岩手県立大学
Iwate Prefectural University

Vibro-tactile Notification in Different Environments for Motorcyclists

Yuta Yamauchi
and Akimasa Suzuki
Iwate Prefectural University
Email:g231r028@s.iwate-pu.ac.jp

Resume

Yuta Yamauchi

- Educational Background
  - Iwate Prefectural University , Iwate , Japan
    - Apr 2015 – Mar 2019: Faculty of Software and Information Science
    - Apr 2019 – present : Graduate school of Software and Information Science
- Field of study
  - ITS
  - actuator

Background

The fatality rate in crashes

- for drivers of four-wheeled vehicles : 0.35%
- for motorcyclists: 1.22%

High risk in the event of an accident. ✚ Motorcycles are small and difficult for other drivers to recognize.

➥ Systems that prevent accidents are important

However…

✓ There are fewer sensors on board than in a four-wheeled vehicle.

✓ The range of notifications is narrow.

Therefore, few systems have been put into practice.

✓ Helmets reduce visibility

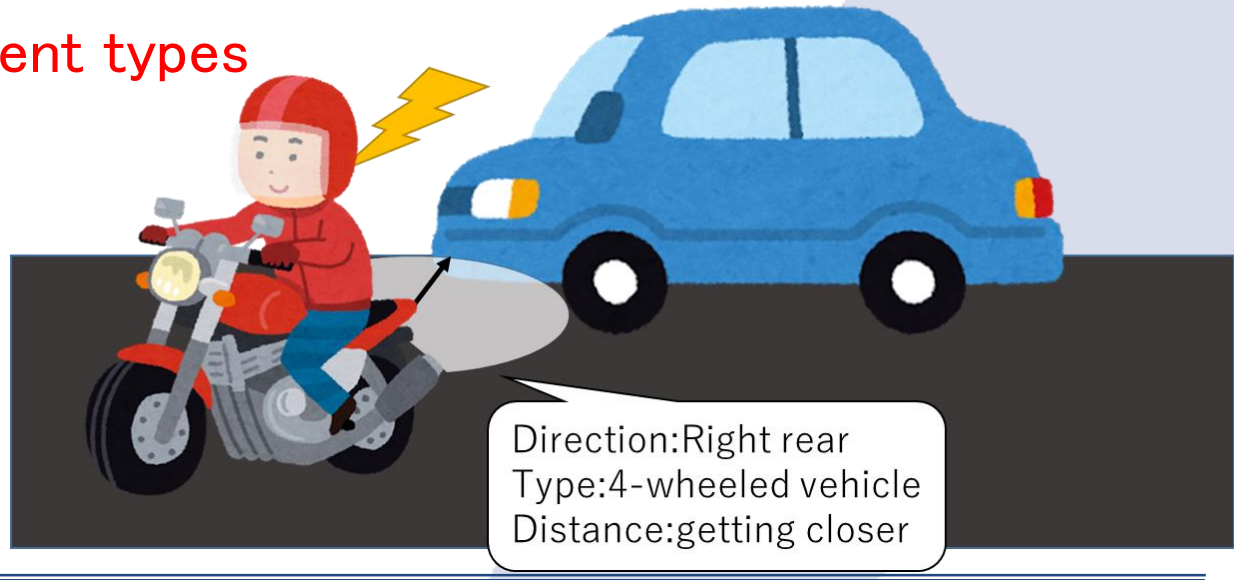
✓ It's hard to hear the sound of the engine and the wind

