

# Recognition of Driving Behavior Toward Electrically

## Powered Scooters Among Young Drivers

—Relationship Between Young Drivers' Perceptions, Experiences,  
and Stress in Passing Situations—

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### I. Introduction

Electrically powered scooters are available as a means of migration of elderly people and people with disabilities. According to the Road Traffic Act, electrically powered wheelchairs are classified as wheelchairs for persons with physical disabilities and are regarded as pedestrians. Electrically powered scooters have become widespread not only among older adults with walking difficulties but also as an alternative mode of transportation for those who have returned their driver's licenses. At the same time, numerous reports have raised concerns regarding safety issues. Among products designed to support the physical functions of older adults, such as nursing beds, handrails, and wheelchairs, electrically powered wheelchairs and nursing beds are associated with particularly high rates of severe and fatal accidents. According to News Release published from National Institute of Technology and Evaluation in August, 2023, the number of deaths caused by accidents of electric wheelchairs was 6 as of July, 2023. Since this number exceeds the those in the same months of the past 10 years, concerns are growing. Improvement in users' maneuvering skills and symbiosis with other

traffics would be important for safe use of an electrically powered scooter.

Among the accidents of electrically powered scooters, contact with automobile has high risk for heavy damage (Miyata, Onimoto, Suzuki, Oga, Sakurai, Sugimachi & Maki, 2021). Safe driving requires not only personal characteristics and driving skills but also the way in which drivers perceive and respond to their traffic environment (Masuda & Haga, 2009). The environments in open roads are classified into road traffic environment, meaning traffic environment and interpersonal traffic environment. The interpersonal traffic environment indicates dynamic state with bicycles and pedestrians, oncoming car and so on (Nagayama, 1975). A precedent study that focused on the interpersonal traffic environment has clarified that drivers feel highest stress when pedestrians are elderly people (Uno & Hashimoto, 2017). Elevated driving stress has been shown to increase the number of traffic accidents (Maeda, Kanamori, Yamamoto & Morikawa, 2017). Further, Tokuda (2014) has clarified that drivers, when passing vulnerable road users, pay attention to speed and interval unlike when passing normal pedestrians, while their driving behaviors

differ depending on the attributes of pedestrian. One factor that contributes to unsafe driving among young drivers is non-cooperativeness. Compared with other age groups, young drivers are more likely to view pedestrians and cyclists as obstructions and to exhibit behaviors such as closing in on them (Japan safe driving center, 1988). Since the level of stress experienced when passing pedestrians differs depending on pedestrian attributes, and Since driving attitudes vary by driver age, both driver and pedestrian attributes should be considered when examining driving behavior. Inexperienced drivers have low recognition for dangerous states and overconfidence for their driving technique as their characteristic (Higuchi, 2011). Moreover, a survey on relationship between accident risks and age/driving experience of British drivers has revealed that age and experience influence accident risks and age is related to such risks in particular (Maycock, Lockwood & Lester, 1991). Given that young drivers, who typically have limited driving experience, are at a higher risk of accidents, it is necessary to provide early education on the understanding of electrically powered scooters. Accordingly, the present study aimed to clarify how young drivers with fewer than five years of driving experience perceive electrically powered scooters on residential roads, and to examine the degree of stress they experience when passing them. Furthermore, this study sought to identify which perceptions and experiences among young drivers are associated with stress in these passing situations.

The results will be basic material to realize safe move of electrically powered scooter users and drivers and allow them to live

together while they recognize each other. Further, it would allow us to organize how the drivers need to understand electrically powered scooter and expected responses as specific driving behaviors.

## II. Method

### 1. Subjects

An anonymous self-administered questionnaire survey was conducted for general drivers who acquired their driving licence within the past 5 years and were living in the Kanto district of Saitama, Ibaraki, Tokyo, Chiba, Tochigi and Kanagawa (hereinafter called "driver(s)"). Answers were obtained from 100 subjects (collection ratio: 85.1%). Seven subjects were excluded for deficiency in their answers and therefore 93 subjects were employed for the analysis.

### 2. Survey procedure

The students in University A were requested to take our questionnaire survey by document or notification. The questionnaire papers were distributed to the students who agreed with participation in the study. Their answers were collected by the leave-and-pick-up questionnaire method. The survey period was from May, 2022 to December.

