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A Study of a Method for Quantifying Drivers' Sensitivity to Potential Risks

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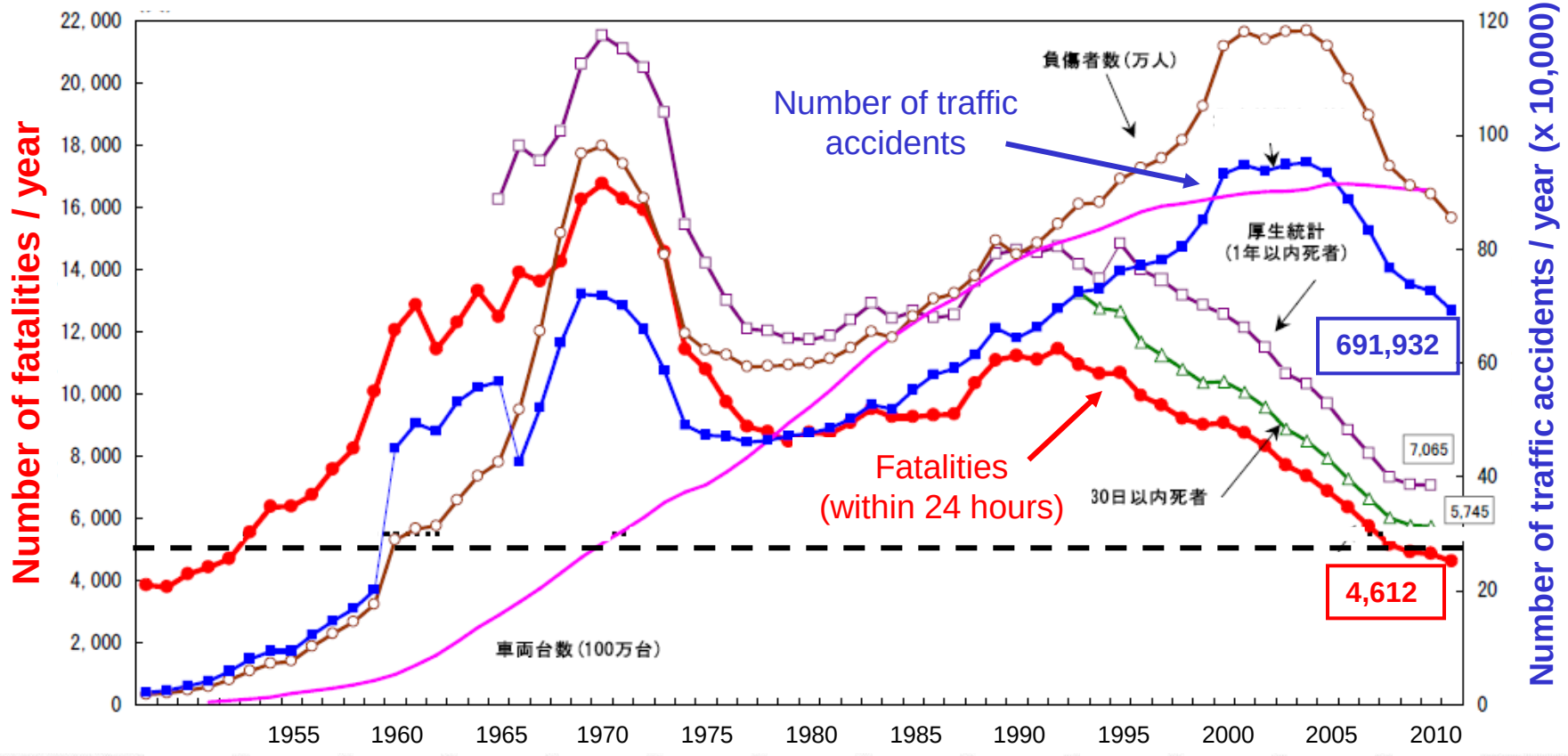
1. Background