when driving motorcycles

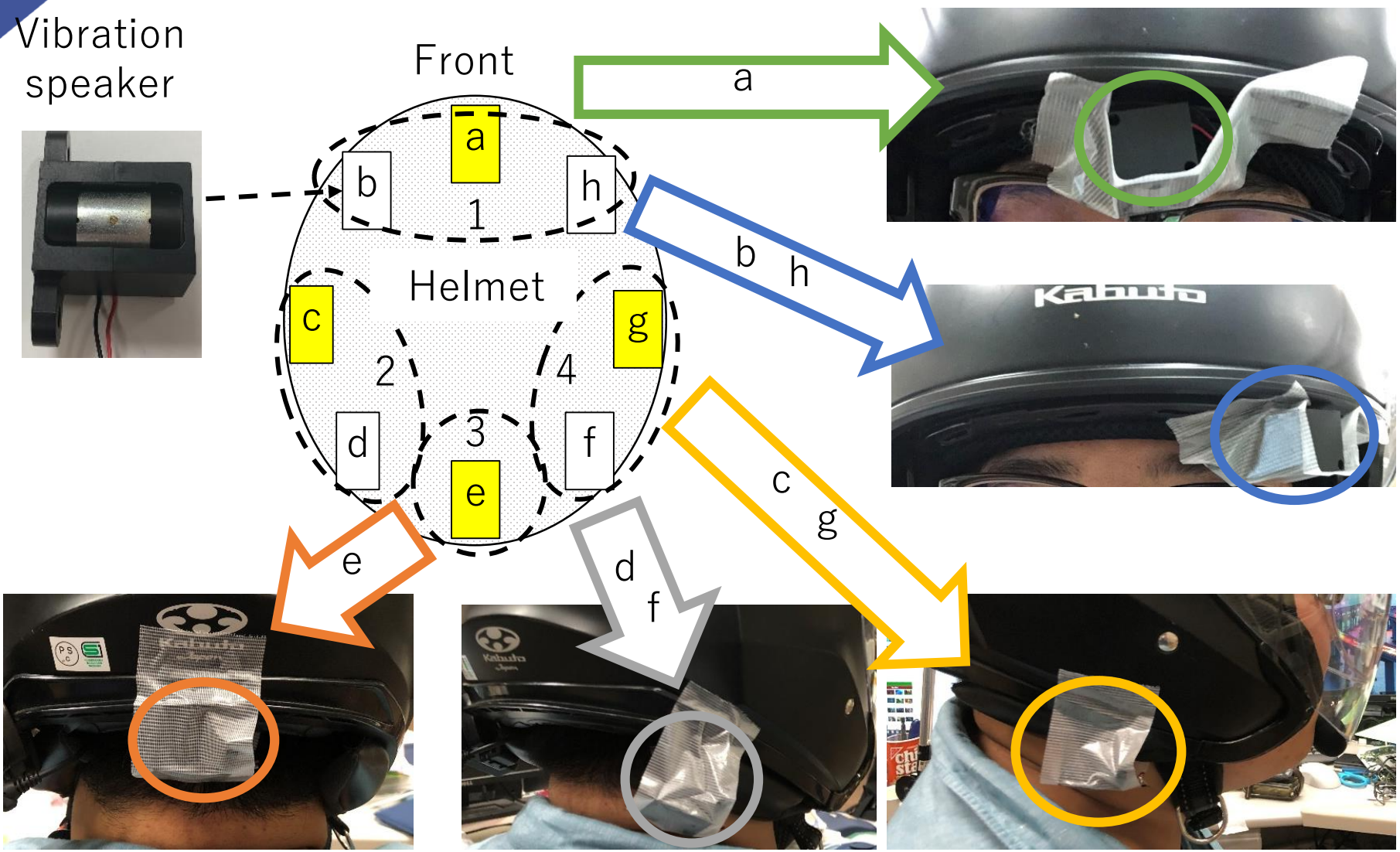
➥ Non-visual and auditory notifications

Purpose of this study

- We have proposed a system that uses haptic sensations to quickly notify drivers of possible hazards or obstacles surrounding the vehicle.
- Our proposed system has higher immediacy and directional resolution than notifications using sounds.
- As no driver notification system currently uses haptic sensations, we do not have to consider conflicts in this area.
- A high intensity expresses the extent of the danger and the direction of the vibration indicates the location of the hazard.
- The system can also alert the driver to different types of obstacles, such as a pedestrian, four-wheeled vehicle, or motorcycle.
- We evaluate the system under windy and engine vibration conditions and examine accuracy of notification via experiment.



