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DEVELOPMENT OF A DRIVING STYLE FEEDBACK METHOD AIMED AT ADAPTIVE LEARNING IN SAFE DRIVING EDUCATION

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Abstract

The aging of driver's license holders is progressing, and in order to allow elderly people to continue driving safely, license renewal periods have been shortened and license systems have been introduced that allow elderly people to drive only vehicles equipped with specific safety devices. In human factors research, it has been pointed out that the driving characteristics of elderly people are caused by a decline in cognitive function due to aging as well as a decline in judgment function, which leads to accidents. Research and development of technologies such as low driver alertness and inattentive detection is being conducted. However, it has not yet been possible to extract critical variables that lead to unsafe behavior in elderly people, which varies greatly from person to person. This research focuses on risk communication using hazard maps as a support measure to help them break away from highly unsafe driving behavior. Drivers have misconceptions about driving, habits that have become habitual through driving experience, and unconscious behaviors that belong to psychomotor skills. This study aims to develop a feedback method to link drivers' self-understanding of their driving style with the risks associated with that style. As a preliminary survey, the driving style (8 factors) of 624 men and women aged 70 or older was analyzed to compare with the driving style of 320 men and women aged 40 to 60 who have elderly drivers in their close friends, and significant differences were found in several factors. Based on the analysis results, hazard map training was conducted after presenting the self-diagnosis results of driving style to 27 drivers aged 70 or older, and a change in awareness of hazards was observed.

Keywords: *Driving style, hazard map, risk communication, adaptive learning, feedback method.*

1. Introduction

For the elderly to live an independent life, securing transportation is an issue. In Japan, in order to allow the elderly to continue driving safely, the license renewal period for those aged 70 and over has been shortened, and a license system has been introduced that allows them to drive only vehicles equipped with specific safety devices (NLI Research Institute, 2025). In human factors research, it has been pointed out that the driving characteristics of the elderly are by a decline in cognitive function due to aging, as well as a decline in judgment function, which leads to accidents. Research and development of technologies such as low driver alertness and inattentiveness detection is being conducted. However, it has not yet been possible to extract the critical variables that lead to unsafe behavior in the elderly, which varies greatly from person to person (Yoshitake, & Shino, 2019).

This research aims to develop an adaptive feedback method that utilizes the concept of risk communication as a support measure to help elderly people break away from unsafe driving behavior. Risk communication is the idea of sharing risk information throughout society, and providing hazard maps and conducting disaster prevention drills for the purpose of reducing natural disasters (earthquakes, floods, typhoons, etc.) is also part of risk communication. A hazard is a factor that may cause a risk. In risk communication in disaster prevention education, in order to increase preparedness, it is shared that the way hazards are perceived and the response actions differ depending on age and individual characteristics (Yoshitake, & Shino, 2018). When providing information on dangerous spots for accidents, etc., feedback is needed to encourage the involvement of the driver who receives the hazard information, allowing them to consider how to use the hazard information.

2. Literature review on risk communication

The 2014 Ministry of Education (Yamori, Kikkawa, & Ajiro, 2005), Culture, Sports, Science and Technology's "Measures for Promoting Risk Communication" emphasizes the importance of effective transmission of risk information and consensus building through dialogue and collaboration among stakeholders. Regarding the concept of risk and risk communication, the direction of understanding and emphasis vary depending on the individual and field of expertise. Based on previous research, this study defines risk communication as "an activity in which various levels of society share diverse information and perspectives through dialogue, joint consideration and collaboration for more appropriate risk management." Arame et al. (2012) points out the need to consider effective ways of involvement for each stakeholder when accustomed to knowledge transfer education (Arame, Hideshima, & Kanda, 2012). The purpose of risk communication is generally stated as "a. education and enlightenment, b. induction of behavioral change, c. fostering trust, and d. participation in decision-making." When developing adaptive feedback methods that apply the concept of risk communication, it is necessary to consider the characteristics of diverse drivers.

