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Relation between Driver Features and Safe Driving

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Abstract*— Although the number of occurrences of traffic accidents in Japan has declined, the rate of decrease in incidence has been decreasing in recent years. In response, various traffic safety measures have been implemented in Japan, but no significant change in the trend of fatalities from driving accidents has yet been reported. Consideration of more useful traffic safety measures requires elucidation of the experience and career of drivers who have dangerous driving awareness. The first goal of this research is to ascertain drivers' danger awareness. The second goal is to use a psychological scale to clarify driving consciousness tendencies and to clarify how personal attributes, experience, and background affect driving.

***Index Terms*— Driver, Driver features, Driving awareness, Social capital.**

I. BACKGROUND

Although the number of traffic accidents occurring in Japan has declined continuously, many traffic accidents still occur. Moreover, trends of the number of fatalities by prefecture shows that the rate of decrease in the number of deaths while riding in automobiles is also flat. [1] This fact demonstrates that traffic safety measures for automobiles are necessary. In response, various traffic safety measures are being implemented in Japan. As measures against traffic accidents on arterial roads, road improvement and speed regulation of accident dangerous areas are cited. Moreover, zoning 30, colored pavement, hump and ballad have been reported as traffic safety measures on residential streets. [2] In addition, because of the development of automobile technology, the introduction of automatic brake systems is progressing. However, no great change has occurred in the trend of the number of automobile deaths. Earlier studies of automobile speed control [3] present the possibility that the maximum speed of an automobile can be reduced by recognition of zone 30. Moreover, based on probe data elucidating the relation between speed and street and roadside characteristics, studies have demonstrated the possibility of narrowing street widths to reduce vehicle speeds. [4] Earlier studies that specifically examined driver consciousness related to automobile speed limits underscore the importance of each driver's regulatory speed: the driver consciousness plays a large role in speed regulation. [5] One study analyzed the speed consciousness of a driver using color pavement on a residential street. [6] Nevertheless, no reported study has clarified differences in safety consciousness beyond the driver's consciousness, including also the driver's experience and personal characteristics. Considering more useful traffic safety measures, it is important to assess the experience and careers of drivers who are driving dangerously.

The purpose of this research is to ascertain the driver's awareness about driving. Specifically examining the conscious tendencies of safe driving of automobiles, we use a psychological scale to clarify how personal attributes, experience and background affect the driving of cars.

II. METHODS

For this study, we conducted a web survey covering all of Japan. Because we requested a survey distribution to the surveillance monitor, the investigation period was short. We set the number of desired responses to 500. The composition ratio by age reflects Japan's national distribution of driver license holders. To assess tendencies of driving consciousness accurately, 338 samples were taken for analyses, excluding those who answered that they "almost never drive a car." Subjects of this study were men and women in their 20s to 50s. Those over 60 were not subject to consideration of factors because of age. Main research items were awareness of driving, driving experience, driving history, personal attributes.

III. MEASURES

A. Outline of driver survey

All the items that explain the drivers' background were used to test for differences in the sex, age, career, family composition, driving age, frequency, average driving distance, self-reported driving skills. The percentage of each items are shown on table 2.

B. Trends of danger awareness and driving consciousness

Table 1: Survey outline

Survey date	7-Apr-17
Target respondents	20–59-year-old drivers
Survey method	Questionnaire survey
Distribution method	Web research
Number of distributed questionnaires	544
Number of analyzed questionnaires	338
Main questionnaire contents	Awareness, Experience, Career about driving, Personal attributes

As explained in this chapter, after ascertaining the

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tendency of driving consciousness of driving, we classify individuals according to their driving consciousness tendencies using factor analysis and cluster analysis.

1. *Consciousness survey results for behaviors during driving*

Figure 1 presents a summary of the consciousness survey results on behaviors during driving. More than 40% of respondents answered "true" to "I always stop, pausing without fail." Specifically, "true / somewhat true" were more than 80% of responses for items such as "I maintain stable driving." and "I try not to brake suddenly except in an emergency." However, results show that 50% of respondents reported as "true / somewhat true" that "I always regulate my speed." "I always stop when the signal is yellow." and "I remember all the meanings of road signs."

2. *Typing of individuals by driving consciousness tendencies*

Factor analysis was conducted to assess the tendency of awareness of safe driving of cars and ascertain the structure from question items related to usual driving. Table 3 presents question items related to usual driving of cars and results of factor analysis. We selected factors for which characteristic values were 1 or more. In addition, as for the question item "I always stop when the signal is yellow", since the scores of each factor were the same level, analysis was carried out omitting the question item.