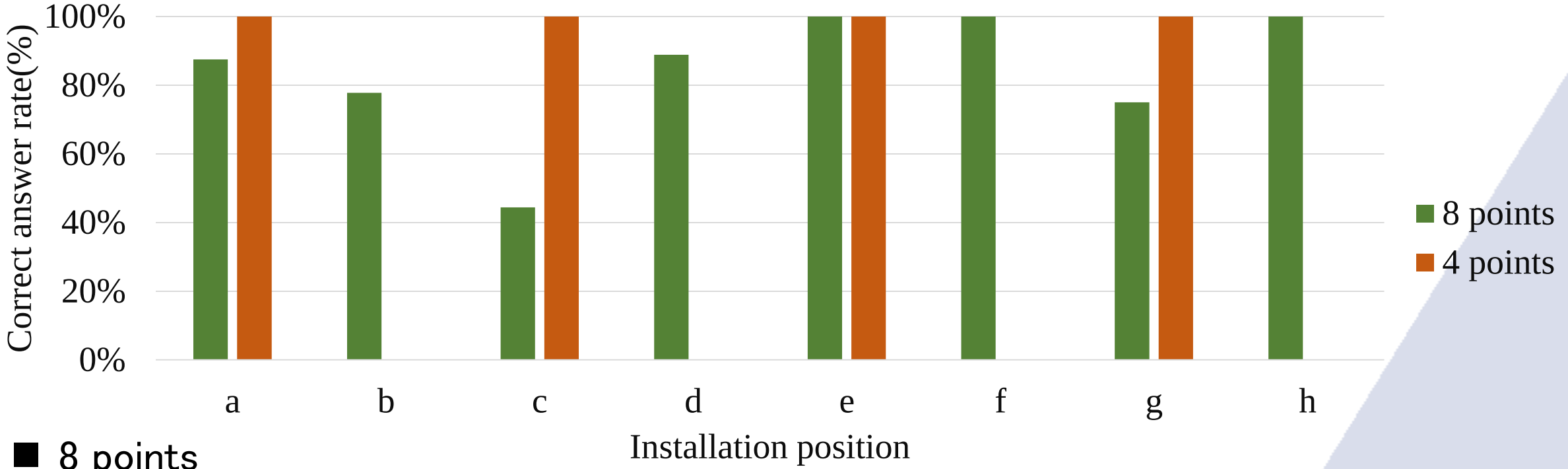
Mounting positions of actuators on a helmet



Experimental arrangement of mounted actuators

- This helmet has four cushions as shown in sections 1 to 4.
- To explore the vibro-tactile directional sense at the motorcyclist's head, we installed eight actuators as shown in a to h.
- Actuators a, b, and h were mounted on cushion 1, c and d were mounted on cushion 2, e was mounted on cushion 3, and f and g were mounted on cushion 4.