### 3. Survey items

The survey items were five items related to subjects' attributes (age, residence, presence of elderly people living together, time since acquiring driving licence, driving frequency), " Presence of electrically powered scooter users within the family and frequency of encountering electrically powered scooters ", "Degrees of the stress when passing an electrically powered scooter", "What the driver feels when passing an electrically powered scooter" and "What the driver want

the electrically powered scooter user to be conscious of". For "Degrees of the stress when passing an electrically powered scooter", the subjects were asked to watch 7-second video of an actual scene of passing them before answering the question. The video was shot with video camera (SONYHDR-AS300) set at a driver's eye level. The study was conducted on residential roads with a roadway width of 4 m, no central solid line, white side lines 0.15 m wide, and 0.75 m shoulders on both sides. Two scenarios were recorded: an oncoming situation in which the electrically powered scooter approached from the opposite direction, and an overtaking situation in which the scooter traveled in the same direction as the car (Fig 1). The scooter (Suzuki Seniorcar ET4D9, body width 650 mm) was positioned such that only its roadway-side wheel extended beyond the side line. Cars traveled at 30 km/h, in accordance with regulations, while the electrically powered scooter traveled at 4 km/h, as recommended in the user manual for narrow,

flat roads. Participants viewed the videos using QR codes attached to the questionnaire, or, if necessary, using playback devices provided by the researchers. Each video was viewed only once.

#### 4. Ethical consideration

The purpose of the study, voluntary participation, protection from disadvantages, and anonymity were explained to participants both orally and in writing. Those who agreed to participate indicated their consent by checking the designated box in the questionnaire. This study was conducted upon approval by the Medical Study Ethical Review Board of Mejiro University (Approval No. 22 -001).

### III. Results and considerations

#### 1. Subjects' attributes

Table 1 shows attributes of the subjects. Their age was 20.25 years old (SD1.17). A total of 75 subjects had had their driver's license within the past 5 years, accounting for 80% of the subjects. All subjects answered

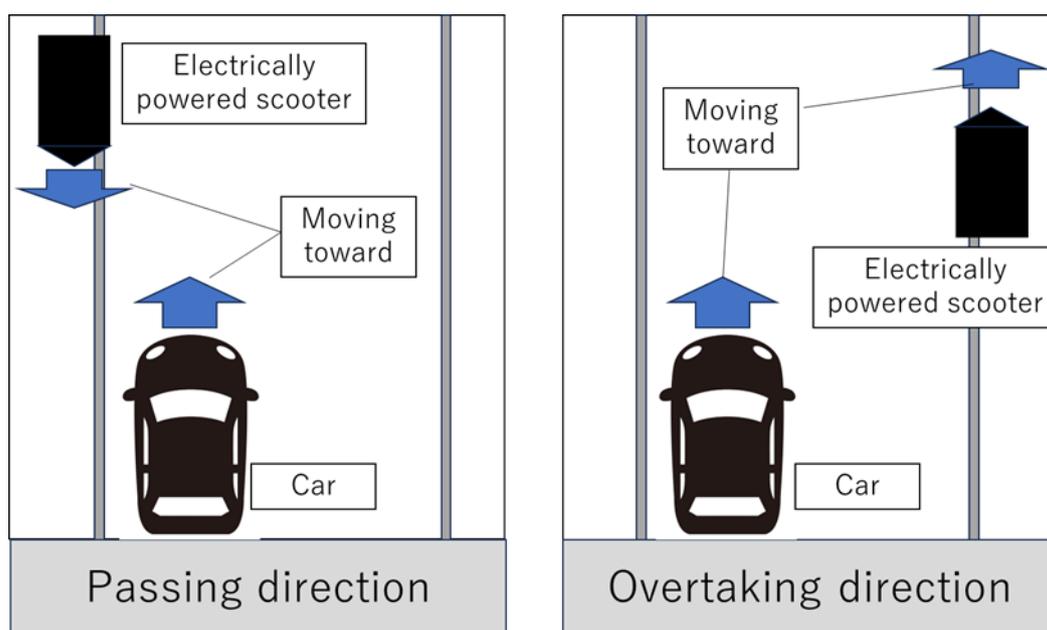


Fig.1. Passing situations between an electrically powered scooter and an automobile

Table1. Subjects' attributes

Age (average)		20.25 ( <i>SD</i> 1.17)
Residence	Saitama	66% (61)
	Tokyo	10% ( 9)
	Ibaraki	8% ( 7)
	Chiba	7% ( 7)
	Tochigi	7% ( 7)
	Kanagawa	2% ( 2)
Presence of elderly persons living together	Living together	24% (22)
	Living together in the past	16% (15)
	Never lived together	57% (53)
	Not answered	3% ( 3)
Time since acquiring driving licence	Less than 1 year	39% (37)
	1-2 years	17% (16)
	2-3 years	24% (22)
	3-4 years	9% ( 8)
	4-5 years	9% ( 8)
	5-6 years	2% ( 2)
Driving frequency	Every day	19% (18)
	Every other day	8% ( 7)
	Around once a week	27% (25)
	Around once a month	15% (14)
	Rarely drive	25% (23)
	Not answered	6% ( 6)
Frequency of encountering electrically powered scooters	Every day	0% ( 0)
	Around once a week	13% (12)
	Around once a month	19% (18)
	Around once a year	28% (26)
	Rarely	32% (30)
	Not answered	8% ( 7)

Population parameter of % is 93

that none of their family members were using electrically powered scooters.