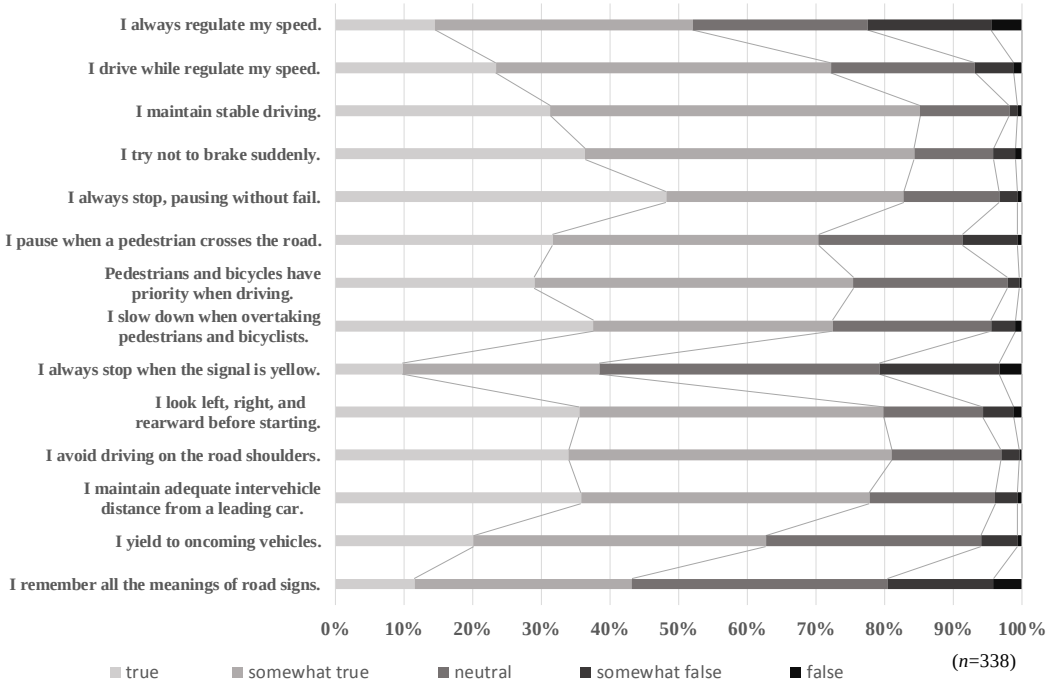

Fig 1: Consciousness survey results on behaviors during driving

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The first factor is the "conscious of all aspects axis" because pedestrians, bicycles, cars, and street conditions and speed items have high factor loading. As a factor 2, devoting attention to the speed and maintaining stable running, was taken as the "conscious of speed axis." Because the third factor is devoting attention to pedestrians and bicycles, it is the "conscious of pedestrian / bicycle axis."

Using the factor scores of the first to third factors obtained using the items related to operation as shown in Table 3, cluster analysis was conducted to classify individuals. We used the Ward method for hierarchical clustering and the squared Euclidean distance between groups. We classified individuals into four clusters.

The mean values and characteristics of factor scores of each cluster are presented in Table 4. Table 4 in the first cluster shows that the average value of all factor scores is high. It is a group that is "conscious of safe driving type." In the second cluster, because the average factor scores of the conscious of speed axis are high, it is the "conscious of speed type." In the third cluster, unlike the second one, we are conscious of pedestrians and bicycles, not speed, so it is named "conscious of pedestrian / bike type." In the fourth cluster because the average value of all factor scores is low, it was set as "dangerous driving type."

Table 2: Outline of driver survey

Driver demographics Variable	Level/value	Percentage (%)
gender	male	59.1
	female	40.9
age	young (20–30)	37.6
	elderly (40–50)	62.4
career	officer/government officer	53.2
	self-employed works	10.7
	part-time workers	11.2
driving distance (one-year average)	less than 500	
	more than 5001 km	