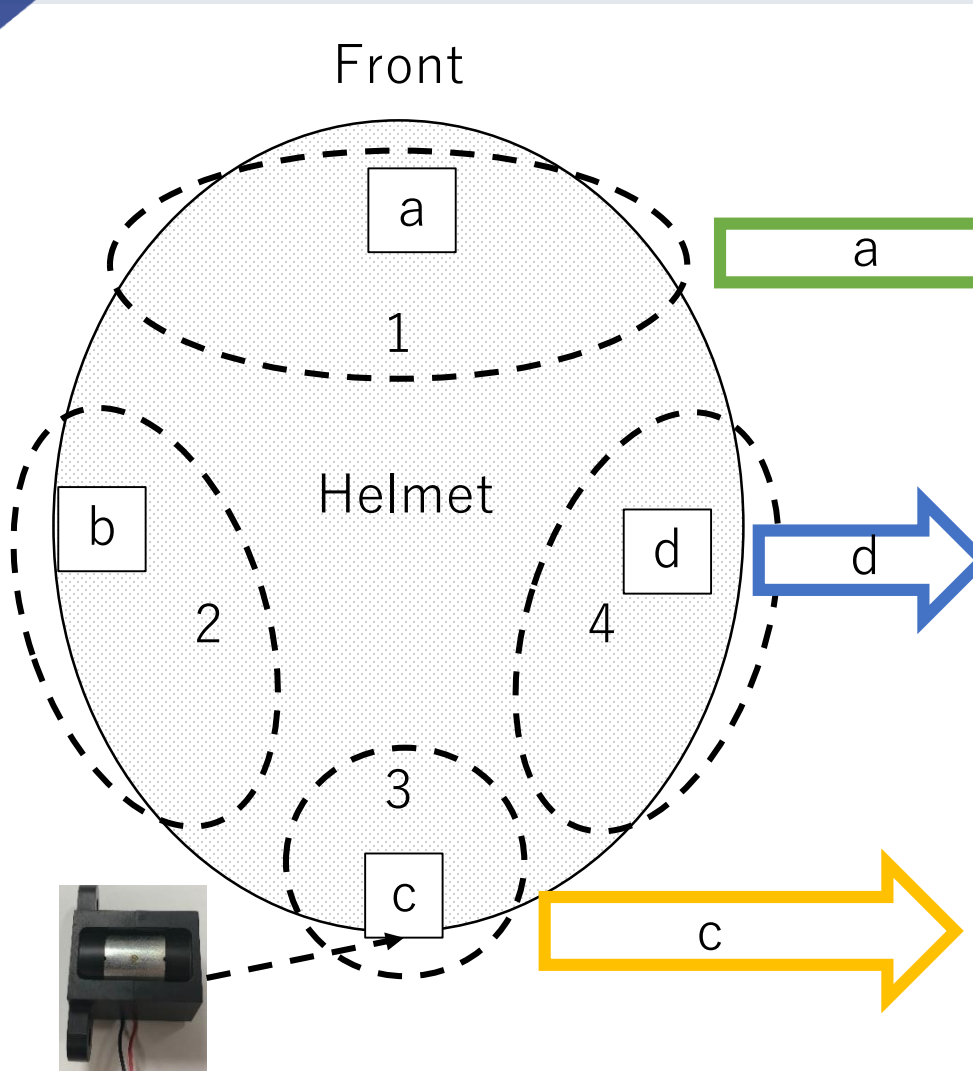
Mounting positions of actuators on a helmet



- 8 points
  - The total correct answer rate is 84%.
  - The cause of the erroneous response was a vibrating actuator installed on the same cushion of the helmet.
- 4 points
  - The total correct answer rate is 100%.

Install four actuators, one on each cushion.