## 2. Stress that drivers feel when passing an electrically powered scooter

We asked the drivers to watch the above mentioned video and rate degrees of stress they felt by 5-point Likert scale for the range

from "Extremely stressful (5pts.)" to "Not stressful at all (1pt.)", and their average scores were obtained. The degree of stress in the scene that the driver passes the electrically powered scooter moving toward them (hereinafter called passing direction) was 4.09 (SD 0.83), while that in the scene

that the driver overtakes the electrically powered scooter moving in the same direction (hereinafter called overtaking direction) was 2.43 (SD 1.16).

**3 . What the driver feels when passing an electrically powered scooter**

The subjects were asked for "What the driver feels when passing an electrically powered scooter" in the form of selection expression (Table 2). The result revealed that 41 (44%), which is the highest, answered "Straying onto roadway so it is dangerous", 36 (39%) answered "Don't know how they're gonna move" as the second highest, 23 (25%) answered "Difficult to pass them because it is large" and 24 (26%) answered "I don't know because I never pass them"

**4 . Relationship between what the driver feels when passing and electrically powered scooter and stress**

For "What the driver feels when passing an electrically powered scooter", Mann-Whitney U test was performed for the relationship between "What the driver feels when passing an electrically powered scooter" except "I don't know because I never pass them" and the degrees of stress in the passing or overtaking directions (Table 3). The result revealed that significant difference was seen between the presence of the answer "Easy to

avoid them because they move slowly" and the degrees of stress in the passing direction. The above result suggests that those who answered "Easy to avoid them because they move slowly" felt less stress in the passing direction.

**5 . Differences in Stress While Passing According to Young Drivers' Experiences**

To examine whether young drivers' experiences influenced stress in passing situations, Mann–Whitney U tests were conducted, comparing stress levels according to cohabitation with older adults, driving experience, and experience encountering electrically powered scooters (Table 4). Participants with less than one year of driving experience and who drove about once a month, as well as those who reported having “almost no” driving experience, were categorized as having no post-licensing driving experience. All others were categorized as having driving experience.

Similarly, those who reported “almost never” encountering electrically powered scooters were categorized as having no encounter experience, and all others as having encounter experience. No significant differences were observed in stress levels according to these experiences.

Table2. What the driver feels when passing an electrically powered scooter (Multiple answers)

Straying onto roadway so it is dangerous	44% (41)
Don't know how they're gonna move	39% (36)
I don't know because I never pass them	26% (24)
Difficult to pass them because it is large	25% ( 2)
Easy to avoid them because they move slowly	19% (18)

Population parameter of % is 86 with no answers excluded

Table3. Relationship between the presence of "What the driver feels when passing an electrically powered scooter" and stress

	Stress in passing direction					Stress in overtaking direction						
	<i>N</i>	Average	Standard deviation	Median	IQR	<i>P</i> value	Average	Standard deviation	Median	IQR	<i>P</i> value	
Straying onto roadway so it is dangerous	Answered	41	4.15	0.73	4.00	4.00-	0.72	2.41	1.20	2.00	1.50-	0.60
	group				5.00						3.50	
Don't know how they're gonna move	No answered	45	4.02	0.94	4.00	3.50-	2.51	1.12	2.00	2.00-	3.00	
	group				5.00							
Difficult to pass them because it is large	Answered	36	4.28	0.56	4.00	4.00-	0.12	2.67	1.22	2.50	2.00-	0.19
	group				5.00						4.00	
Easy to avoid them because	No answered	50	3.94	0.94	4.00	3.00-	2.32	1.10	2.00	1.00-	3.00	
	group				5.00							
they move slowly	Answered	23	4.35	0.65	4.00	4.00-	0.10	2.61	1.17	2.00	2.00-	0.43
	group				5.00						4.00	
Easy to avoid them because they move slowly	No answered	63	3.98	0.89	4.00	4.00-	2.41	1.17	2.00	1.00-	3.00	
	group				5.00							
Easy to avoid them because they move slowly	Answered	18	3.72	0.90	4.00	3.00-	0.04*	2.39	1.29	2.00	1.00-	0.63
	group				4.00						3.00	
they move slowly	No answered	68	4.18	0.81	4.00	4.00-	2.49	1.13	2.00	2.00-	3.75	
	group				5.00							