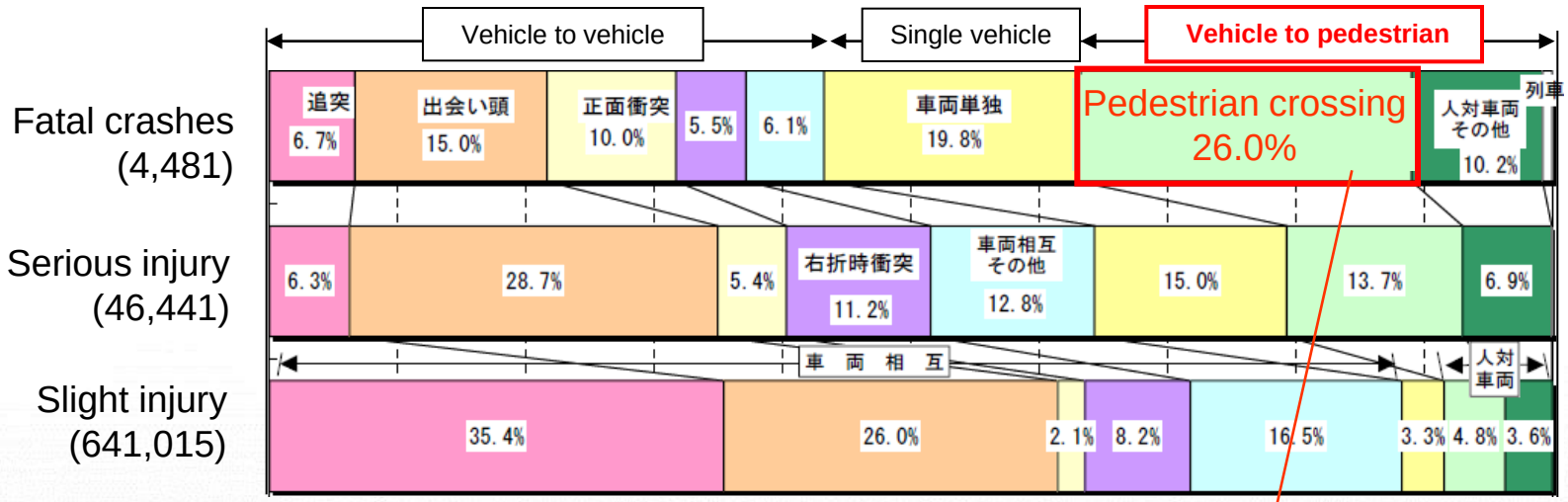
In 2009, the number of traffic fatalities in Japan dropped below 5,000. The government set a target of halving the number by 2018. To reduce the accidents further, safety measures must be implemented from various perspectives that encompass drivers, vehicles and roads.



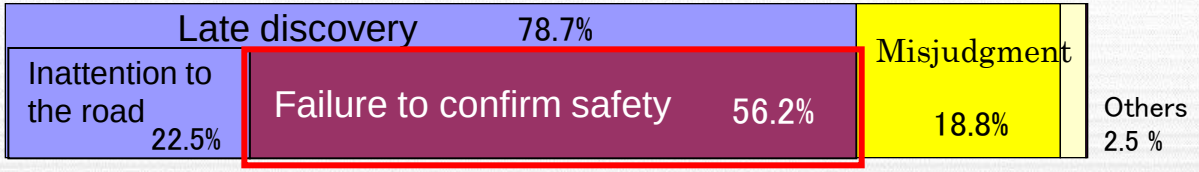
2. Purpose of this study

- Pedestrian accidents are the most type of fatal traffic accident.
- The most common driver-related factor in pedestrian accidents is drivers' failure to confirm safety. Drivers' low risk sensitivity is closely related to the occurrence of pedestrian accidents.
- The purpose of this study is to propose a method of quantifying drivers' risk sensitivity to a pedestrian accident based on their driving behavior.