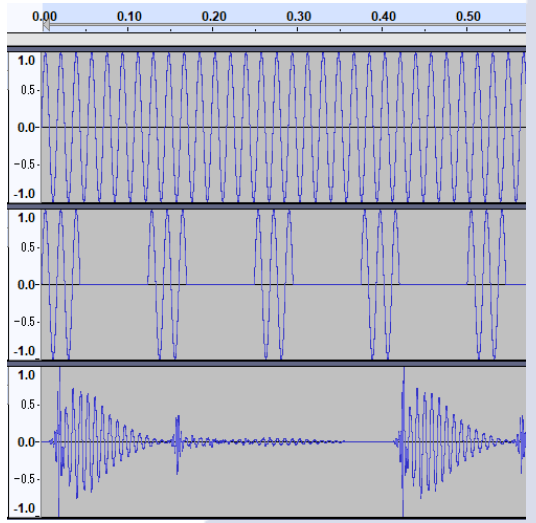
Overview of our proposed system



four-wheeled

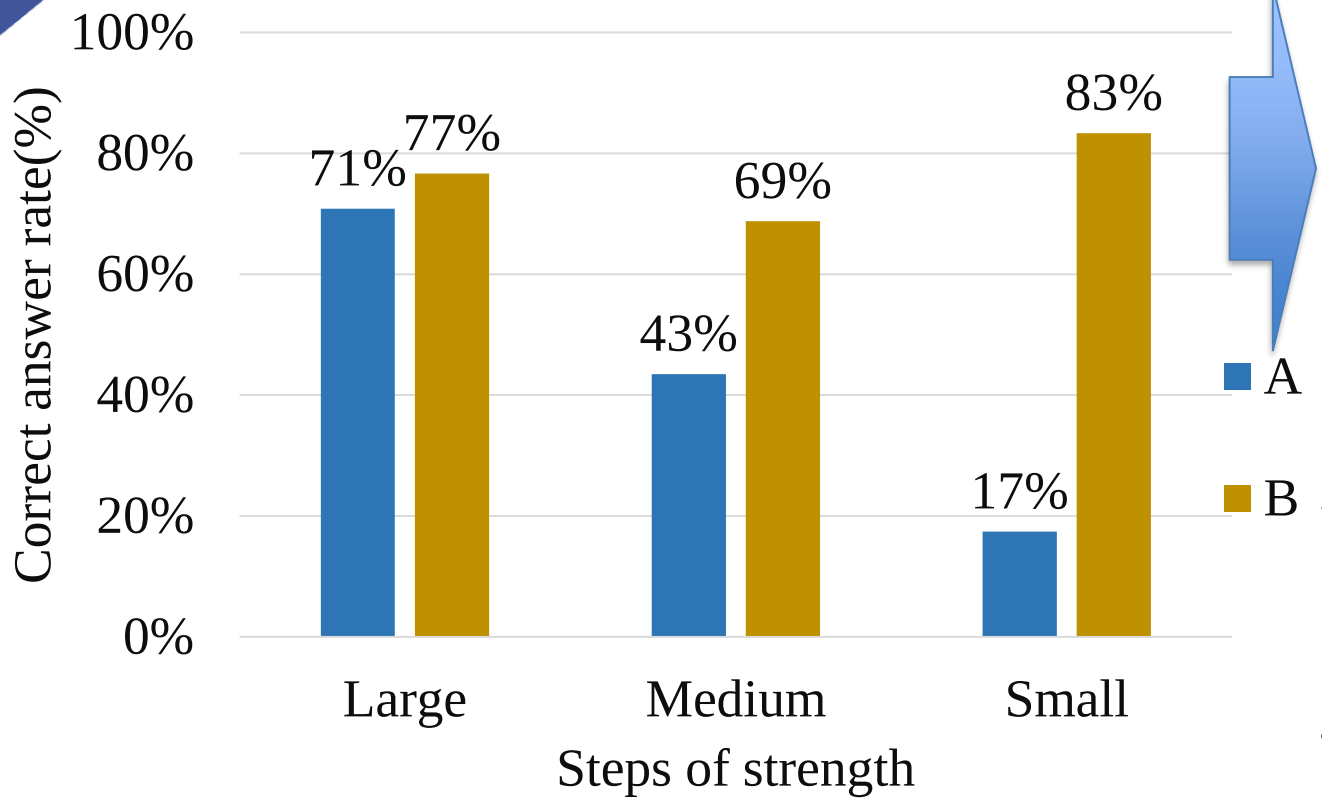
motorcycle

pedestrian



- The sound data are deformed waves for three categories (*i.e.*, pedestrian, four-wheeled vehicle, and motorcycle) the same as in our previous study for four-wheeled vehicles.
- We experiments in this study will be conducted in the four-wheeled vehicle category.

Vibration strength



For normalization

1. Via a questionnaire, we determined the maximum and minimum strengths motorcyclists can detect with no stress.
   - The results indicate that the difference between the maximum and minimum strengths for actuator b was smaller than that for the other positions.
2. We used the maximum and minimum strengths, which participants feels as same as b, for all the actuators.
3. The ”medium” strength level was defined as participants feel “medium” between ”large” and ”small” vibration.

