping assistance system, which keeps the car in a lane through steering support. However, it is also possible that, while driver workload is reduced, the driver's attention is also reduced, resulting in unexpected accidents. The undesirable behavioural adaptation was reported by Hoedemaeker and Brookhuis (1999) and Hjälmdahl and Várhelyi (2004). It is necessary to examine driver workload and attention from the viewpoints of cognitive engineering and human physiology. First, it is necessary to clarify the relationship between driver workload and brain activity, which includes recognition and judgment. It is then necessary to evaluate the driver's attention and to clarify the relationship between brain activity and driving performance.

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