3. Research Question

Okamoto et al. (2012) point out that the safety driving education in Japan has aimed to acquire vehicle operation skills and skills to adapt to traffic conditions, and that education on hazard prediction and driving planning has not been sufficiently conducted (Okamoto, Nakahira, & Kitajima, 2012). For example, even if a person has excellent driving skills and has acquired knowledge of hazard prediction, as long as he or she drives at high speeds without properly controlling feelings of irritation and impatience, the possibility of being involved in an accident cannot be reduced. Keskinen (1996) constructed a hierarchical model of driving behavior and clarified that driving safety is not determined solely by driving skills (Keskinen, 1996). The four hierarchies are, from top to bottom, life goals and life skills, driving goals, responding to traffic conditions, and vehicle operation. Life goals and life skills are placed at the top because high-risk values and impulsive motivations induce accidents. Placing behavioral layers related to social adaptation, such as motivation and attitudes, at the top emphasizes their importance as controlling factors of safe driving.

Young drivers tend to be seen as drivers who like to drive, but some of them are eager to drive, while others would rather avoid driving if possible. For example, beginners tend to be seen as being conscious of the burden of driving, but some of them are highly conscious of the burden, while others drive without feeling much of a burden. Even if the gender, age, years of experience, and accident history are the same, the attitude toward driving and the sense of burden are different. This study investigates whether there are changes in driving style as well as vehicle operation skills depending on the age group. In this study, in order to investigate the perceptions of various people involved with drivers, we will investigate the differences in perceptions of driving style by age group and the perceptions of people close to the driver other than the driver himself.

4. Method

This study used survey data from two groups conducted online in 2024. The first was survey data from 624 elderly drivers (hereafter, the self-group) and the second was survey data from 360 people who have elderly drivers aged 70 or older in their close circle (hereafter, the close relatives' group). The first data consisted of 208 people by gender and age. The survey included their own driving frequency, driving scenes, driving purposes, driving style, and the timing of voluntary return of their driver's license. Given the current situation, it is believed that the older the person, the more likely they are to have a psychological dilemma regarding securing transportation and maintaining safe driving, so it is thought that there are differences in how people of the same age perceive the timing of voluntary return of their driver's license.

The second data consisted of 56 people by gender and age group between 40 and 60 years old. We surveyed familiar elderly drivers on their driving frequency, driving situations, driving purposes, driving styles, and when they would like to surrender their driver's license. This study used the driving-style questionnaire (DSQ) developed by Akamatsu (2001), who has a long track record of research in Japan (Akatsuka, 2011). The survey consists of the following eight factors: DSQ1) Confidence in driving skills, DSQ2) Passiveness in driving, DSQ3) Tendency to drive impatiently, DSQ4) Tendency to drive meticulously, DSQ5) Driving while preparing for traffic signals in advance, DSQ6) Cars are a status symbol, DSQ7) Tendency to drive erratically, and DSQ8) Tendency to be anxious. The degree of applicability to each question was evaluated on a four-point scale (4: Very applicable to 1: Not applicable at all).

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5. Analysis results

5.1. Basic data analysis results

(1) Comparison of driving frequency by age

When comparing driving frequency between the self-driving group and the close relative's group, the proportion of both groups who drive 2-3 times a week was high (Table 1). Table 2 compares the usage scenarios of the driver's license. As both groups use the vehicle most frequently for daily life (shopping), elderly drivers tend to use the vehicle more within their living area, mainly in the neighborhood, and the close relative's group also tend to recognize this.

