Chapter 23

Basic Study on the Effect of Scent on Arousal Level Using Multi-Channel Near-Infrared Spectroscopy (MNIRS)

Shun’ichi Doi
Faculty of Engineering, Kagawa University, Japan

Takahiro Wada
Faculty of Engineering, Kagawa University, Japan

Eiji Kobayashi
Faculty of Engineering, Kagawa University, Japan

Masayuki Karaki
Faculty of Engineering, Kagawa University, Japan

Nozomu Mori
Faculty of Engineering, Kagawa University, Japan

ABSTRACT

Long term monotonous driving has been often found to decrease the driver’s arousal level and effect his/hers property of perception, cognition and judgment. It is preferable to apply arousal assist for the driver instead of huge stimulus such as warning sound and vibration to the driver while driving. On the other hand, the effect of the scent is also reported as an environmental stimulus for driver.

In this study, the seven kinds of scent were used as olfactory stimulation and the influence of scent on the driver’s psychosomatic state was examined using a fixed-based driving simulator by measuring biological measurements including electrocardiogram and finger plethysmograph. As for brain activity of olfactory cortex, the multi-channel near-infrared spectroscopy (MNIRS) has been shown to enable the evaluation of changes in hemodynamic. The MNIRS was also used to monitor the activity of the frontal cortex as mirrored by hemodynamic responses subjected to olfactory stimulation.

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As a result, it is verified that not only characteristics of the scent but also the driver’s preference and subjective judgment of scent changes affect on the each driving performance. The brain activity change by olfactory stimulation and the brain blood flow change by other stimulation were also investigated. The effects of the functional brain imaging of olfactory activity were measured and the comfortable scent for the individual subject was verified to be effective for maintaining the arousal level.

INTRODUCTION

Monotonous and drowsy driving is a major cause of accidents in situations involving long-term highway driving. To assist the driver and prevent an accident, the use of arousal assistance for the driver is preferable to a huge stimulus such as a warning sound or vibration. There are various reports concerning the effects of arousal upon a driver and its role in maintaining his or her awareness of traffic environments. (Hirata, 2001).

In this study, we examined the effect of scent on the driver’s psychosomatic state by using a driving simulator and measuring biological indicators by methods such as an electrocardiogram, electrooculogram and finger plethysmograph. With respect to brain activity in the olfactory cortex, the multi-channel near-infrared spectroscopy (MNIRS) system can be used to evaluate changes in hemodynamics (Kobayashi et al, 2007). The MNIRS system was used to monitor the activity of the frontal cortex as mirrored by the hemodynamic responses in response to olfactory stimulation. In addition, changes in brain activity in response to olfactory stimulation and changes in blood flow in the brain in response to other stimuli were investigated.

EXPERIMENTAL PROCEDURE

1. Experiment 1 on Driving Simulator

In this study, two kinds of experiments were executed, as described in Table 1. In experiment 1, the subject drove along a straight road for 20 minutes at 60 km/h using a driving simulator (DS) (DS-2000, Mitsubishi Precision co. Ltd) (Figure 1). Under this condition, almost all subjects tended to become somnolent. We attempted to maintain

Table 1. Experimental overview

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1: driving simulator</th>
<th>Experiment 2: seated position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>Simulated drive (Straight road)</td>
<td>Sitting with eye-mask</td>
</tr>
<tr>
<td>Test duration</td>
<td>20 minutes</td>
<td>10 minutes 45 seconds</td>
</tr>
<tr>
<td>Measurement items</td>
<td>Subjective judgment + Electrocardiogram</td>
<td>Electroencephalogram + Finger plethysmograph + Lateral displacement on DS + Blood flow</td>
</tr>
<tr>
<td>Subjects</td>
<td>11 (Sub A–K) Average age 23.0</td>
<td>5 (Sub. A–E) Average age 22.4</td>
</tr>
<tr>
<td></td>
<td>10 males: 1 female</td>
<td>4 males: 1 female</td>
</tr>
<tr>
<td>Supplying Timing</td>
<td>For a duration of 15 seconds</td>
<td>Cyclic (supplied for 15 seconds and shutoff for 45 seconds)</td>
</tr>
<tr>
<td></td>
<td>after the vehicle in the DS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oversteps the lateral line</td>
<td></td>
</tr>
<tr>
<td>Scent</td>
<td>Four scents were selected through subjective judgment</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Driving simulator
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