Table 3: Factor analysis result of driving tendency

Survey item	First factor conscious of all aspects axis	Second factor conscious of speed axis	Third factor conscious of pedestrian / bicycle axis
I always regulate my speed.	0.4474	0.2322	-0.0508
I drive while constantly checking the speed.	-0.0401	1.0263	-0.0258
I maintain stable driving.	0.2721	0.3904	0.1584
I try not to brake suddenly.	0.1643	0.3006	0.0935
I pause when a pedestrian crosses the road.	0.3382	0.0411	0.4427
Pedestrians and bicycles have priority when driving.	-0.0012	0.0077	0.9979
I slow down when overtaking pedestrians and bicyclists.	0.5131	0.0754	0.246
I always stop when the signal is yellow.	0.43	0.1037	0.0959
I look left, right, and rearward before starting.	0.5311	0.152	0.0052
I avoid driving on the road shoulders.	0.5102	0.0161	0.181
I maintain adequate intervehicle distance froma leading car.	0.8245	-0.0372	-0.0314
I yield to oncoming vehicles.	0.5806	0.0416	0.1813
I remember all the meanings of road signs.	0.2913	-0.0153	0.1283
Characteristic value	3.4807	1.485	1.4568
Contribution rate	26.77%	11.42%	11.21%
Cumulative contribution rate	26.77%	38.20%	49.40%

Table 4: Driving tendency Factors by cluster Factor average value

Factor			No. 1	No. 2	No. 3
Cluster name		*n*	conscious of all aspects axis	conscious of speed axis	conscious of pedestrian / bicycle axis
1	conscious of safe driving type	81	0.997	0.815	1.247
2	conscious of speed type	119	-0.051	0.38	-0.019
3	conscious of pedestrian / bike type	55	-0.148	-1.319	0.356
4	dangerous driving type	83	-0.782	-0.466	-1.426

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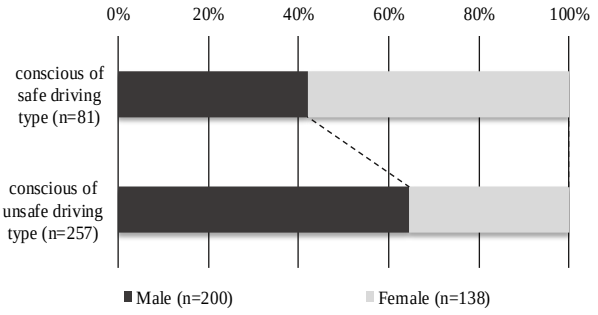
3. Relation between driving trends, driving experience, personal attributes

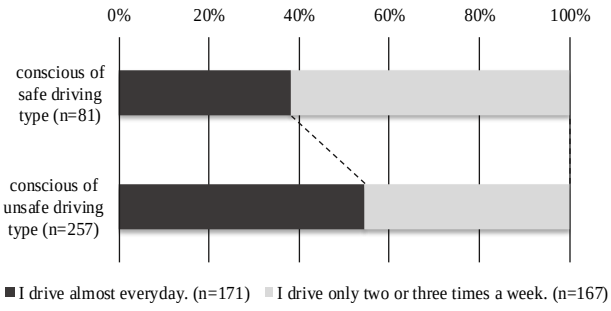
This survey assesses details not only awareness of driving of cars, but also driving experience, driving history, and personal attributes. From here, we ascertain the relation between those questions and driving trends. To analyze people with awareness of safe driving, we compare the two groups of "conscious of safe driving type" and "conscious of unsafe driving type" which summarizes the other three clusters. Figure 2 depicts the relation between sex and driving tendencies. For the test of independence, the two-sided P value was 0.0000, indicating a significant difference. Results of residual analyses demonstrate that women are more likely to drive more safely than men do.



Independence test ($\chi 2 = 12.1202$; P = 0.0000)

Fig 2: Relation between sex and tendency of driving consciousness

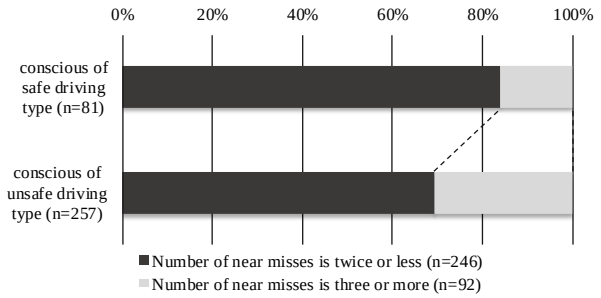
Next, the relation between driving frequency and driving tendency is depicted in Fig. 3. For the test of independence, the two-sided *P* value was 0.0157, indicating a significant difference. Results of residual analyses showed that people with driving frequency of 2–3 times per week are more likely to drive more safely than people who drive almost every day.



Independence test ($\chi 2 = 5.8367$; $P = 0.0157$)

Fig 3: Relation between driving frequency and tendency of driving consciousness

Next, the relation between the number of near misses within one year and the driving trend is portrayed in Fig. 4. For the test of independence, the two-sided *P* value was 0.0144, indicating a significant difference. The results of residual analysis show that people with fewer near misses show a stronger tendency for safe driving.



