Effects of in-vehicle real-time traffic safety warning information: An evaluation based on drivers' short-term memory and driving experience

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Abstract

The occurrence of traffic accidents is influenced by various driving environmental factors such as site road structure, traffic volume, and signal operation. However, a majority of traffic accidents are attributable to how drivers behave in response to the driving environment. In practice, provision of traffic warning signs, either on road sides or inside vehicles, is more likely to be considered as a feasible measure to improve traffic safety than more traditional measures such as redesign of road geometry and safety facilities on roadways. Moreover, in recent years the performance of precautionary measures has been enhanced by use of Intelligent Transportation Systems (ITS). Nevertheless, it has been not well solved how to evaluate the effectiveness of such measures in terms of traffic safety.

The 'Smart 2-miles Hiroshima' project in Japan is an attempt to improve road safety by ITS measures. To investigate the influence of In-Vehicle Real-time Traffic Safety Warning Information on traffic safety, a field driving using a probe-vehicle experiment was conducted on the national highway "route 2" in Hiroshima City in November 2006. This study examines this influence by particularly addressing human factors based on the argument that the usability of the given information would depend on drivers' short-term memory. As short-term memory is limited in human's capacity of information processing, the information is only temporarily stored and never recalled once it has faded, while the information fades if another task is interposed. Many researchers in psychology have formulated the monotonous loss of information over time that occurs in short-term memory in terms of a forgetting curve which was firstly generated by Ebbinghaus (1885). He found out that the rate of forgetting is usually high at first, gradually slows and nearly levels out. The "forgetting phenomenon" can also be identified in drivers' behavior. Even though this is true, the relationship between the capacity of driver's short-term memory and driving experience is questionable because it is a common sense that driving skill might be improved to some extent with the increasing driving experience.

In this study, firstly, we formulate the utility function of In-Vehicle Real-Time Traffic Safety Warning Information based on the forgetting curve, assuming that the performance of the given safety information depends on the characteristics of drivers' short-term memory. Secondly, we develop a new utility function for the given safety information by introducing a factor that represents driving experience, which can be seen as relating to long-term memory. Finally, to analyze the influence of the information on traffic safety, we develop a driving consistency risk model related to the importance of speed deviation proposed by Solomon (1964), Cirillo (1986), and Garber et al (1989, 2000) by means of an ordered response probit model based on the speed choices of a driver. In addition, the study addresses the validation of the proposed method by scrutinizing the sign and significance of parameters based on empirical data. Moreover, the performance of the proposed method is examined by comparing with a conventional method that uses dummy variables and does not consider drivers' short-term memory.

It is expected that the proposed method can be used for deriving objective measures for evaluating the contributions of ITS applications to traffic safety with consideration of human factors. Moreover, the study can showcase the need of in-vehicle traffic safety warning information.
References