TOPICS

Drivers' Brain Activation Patterns in Car-Following Situation as Determined by Functional MRI[1)]

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The recent development of functional magnetic resonance imaging (MRI) has provided us with a non-invasive means of the identifying active brain regions as a subject performs a task. To evaluate the degree of driver distraction, we can estimate the level of driving performance from the brain activity, since driver distraction is conventionally assessed based on the driving performance.

The purpose of this study was to determine the neural substrates of a driving task and to identify brain regions that are related to driving performance. To simplify the analysis of the driving performance, the driving task was restricted to maintaining a safe distance from the vehicle in front.

The experiment used an MRI scanner and a driving simulator. Twenty-one right-handed volunteers participated. The subjects controlled the speed of their car from within the MRI gantry by manipulating a joystick with their right hand (**Fig. 1**). No steering control was required. The experiment consisted of an active car-following session (active session) and a passive car-following session (passive session). The active session consisted of three control epoch/task epoch pairs. During the control epochs the subject merely viewed a car-following scene. During the task epochs, the subject was required to manipulate the joystick to maintain a constant distance between their car and the car in front. During the passive sessions, the subject did not manipulate the joystick but instead viewed a replay of his or her previous active session.

By comparing the brain activity (MR signal change) of the active session with that of the passive session, we determined the active brain regions. We found that the task activated several cortical regions including the bilateral cerebellum, basal ganglia, pulvinar nuclei of the thalamus, ventral and dorsal premotor cortex, inferior parietal lobule, left primary sensorimotor cortex, and anterior cingulate cortex and supplementary motor area (**Fig. 2**).

The car-following performance was negatively correlated with the activity of the anterior cingulate gyrus. **Figure 3** shows the correlation between the car-following performance (distance CV, coefficient of variation in the car-following distance) and brain activity (MR signal change). The green regions in the upper-left and -right images indicate the positive correlation with the distance CV. Task-related MR signals in the anterior cingulate gyrus of each subject are plotted against the distance CV (bottom).

Maintaining a safe distance from the vehicle in front while driving requires the recruitment of discrete sets of cortical and subcortical regions that are related to visuomotor control and to error detection and prevention. The car-following performance was found to be correlated to the activity of the anterior cingulate gyrus, making it a candidate for a driver distraction indicator.

Reference

1) Uchiyama, Y., Ebe, K., Kozato, A., Okada, T. and Sadato, N. : "The Neural Substrates of Driving with a Safe Distance: A Functional MRI Study", Neurosci. Lett., **352**(2003), 199-202

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Fig. 1 Subjects were placed in a spine position in the MRI gantry.

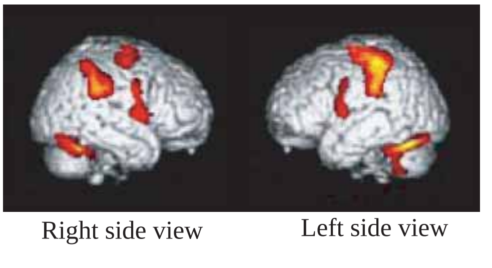

Fig. 2 Active brain regions during the active car-following session compared with the passive viewing session.

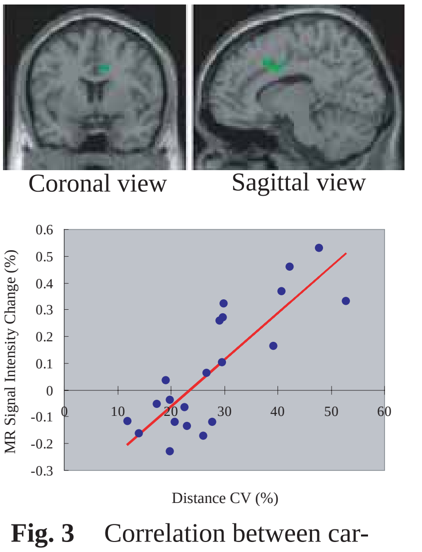

Fig. 3 Correlation between car-following performance and brain activity.