Breakdown of traffic accidents by type in Japan (2011)



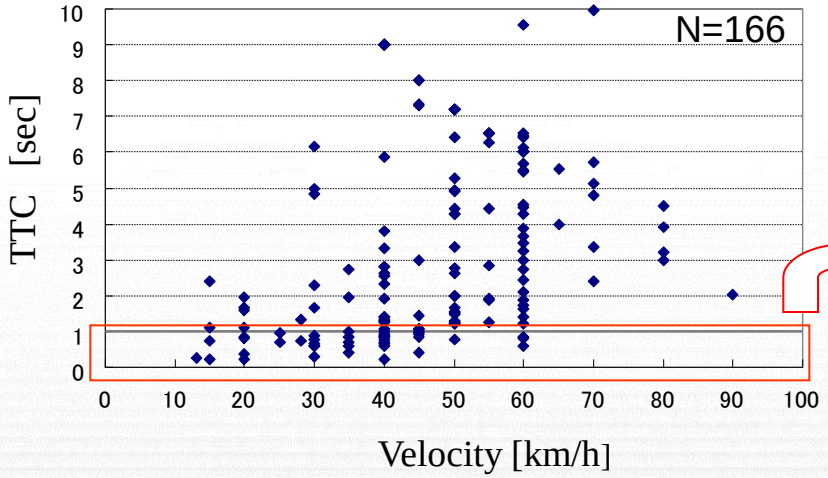
Driver-related factors in pedestrian accidents



3. Driving situation examined

- Focused on accidents in which vehicles traveling straight collide with pedestrians, which is a frequent pattern.
- In accidents with TTC of 1 s or less, vehicles often collide with a pedestrian who appears from behind a parked vehicle when passing by the vehicle.
- Defined a potential risk as one a driver cannot see because of a blind spot. In this study, tried to quantify drivers' risk sensitivity to a potential risk of a pedestrian accident when passing by a street-parked vehicle.

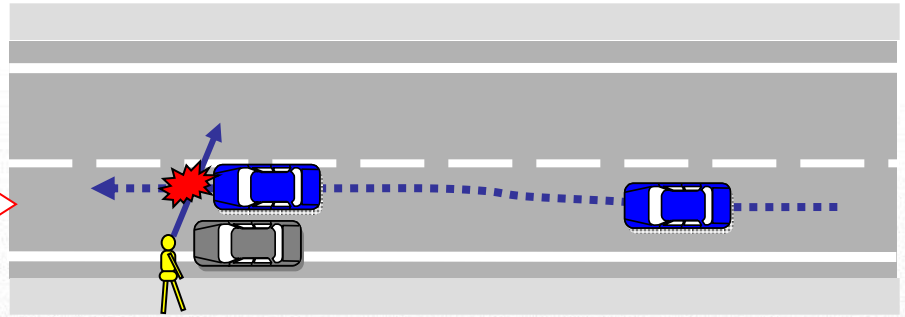
Vehicle velocity vs. TTC at the time a pedestrian starts to cross the road



Data source: ITARDA database

Typical example of a situation with a short TTC

Pedestrian appears from behind parked vehicle



Vehicle velocity: 35 km/h;
Estimated headway: 0.5 m;
Estimated TTC: 0.4 sec

4. Index of sensitivity to potential risks

The driver's estimated velocity of a hypothetical collision object:

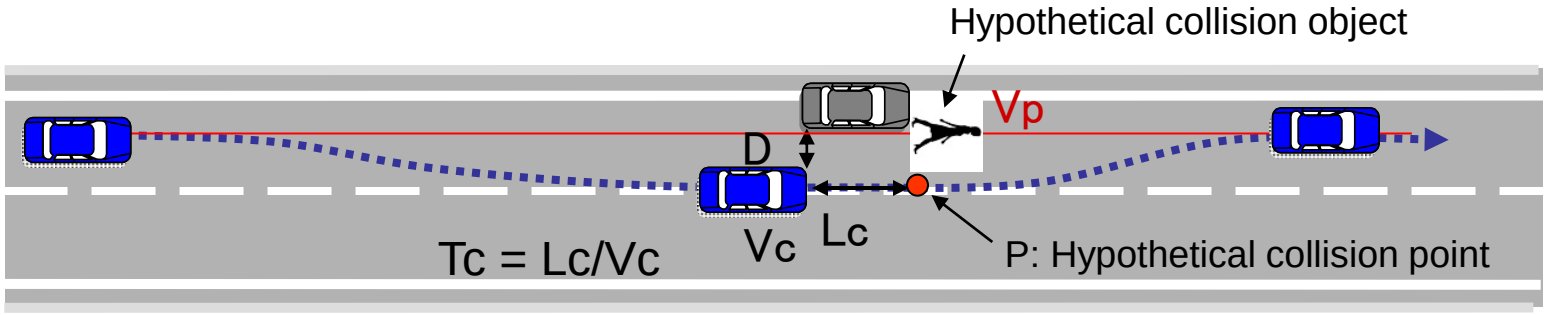
$$Vp = D/Tc$$

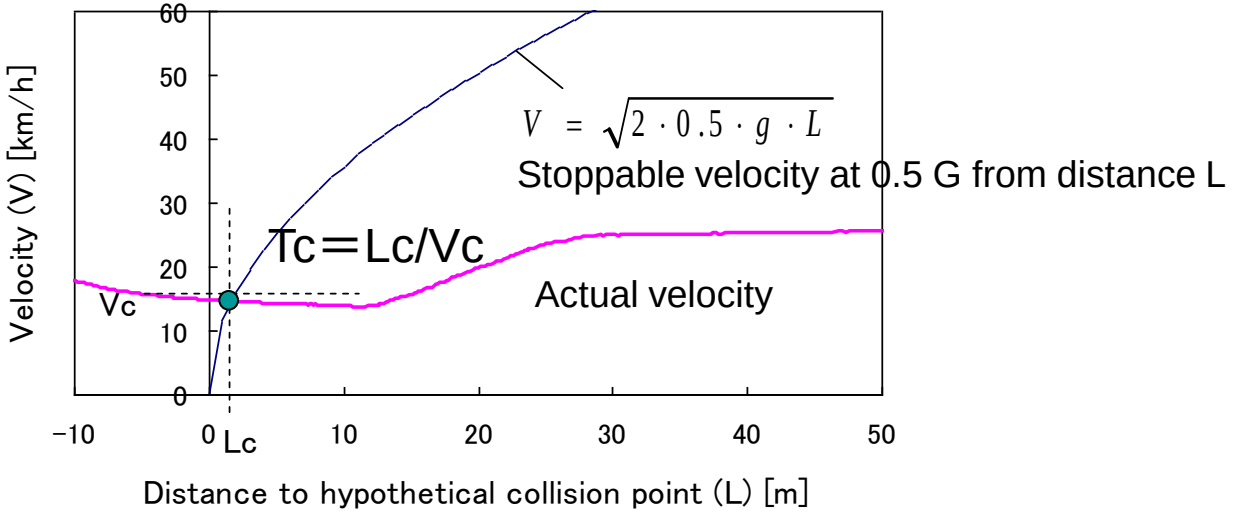
$$= 2 \cdot 0.5 \cdot g \cdot D/Vc$$

D: Lateral distance of the passing vehicle to the parked vehicle

Tc: Time limit in which it is possible to stop before a hypothetical collision point P by hard braking at 0.5 G.

Vc: The passing vehicle's velocity at the time limit.





5. Experimental procedure

Measured driving behavior when passing by a parked vehicle in a controlled environment on a proving ground course.

- **Measurement situations**

  1. Situation using a moving collision object to simulate a pedestrian appearing from behind a street-parked vehicle
  2. Situation with a parked vehicle only, representing a potential risk

- **Measured data**

  CAN bus data, vehicle position data obtained by kinematic GPS and images of the forward view and driver's face and feet