Independence test ($\chi 2 = 5.9878$; $P = 0.0144$)

Fig 4: Relation between near misses and tendency of driving consciousness

Finally, Fig. 5 portrays the relation between the presence or absence of attention to driving from a passenger within a year and driving tendencies. Tests of independence yielded a two-sided *P* value of 0.0377, indicating a significant difference. Few people responded that they "received a warning," but results of residual analysis showed that those who reported that they "received a warning" tended to be less conscious of safe driving.

4. Relation between trend of driving consciousness and social capital

Table 5: SC factor analysis result

Survey item	First factor	Second factor	Third factor
	trust axis	social participation axis	communication axis
I have friends and relatives in the area.	0.3476	-0.0319	0.075
I will greet neighbors and local residents.	0.515	-0.1184	0.1868
I am interested in the history and culture of the area.	0.6121	0.0619	-0.0131
I trust local administrators.	0.6705	0.0771	0.0091
I trust local residents.	0.8253	0.0609	-0.0229
I am satisfied with my life in this area.	0.7173	-0.0277	-0.0474
I participate in community cleanup activities.	0.0474	0.0834	0.9313
I participate in local volunteer activities.	-0.0197	0.9717	0.9313
Characteristic value	2.0271	0.6539	1.8616
Contribution rate	25.34%	8.17%	23.27%
Cumulative contribution rate	25.34%	33.51%	56.78%

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In this survey, social capital (SC) is used to evaluate social connections, trust relations based on social connections, and social activities. To understand the SC structure of the respondent, factor analysis was conducted. The investigation items of the SC and the results of the factor analysis are presented in Table 5. Factors were selected so that the cumulative contribution rate was 50% or more. The first factor is an item related to trust. Because it has a high factor loading amount, it was set as the "trust axis."

The second factor is "social participation" because items for the "social participation axis" are particularly high. The third factor is "communication axis" because the item "participate in local cleanup activities" is particularly high.

Subsequently, using the factor scores of the first to third factors obtained using the SC factor analysis result shown in Table 5, cluster analysis was performed to classify individuals. We used the Ward method for hierarchical clustering and the squared Euclidean distance between groups. We classified individuals into four clusters.

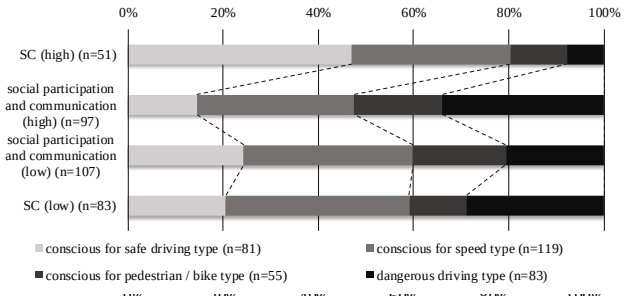
Average values and the characteristics of the factor scores of each cluster are presented in Table 6. From Table 6 in the first cluster, the average value of all factor scores is high, so SC is high. The second cluster named "social participation and communication (high)" because the factor score average of social participation axis / communication axis is high. The third cluster is named "social participation and communication (low)." The fourth cluster was "SC (low)" because the average values of all factor scores are low.

Next, the relation between the driving tendency clustering result and the SC is shown in Fig. 6. For the test of independence, the two-sided *P* value was 0.0000, indicating a significant difference. As depicted in Fig. 6, the ratio of safe driving tendency was high in the group with high SC. The ratio of dangerous driving tendency was high in the group with low SC. Results of the test for independence between clusters are shown on the right side of Fig. 6. This fact clarifies a significant difference between people with SC (high) and other clusters. No significant difference was found between the other clusters.

The analysis below shows that SC is significantly different between the "SC (high)" cluster and other clusters. Therefore, "social participation and communication (high)", "social participation and communication (low)" and "SC (low)" are combined as "SC (low)" and are classified into two categories of "SC (high)" and "SC (low)."