Table 1. Comparison of Driving frequency.

	the self-group			the close relatives' group		
	70～75 N=208	75～79 N=208	80 or more N=208	40～49 N=104	50～59 N=104	60～69 N=104
1 day or less per week	25%	22%	22%	18.3%	11.5%	8.7%
2-3 days per week	33%	37%	38%	34.6%	41.3%	30.8%
4-5 days per week	17%	18%	17%	19.2%	14.4%	19.2%
6-7 days per week	25%	24%	24%	17.3%	17.3%	22.1%
Unknown				10.6%	15.4%	19.2%
Total	100%	100%	100%	100%	100%	100%

Table 2. Comparison of Driving scenarios.

	the self-group			the close relatives' group		
	70～75 N=208	75～79 N=208	80 or more N=208	40～49 N=104	50～59 N=104	60～69 N=104
Commuting to work or school	6.3%	2.4%	1.4%	6.7%	6.7%	1.9%
Pick-up and drop-off	3.8%	4.8%	4.3%	9.6%	2.9%	5.8%
Medical visits	1.4%	3.4%	8.2%	12.5%	14.4%	12.5%
Work	2.4%	6.3%	2.4%	9.6%	8.7%	14.4%
Daily life (shopping)	74.5%	75.5%	71.6%	54.8%	55.8%	52.9%
Travel, leisure, and homecoming	11.1%	6.7%	10.1%	1.9%	2.9%	3.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(2) Timing of voluntary surrender of driver's license

Table 3 shows the timing of surrender of driver's license by age group. Although there was some variation in the driver group, it can be seen that the timing of voluntary surrender became shorter as the age increased.

Table 3. Comparison of voluntary surrender timing of driver's license.

	the self-group			the close relatives' group		
	70～75 N=208	75～79 N=208	80 or more N=208	40～49 N=104	50～59 N=104	60～69 N=104
Not considering it	43.8%	39.4%	30.3%	67.3%	77.9%	73.1%
Plan to return within 1 year	1.0%	1.4%	5.8%	2.9%	5.8%	11.5%
Plan to return within 3 years	4.3%	9.6%	14.9%	15.4%	6.7%	7.7%
Plan to return within 5 years	11.5%	20.7%	27.9%	8.7%	4.8%	5.8%
Plan to return within 10 years	26.9%	23.1%	16.3%	4.8%	3.8%	1.0%
Plan to return later	12.5%	5.8%	4.8%	1.0%	1.0%	1.0%

(3) Driving style

In the driving style scale, the higher the score, the stronger the tendency of the driving style (attitude, intention, and way of thinking toward driving) represented by that scale is interpreted as being.

Table 4. Comparison of driving style.

	the self-group			the close relatives' group		
	70～75 N=208	75～79 N=208	80 or more N=208	40～49 N=104	50～59 N=104	60～69 N=104
DSQ 1) Confidence in driving skills	3.02	3.08	3.13	3.12	2.94	3.12
DSQ 2) Passivity towards driving	2.14	2.19	2.26	2.37	2.65	2.52
DSQ 3) Tendency to drive hastily	2.37	2.34	2.32	2.64	2.76	2.66
DSQ 4) Tendency to drive meticulously	3.08	3.11	3.32	3.06	3.27	3.06
DSQ 5) Driving while preparing for traffic lights	2.13	2.12	2.26	2.70	3.00	2.68
DSQ 6) Cars as a status symbol	2.59	2.62	2.54	2.71	2.74	2.87
DSQ 7) Tendency to drive erratically	1.44	1.38	1.42	2.43	3.05	2.79
DSQ 8) Tendency to be anxious	2.14	2.03	2.13	2.84	3.02	2.80

(4) Purposes of driving by age group

Table 5 shows the results of a survey in which participants were asked to select from the following five multiple choice items regarding the purpose of driving a car. In both groups, 1 was the most common answer, followed by 5.