\* :  $p < 0.05$  IQR : Interquartile range

Table4. Differences in stress while passing according to young drivers' experiences

	Stress in passing direction					Stress in overtaking direction							
	<i>N</i>	Average	Standard deviation	Median	IQR	<i>P</i> value	Average	Standard deviation	Median	IQR	<i>P</i> value		
Presence of elderly persons living together	Experienced group	37	4.22	0.82	4.00	4.00-	4.00	0.14	2.51	1.22	2.00	1.00-	0.61
	Inexperienced group	53	3.96	0.83	4.00	4.00-	4.00	0.14	2.38	1.11	2.00	2.00-	4.00
Driving experience	Experienced group	56	4.18	0.79	4.00	4.00-	4.00	0.18	2.54	1.19	2.00	2.00-	0.33
	Inexperienced group	31	3.94	0.85	4.00	3.00-	4.00	0.13	2.26	1.06	2.00	1.00-	3.75
Experience encountering electrically powered scooters	Experienced group	56	4.20	0.77	4.00	4.00-	4.00	0.13	2.46	1.16	2.00	2.00-	0.95
	Inexperienced group	30	3.87	0.94	4.00	3.75-	4.00	0.13	2.47	1.17	2.00	1.00-	3.00

\* :  $p < 0.05$  IQR : Interquartile range

Table 5. What the driver want the electrically powered scooter user to be conscious of" (multiple answers)

I want them to run on the side of the road as much as possible	75% (70)
I don't want them to look the other way	62% (58)
I want them to avoid crossing roads except pedestrian crossing	61% (57)
I want them to use blinkers	58% (54)
I want them to confirm the back as much as possible	43% (40)
I want them to stop when passing each other	19% (18)

The population parameter of % is 91 except those who did not answer

**6 . What the driver want the electrically powered scooter user to be conscious of**

For the question "What the driver want the electrically powered scooter user to be conscious of", 70 subjects (75%), which was the highest percentage, answered "I want them to run on the side of the road as much as possible" (Table 5).

**IV. Discussion**

The authors asked young drivers who acquired their driving licence within the past 5 years to watch the scene of passing an electrically powered scooter, and measured their degrees of stress. The degree of stress in the scene that the driver passes the electrically powered scooter moving toward them (hereinafter called passing direction) was 4.09 (SD 0.83), while that in the scene that the driver overtakes the electrically powered scooter moving in the same direction (hereinafter called overtaking direction) was 2.43 (SD 1.16).

As stated in the enforcement regulations Chapter 1-Article 1 of the Road Traffic Act, the electrically powered scooter is defined as wheelchair to be used by a pedestrian. Therefore, an electrically powered scooter is to run on the right side of roads, same as

pedestrians. When a driver passes an electrically powered scooter in the passing direction, the driver passes them moving toward the driver on the right side of the car. Uno & Hashimoto (2017) have indicated that stress felt by a driver is higher when a pedestrian is on the right side than when they are on the left side. Although oncoming situations allow drivers to observe the facial expressions and conditions of scooter users, the closer distance between the scooter and the car may induce stress for drivers. Future research should equalize the distance between car and scooter to clarify stress differences between passing directions and to identify factors beyond distance.

The rate of the drivers who answered "Straying onto roadway so it is dangerous" for the case that the driver passes an electrically powered scooter was highest. Further, for the question "What the driver want the electrically powered scooter user to be conscious of", 70 subjects (75%), which was the highest rate, answered "I want them to run on the side of the road as much as possible". Victoria, Fany, Roby & Sarit (2016) has pointed out straying onto roadway as an issue, and therefore this should be improved so other people can move safely. On the other

hand, it has also been reported that electrically powered scooter users have no choice but to take car automobile roads because sufficient space in which they can run safely has not been secured (Yongho, Won, Hee, Sung, Tae, Min, Lk Joon & Taerim, 2020). Most of the subject drivers in this study acquired their driving licence within the past 5 years and were young. This device is for the elderly or people with disabilities and therefore it is not a familiar device for youth. Therefore, it is possible that they did not recognize the device. As society continues to age, the number of electrically powered scooter users is expected to increase. It is therefore important to educate young drivers about the existence of such mobility support devices, the rules governing their use, and their operational characteristics. Specifically, they should understand that the relatively large width of scooters often causes them to extend beyond lane markings, and that scooter users tend to select flatter routes to avoid tipping risks on sloped drainage paths. By recognizing objectively that shorter passing distances may lead to increased stress, young drivers can make calmer decisions and adopt safer strategies, such as stopping until sufficient clearance is secured.