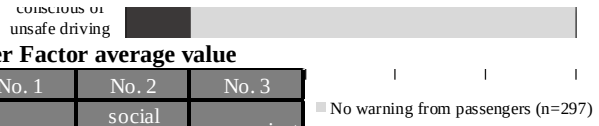
IV. DISCUSSION

This section explains factors affecting driving consciousness tendencies. Specifically, personal attributes,



Independence test ($\chi 2$ =29.1813; *P* =0.0000)

Fig 6: Relation between SC and tendency of driving consciousness.



test ($\chi 2$ =4.3202; *P* =0.0377)

…nce or absence of warning from passengers and tendency of driving consciousness

Table 6: SC Factors by cluster Factor average value

Factor			No. 1	No. 2	No. 3
	Cluster name	*n*	trust axis	social participation axis	communication axis
1	SC (high)	51	0.835	0.644	1.590
2	social participation and communication (high)	97	0.202	1.017	0.396
3	social participation and communication (low)	107	0.157	-0.523	-0.306
4	SC (low)	83	-0.951	-0.909	-1.052

Table 7: Dummy variable of each explanatory variable

Items	Categories
Sex	1. Female dummy
	0. Male dummy
Driving frequency	1. I drive only two or three times a week.
	0. I drive almost everyday.
Near misses	1. Number of near misses is twice or less.
	0. Number of near misses is three or more.
Presence or absence of warning from passengers	1. No warning from passengers
	0. Warning from passengers
Social Capital	1. Social Capital (high)
	0. Others

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Table 8: Binomial logistics regression model for driving tendency consciousness

		partial regressionc oefficient	odds ratio	*P* value	
Independent variable	Female dummy	0.8999	2.4593	0.001	***
	Dummy driving less than 2–3 times/ week	0.6813	1.9764	0.0167	**
	Dummy fewer than 2 near misses per year	0.5786	1.7835	0.0997	*
	Dummy with no warning from fellow passengers within one year	0.9836	2.674	0.0795	*
	SC (high) dummy	1.3138	3.7202	0	***
Constant term		-3.5273	0.0294	0	***
Coefficient of determination		Cox–Snell	Nagelkerke	McFadden	
		0.1199	0.1796	0.116	
Significance of regression expression		*P* value=0.0000			
Percentage of correct classifications		77.51%			

*: $P<0.10$ **: $P<0.05$ ***: $P<0.01$

experience, and personal history are related to driving. Personal attributes, and SC were used as explanatory variables for binomial logistic regression analysis performed using "conscious of safe driving type" and "non-conscious of safe driving type" as objective variables, grouped based on driving tendency consciousness typified in section 3.

Table 7 shows that we converted each explanatory variable to a dummy variable. Table 8 presents factor analysis results of the driving tendencies.

Five factors exhibit particularly strong influence: "conscious of safe driving type", "female dummy", "dummy fewer than 2–3 times a week driving", "dummy fewer than two near misses per year", "dummy with no warning from fellow passengers within one year" and "SC (high) dummy". From the odds ratio, the value of "SC (high) dummy" is inferred as the highest, social connections are strong. The next highest odds ratio is "dummy with no warning from fellow passengers within one year". Those who have built up a trust relation based on it have shown that the tendency of safe driving is strong. From the P value, "female dummy" and "SC high dummy" were below P <0.001, indicating that safe driving awareness is strongly affected. Subsequently, the P value of "dummy fewer than 2–3 times a week driving" is low, indicating P=0.0167. From this value, people with relatively low driving frequency tend to keep safe driving. Regarding "dummy fewer than two near misses per year" and "dummy with no warning from fellow passengers within one year" the P value shows 0.10 or less, and near misses people who had fewer events and who did not receive warning from fellow passengers were found to have a strong safe driving tendency.

The P value of the constant term is 0.0000. Correct classifications were 77.51%.

V.CONCLUSION

This research specifically examined the driving tendencies of automobiles, and clarified the individual attributes, experience, and career related to driving of cars, and how SC and others influence it. Variations among items were found in the answer "true / somewhat true" from the aggregation result on various behaviors during driving. Classification according to the tendency of driving consciousness revealed clusters showing tendencies of four driving consciousnesses: "conscious of safe driving type", "conscious of speed type", "conscious of pedestrian / bike type" and "dangerous driving type". Because factors were analyzed into two groups of "safe driving tendency" and "non-safe driving tendency" the trend of safe driving consciousness includes "female dummy", "dummy driving less than 2–3 times a week", "dummy fewer than two near misses per year", "dummy with no warning from fellow passengers within one year" and "SC (high) dummy" was clarified.

A future task is to classify dangerous driving, such as driving over speed limits and lane changes without instruction, to examine the relation with "tendency of driving consciousness" clusters. Furthermore, "smartphone use while driving" must be assessed to analyze its relationship with the "tendency of driving consciousness" cluster.

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