Table 5. Comparison of driving style.

	the self-group			the close relatives' group		
	70～75 N=208	75～79 N=208	80 or more N=208	40～49 N=104	50～59 N=104	60～69 N=104
Purpose1: Means of transportation	89.4%	82.2%	85.1%	81.7%	80.8%	82.7%
Purpose2: Maintaining independence	32.2%	39.9%	40.4%	35.6%	37.5%	38.5%
Purpose3: Maintaining a proactive attitude	23.6%	22.6%	22.1%	22.1%	14.4%	21.2%
Purpose4: Maintaining social connections	13.0%	13.5%	19.7%	17.3%	13.5%	18.3%
Purpose5: Maintaining daily life	52.9%	73.1%	68.3%	49.0%	50.0%	62.5%

5.2. Logistic regression analysis

From the responses regarding the planned time of license surrender, different trends were confirmed between the self-driving group and the close relative group. To analyze the factors influencing license surrender, driving frequency, driving purposes1 to 5, and eight driving style factors were analyzed using the stepwise method of logistic regression analysis, with the independent variables being the intention to surrender the driver's license and the dependent variable being the presence or absence of the intention to surrender the driver's license. The analysis results showed that driving frequency had an influence regardless of whether the person was the self-driving group or the close relative group, and for the self-driving group, DSQ2: Passivity toward driving, DSQ3: Tendency to drive impatient, and driving purpose (whether driving purpose is considered as purposes1 a means of transportation) influenced the consideration of license surrender. The correct answer rate for the self-driving group model was 62.0%, and the correct answer rate for the close relative group model was 61.5%.

6. Discussion

This study investigated the characteristics of various drivers in order to develop an adaptive feedback method that applies the concept of risk communication. It was hypothesized that feedback would be effective based on the gap between the elderly driver's own perception and that of the elderly driver as seen by their close relatives. Analysis demonstrated that while the two groups shared the same views on driving frequency and usage scenarios, the triggers for recognizing unsafe behavior were different. The theoretical implications of this study are as follows:

1. A high proportion of participants cited "maintaining independence" and "maintaining daily life," which are the top objectives in Keskinen's (1996) four-tier model, as their driving purpose. It is necessary to consider that driving purposes are triggers for safe driving.

2. When returning a driver's license, the driver's perception of their own driving style has an influence. More specifically, DSQ2: Passivity toward driving and DSQ3: Tendency to drive impatient may have an influence.

3. Although the elderly drivers and their relatives had similar views on driving behavior, their perceptions differed regarding license surrender, and the elderly drivers may have made decisions that took their own driving style into account more than their relatives.

4. Feedback on driving style based on a combination of self-diagnosis and the index may change the drivers' perception of their own driving style.

Based on the analysis results, this study conducted safety education (2.5 hours) for 27 drivers aged 75 years or older. In interviews after the training, many participants pointed out the effectiveness of interacting with others, and a certain degree of effectiveness was confirmed.

7. Conclusions

In Japan, the ageing of driver's license holders is progressing, and safe driving education suited to a super-aging society is required. Drivers have misconceptions about driving, habits that have become habitual through driving experience, and unconscious behaviors that belong to psychomotor skills.

This study investigated the driving behavior of elderly drivers and people who have elderly drivers in their close circle. The results showed that there is a difference in the time when elderly drivers themselves and their close relatives consider returning their licenses. Not only receiving objective feedback on their driving style through training, but also receiving feedback from people who have elderly drivers in their close circle based on their driving purpose, may deepen awareness of their own driving style and lead to improved safe driving behavior.

8. Limitations and recommendations

This study examined how to develop an adaptive feedback method in safety education. The data used in this study was limited to a small number of subjects, which is a future challenge. In addition, the effectiveness of adaptive feedback based on this survey has not been verified. It is also necessary to consider what kind of safety education and when feedback using the risk communication concept examined in this study should be provided. In addition, from the perspective of effectiveness, the study plans to verify whether it is sustainable.

In order to improve the accuracy of the logistic regression analysis, it is necessary to add data on regional characteristics that have not been used so far and change the explanatory variables. The data used in this study does not take into account regional characteristics in Japan, and does not take into account environmental factors such as proximity to public transportation.

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