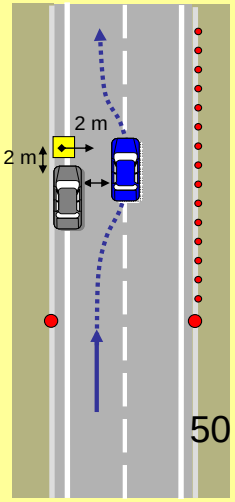
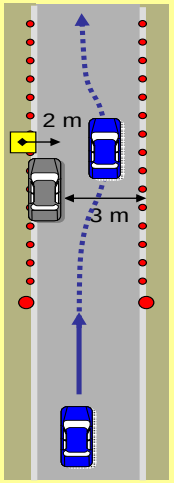
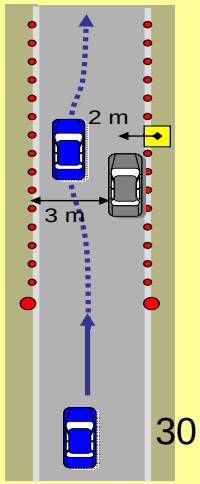
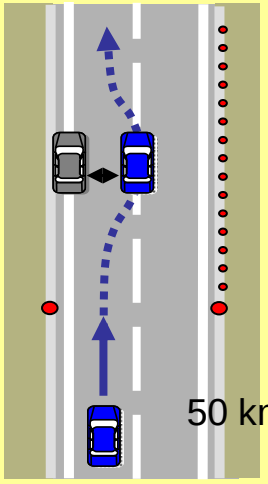
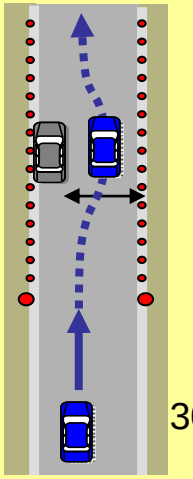
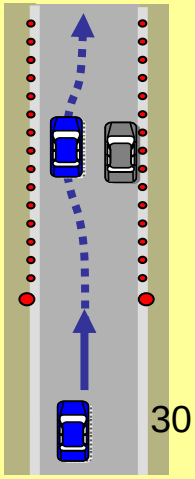
- **Participants**

  10 participants in each driving situation. Participants were Nissan employees ranging in age 20s - 50s and they drive regularly.

  Purpose of the experiment was explained in advance and the participants gave their informed consent.

➢ Test conditions

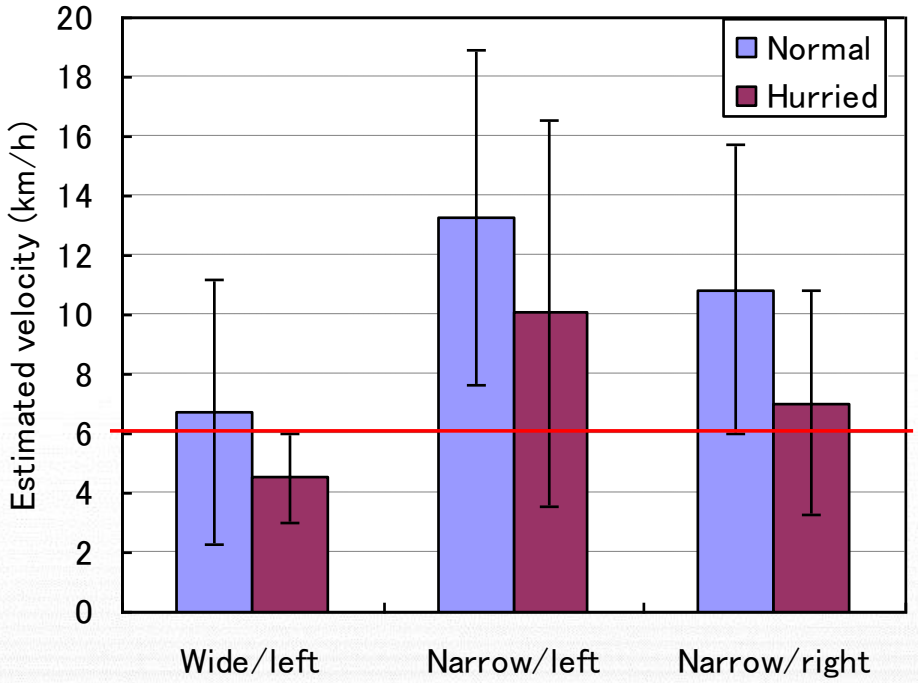
6 environmental setting (below) x 2 driving situations (normal / hurried)
3 driving sessions each for 10 participants.

