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A Study of a Driver Model Using Unconscious Driving Behaviors

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Abstract

The automation of automobiles will change driver behavior, as the unconscious region stressed by the conscious region. Driving operation is considered to be done unconsciously, as human biological signals start 0.3 seconds before a decision is made. It is thought that driving operation changes when the unconscious region is pressured. In this paper, we set mental calculations as a dual task technique of a non-driving task for drivers, and verified the changing of driver operations by this load pressure on a driver's consciousness region.

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Keywords: human engineering, driver model, mental workload, unconsciousness, dual task technique ;

1. Preface

In recent years, vehicle operations have become increasingly automated. The change from MT cars to AT cars can be cited as a typical example of automation. With the shift from MT cars to AT cars, though the number of accidents has reduced and driving has become safer, it has been observed that there is an increasing proportion of accidents caused by human operations such as while turning and rear-end and head-on collisions, as shown in Figure 1[1]. Also, comparison of the ratios of accidents by each human factor shows that more people are not ensuring safety or not paying attention while driving, etc. From this, it seems that with increased automation, drivers are losing consciousness of driving operations. The horizontal axis in Figure 1 is calculated as shown in Formula (1).

$$\text{Accident ratio of AT or MT cars} = \frac{\text{No. of accidents of AT or MT cars}}{\text{Number of AT or MT cars}} \quad (1)$$

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In this research, the assumption is that changes are taking place because of the load tasks in addition to driving operations, as divers are not ensuring safety or not paying attention while driving. Therefore, it is necessary to verify what the effect will be on driving operations by loading the driver with tasks.

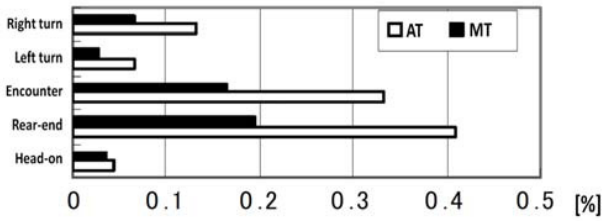

Fig. 1 Accident ratio comparison of accident types [1]

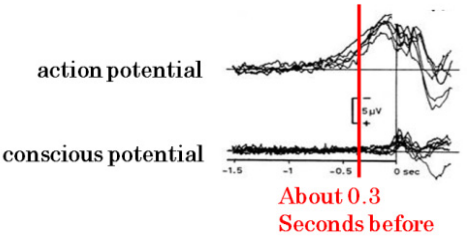

Fig. 2 Readiness potential [2]

When verifying driver behavior, the focus was on brain activity during driving operations. Looking at the brain activity, we found that the driving operations were reflex actions, and that the driver was not making conscious decisions. From this, we can establish the hypothesis that driving operations determine the unconscious and reflex actions after the situation is recognized.

Libet[2] proved this in 1983. In his research, there is an experiment in which the reactions from the subjects are sought in an arbitrary timing, and the brain activity related to that is observed. At that time, he measured the starting of the electrical signals known as readiness potential in the conscious potential that determines conscious actions, and the action potential that unconsciously tries to move the muscles. Figure 2 shows the starting of the two readiness potentials (conscious potential and action potential). From this, it is understood that, since the action potential occurs approximately 0.3 seconds before the conscious determining potential, the actions are unconscious and reflexive. And goals operations can be said to operate unconsciously[3].

From this, we consider a reflexive action model of drivers in which the unconsciousness state is taken into account. The current behavior model is comprised of the 3 factors of "Recognition, Judgment, and Operation"[4]. In occurrence of the readiness potential in the brain activity, the action potential occurs approximately 0.3 seconds before the conscious determining potential as mentioned in the previous paragraph. Accordingly, in this research, it is assumed that the actions are performed by reflexive operations comprising of the 2 factors of "Recognition (Judgment) and Operation". Thus it is thought that, when the driving operations are performed reflexively, the driver's conduct will be affected by his physical condition and changes within the car's environment.

2. Driver Model

In this research, the area used for driving operations is considered the unconscious area, and the area used for the processing of the sub-tasks as the conscious area, as shown in Figure 3, as habitual actions are carried out unconsciously without repeating conscious decisions. The assumption is that an increase in the conscious area will lead to the unconscious area being stressed, and cause increased frustration. Therefore, in the driving operations that are performed reflexively, it is thought that the driver's conduct will be affected by his physical condition and changes in environment in the car.

From this, assuming that the score of the activity area of the driver's brain is fixed, and that it is comprised of the scores of the conscious area and unconscious area, Formula (2) is established.

$$\sum_i f(\alpha_i \cdot a_i) + \sum_j f(\beta_j \cdot I_j) = P_k \quad (2)$$

In formula (2), $\sum_i f(\alpha_i \cdot a_i)$, represents the score of the unconscious area, $\sum_j f(\beta_j \cdot I_j)$ represents the score of the conscious area, and P_k represents the activity area of the brain when the driver is in k state. In this research, driving operations that are performed unconsciously are defined as the unconscious area, and other actions and thoughts that are performed consciously are defined as the conscious area. There are two factors, unconscious area in a_i and conscious area in I_j. α_i and β_j are considered as the variables after taking into consideration the individual's differences in each factor.