Headway distances of elderly drivers: Longitudinal study over one decade

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1. Introduction

The number of elderly drivers who drive their own passenger vehicle has been increasing in aging society. Advanced driver assistance systems will be helpful to the elderly drivers in order to promote safe driving and to enhance areas of their daily activity. Elderly drivers often compensate their driving behaviors based on their age-related decline of the cognitive and physical functions. Investigating real behaviors of the elderly drivers are essential to develop the assistance systems that are indeed suitable for elderly drivers driving behaviors.

In this paper, we describe a longitudinal study of driving behaviors of elderly drivers which have been conducted in real road environments. The longitudinal measurement of the driving behaviors on actual roads is expected to clarify the compensatory behaviors and potentially risky behaviors. The relevant research project is “CANDRIVE (Canadian Driving Research Initiative for Vehicular Safety in the Elderly) cohort study” (1). This project has recorded the driving habits of 1000 older drivers for five years as well as yearly comprehensive assessments of physical, behavioral, and mental factors. We compared the driving behaviors of three elderly drivers in three times: determined in 2001 or 2003 (differences between the participants; called “first experiment”), in 2008 or 2009 (“second experiment”), and in 2014 (“third experiment”).

Car-following behavior is a research target in this study. This behavior has the static aspect of how much distance drivers leave to a leading vehicle (2). We investigated the distributions of headway distance to clarify the static aspect of the car following behavior.

2. Methods

We have conducted field experiments using the same instrumented vehicle, the same road, and the same participants. The instrumented vehicle consists of several sensors measuring the vehicle status (speed, acceleration, etc.) and the driver’s operations (pedal applications, steering operations, etc.). Laser radar units fixed within the front and rear bumpers record the relative distances and relative speeds to the leading and following vehicles. This vehicle has a recorder system, which sampling rate is 30 Hz.

The driving route was 15 km and the travel time was about 25 minutes. The car-following behavior analyzed in this study recorded on a bypass with one traffic lane. The distributions of “Time Headway (THW)” were compared between the three experiments. The THW was defined as the relative distance to a lead vehicle divided by the driving speed of the driver’s own vehicle. The distributions suggest proportion of the time when the drivers take the relevant THW to the total time while driving on the target road.

The participants were three elderly drivers (one female) with informed consent. Their ages were 57, 66, and 70 years old in the first experiment, 65, 71, and 74 years old in the second experiment, and 70, 77, 80 years old in the third experiment. All of the drivers drove more than three times per one week in their daily lives in all the three periods.

3. Results

Figure 1 presents the distributions of the THW for each participant. In the second experiment, the THWs of the participant A & B were longer and that of the participant C was shorter compared to the first experiment. In the third experiment, the THW of the participant A was longer and those of the other two drivers were shorter compared to the second experiment. When comparing the THWs between the participants, the participants took longer THWs until they were about 70 years old. The participants tended to take closer THWs after the age of 70.
4. Discussion

Small longitudinal study of the car-following behavior implies that headway distances of the elderly drivers become longer until about seventy years old and those become shorter after the age. Taking the longer headway distances might be a compensate behavior of the elderly drivers. The deterioration of their visual and attentional functions may lead to keeping more spaces from a leading vehicle. The attempt to keep more margins increases the THW.

Two causes of taking shorter headway distances after 70 years old are considered: one is an influence of the age-related decline of the elderly driver’s vision and attention. The elderly participants could not detect the movements of the lead vehicle under the far car-following conditions. Another is a risky driving behavior due to their self-confidence in “continuing driving even for their age”. The contents of the advanced driver assistance systems should be changed according to the causes.

References