Road width / Parked vehicle position	Wide (8 m)	Narrow (5 m)	
	Left side	Left side	Right side
With collision object 			
Without collision object (Potential risk situation) 			

6. Results

➢ Participants' risk sensitivity in the situation with a collision object

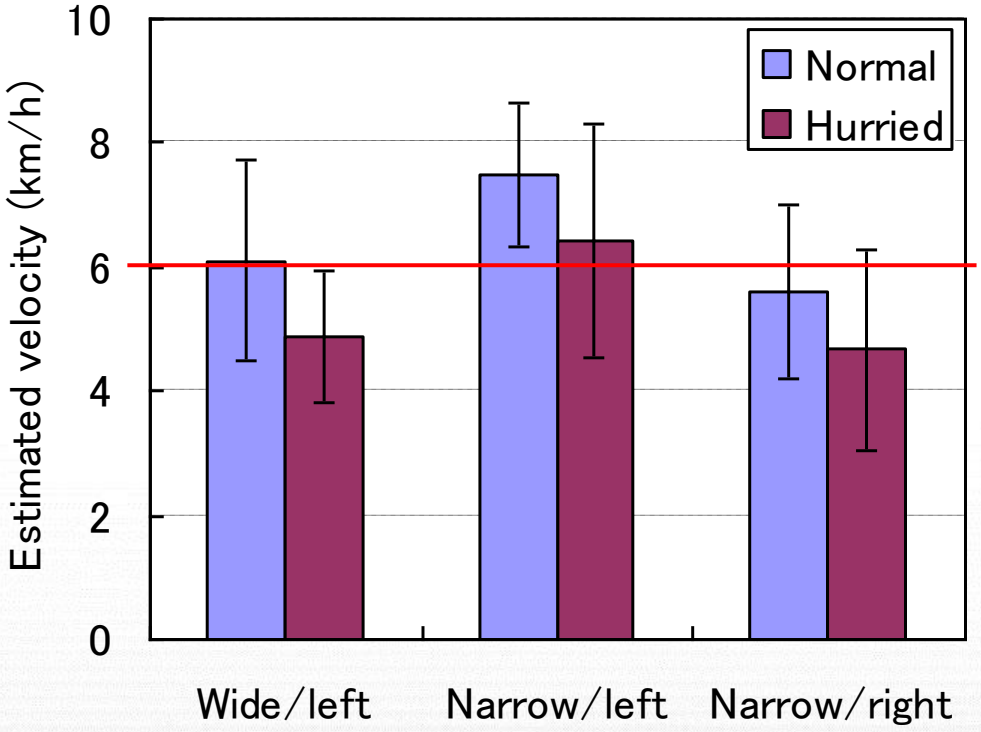
- ✓ Estimated velocity was higher on the narrow road than on the wide road.
- ✓ It was higher for the parked vehicle on the left side than on the right side.
- ✓ It was lower in hurried driving than in normal driving.
- ✓ Participants' risk sensitivity was higher on the narrow road. In normal driving, they estimated the object's velocity at 10 km/h (a bicycle) and in hurried driving at 6 km/h (a pedestrian hurrying across the road).



Participants' estimated velocity of a hypothetical collision object in hurried driving situations with 1SD