Understanding on electrically powered scooters user will be improved by giving opportunities for the youth to know the present situation of the usage of electrically powered scooters at driving schools or events, we believe. Future efforts should also consider incorporating real driving experiences into educational methods.

Degrees of stress of those who answered "Easy to avoid them because they move slowly" when passing each other in passing

direction was low then who not answered. The videos of the electrically powered scooter traveling at 4 km/h were used in this study. Therefore, it is possible that the respondents may have perceived that the electrically powered scooter was traveling slower than the normal traveling speed of it. The normal walking standard for 18 to 64 year old on a level ground is 4.02 km/h, while the maximum speed of electrically powered scooter is 6 km/h, which is faster than the walking speed of adults (Ministry of Health, Labor and Welfare, 2013). When passing electrically powered scooters traveling at their maximum speed of 6 km/h, young drivers may fail to recognize them as slow-moving vehicles. Although this study found no significant differences in stress related to experiences such as cohabitation with older adults, driving, or encountering scooters, it is plausible that stress is influenced by factors such as scooter speed, prior interactions with older adults, and recognition of electrically powered scooters. Identifying factors that help reduce stress will be crucial for developing effective educational content.

Since it has been reported that the number of traffic accidents increases with an increase in drivers stress, it is necessary to keep distance that would not make drivers feel stress ( Maeda, et. al, 2017 ) . In the experiment for behaviors of the automobile drivers who recognized pedestrians conducted by Tokuda (2014), when the distance between a pedestrian and an automobile at the time of the start of measurement is assumed as 100, the maximum detour distance between a physically unimpaired person and the automobile was 131% while that for an electrically powered scooters was 164%,

which was much higher than the other. It is desired to secure pavement on which an electrically powered scooters can run and maintain road environment where and electrically powered scooters can be avoided sufficiently. Since it is unrealistic to expect all roads to be sufficiently wide, driver education should encourage waiting until there is adequate space to pass electrically powered scooters. Promoting such behavior as a social norm is desirable for achieving a society of coexistence.

### V. Limitations of this study

As a study limitation, the results of this study reflect only the degree of stress experienced while watching videos, not in actual traffic environments. The questionnaire did not include items on specific considerations when passing or detailed experiences of passing situations. In addition, Since the study focused exclusively on young drivers, it was not possible to analyze differences by years of driving experience. Future studies should investigate actual driving environments across different age groups to clarify what considerations drivers make when passing scooters and what stresses they experience.

This study simulated right-side travel of electrically powered scooters and left-lane travel of automobiles, consistent with residential roads. However, it was not possible to determine whether stress during passing was influenced by the distance between scooter and car or by other factors. Future research should hold the distance between scooter and car constant to examine whether stress levels differ according to passing direction.

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## Powered Scooters Among Young Drivers

— Relationship Between Young Drivers' Perceptions, Experiences,  
and Stress in Passing Situations —

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In this study, the authors aim to clarify drivers' recognition and stress levels when they pass it, assuming a scene where an automobile passes an electrically powered scooter as an interpersonal traffic environment. Furthermore, this study sought to identify which perceptions and experiences among young drivers are associated with stress in these passing situations.

An anonymous self-administered questionnaire survey was conducted for general drivers who acquired their driving licence within the past 5 years and were living in the Kanto. 93 subjects were employed for the analysis. For "Degrees of the stress when passing an electrically powered scooter", the subjects were asked to watch 7-second video of an actual scene of passing them before answering the question.

The result revealed that the degree of stress in the scene that the driver passes the electrically powered scooter moving toward them (hereinafter called passing direction) was 4.09 (SD 0.83), while that in the scene that the driver overtakes the electrically powered scooter moving in the same direction (hereinafter called overtaking direction) was 2.43 (SD 1.16). The rate of the drivers who answered "Straying onto roadway so it is dangerous" for the case that the driver passes an electrically powered scooter was highest.

Degrees of stress of those who answered "Easy to avoid them because they move slowly" when passing each other in passing direction was low. The distance between vehicles during passing, as well as the speed of electrically powered scooters, may influence the stress experienced by young drivers. Accordingly, it is necessary to provide young drivers with education regarding the devices themselves and the rules governing their use.