➢ Participants' risk sensitivity in potential risk situations

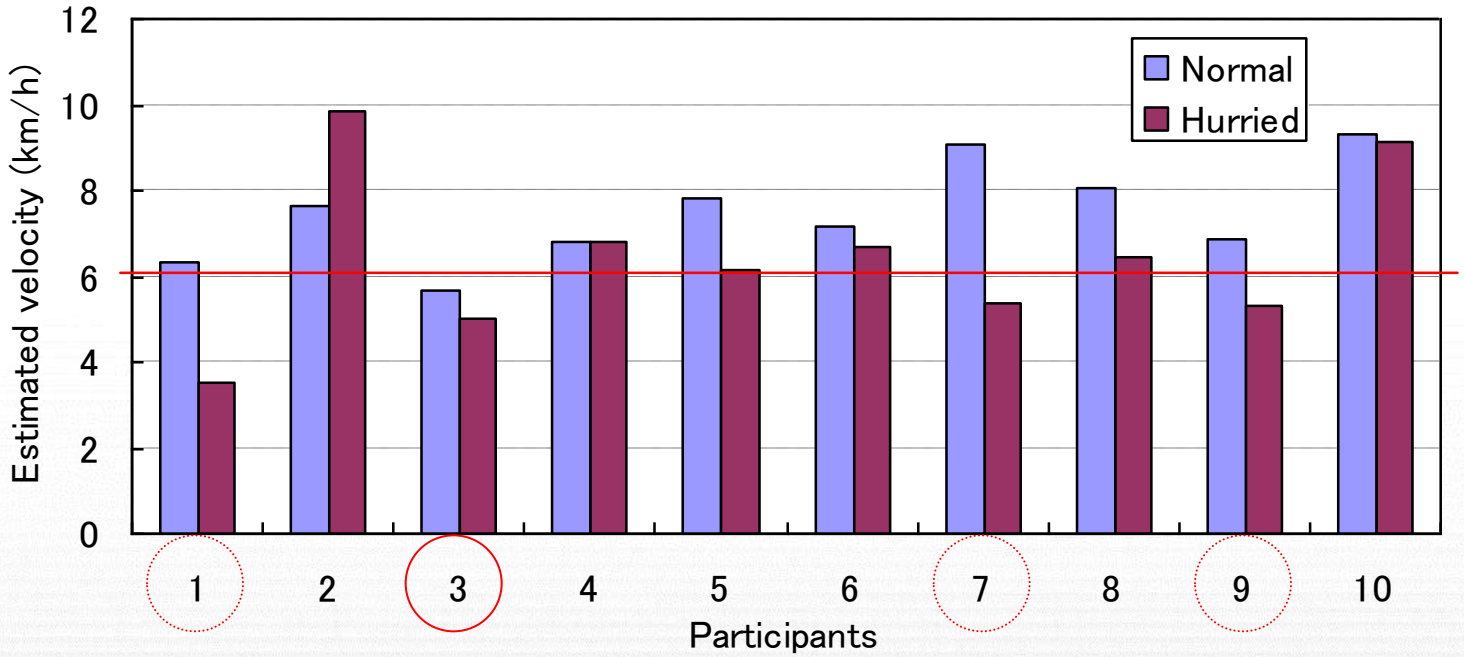
- ✓ Estimated velocity was lower than in the situation with the collision object.
- ✓ Estimated velocity was the highest on the narrow road with the parked vehicle on the left side. Object's velocity was estimated at 6 km/h (a pedestrian hurrying across the road).



Participants' estimated velocity of a hypothetical collision object in potential risk situations (one standard deviation)

➢ Comparison of individual differences among participants

- ✓ No. 3 driver was lax in estimating velocity of collision object.
- ✓ Drivers No. 1, 7 and 9 tended to be less strict in their velocity estimation in hurried driving.
- ✓ Results suggest that drivers who tend toward unsafe driving can be identified by using their estimated velocity of a collision object in potential risk situations.



Estimated velocity of hypothetical collision object by individual participants (Narrow/left) in potential risk situations

7. Summary

- Proposed a method of quantifying drivers' risk sensitivity based on their driving behavior in situations of passing by a street-parked vehicle with a potential risk of a pedestrian accident.
- Quantified participants' sensitivity to potential risks based on their estimated velocity of a hypothetical collision object.
- Conducted tests on a providing ground course that reproduced a situation of driving by a street-parked vehicle. Found that participants' risk sensitivity was higher on a narrow road with a vehicle parked on the left side. Participants' risk sensitivity tended to decline in hurried driving.
- Comparison of the participants' estimated velocities of a hypothetical collision object revealed the possibility of identifying drivers who tend toward unsafe driving.

8. Future work

- Apply proposed risk sensitivity index to data collected in real-world driving with 100-car study and/or SHRP2. Clarify relationship between drivers' risk sensitivity and near-miss incidents and examine the feasibility of using the proposed index to make safe driving assessments.

- Need to extend its application to investigations of drivers having different attributes and to other potential risk situations.

Thank you for your kind attention