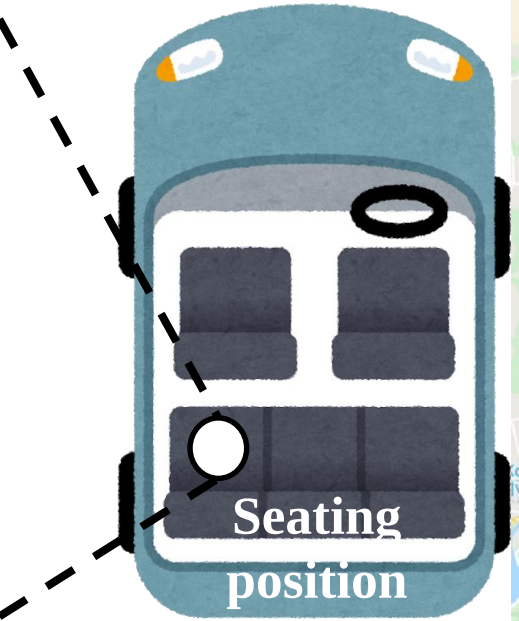
✓ This graph shows that it is possible to discriminate between three levels of vibration intensity if there is a sufficient vibration intensity difference.

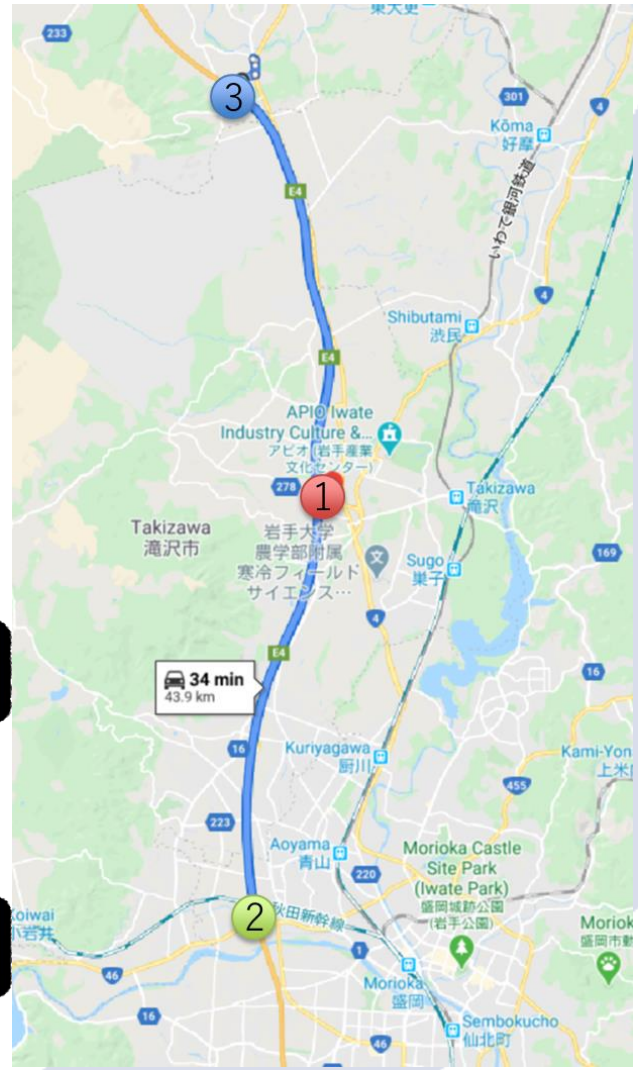
Position	Large	Medium	Small
a	-6dB	-10dB	-14dB
b	-8dB	-12dB	-19dB
c	-6dB	-10dB	-13dB

Robustness evaluation of the system

Robustness evaluation of the system to external factors during operation of motorcycles.

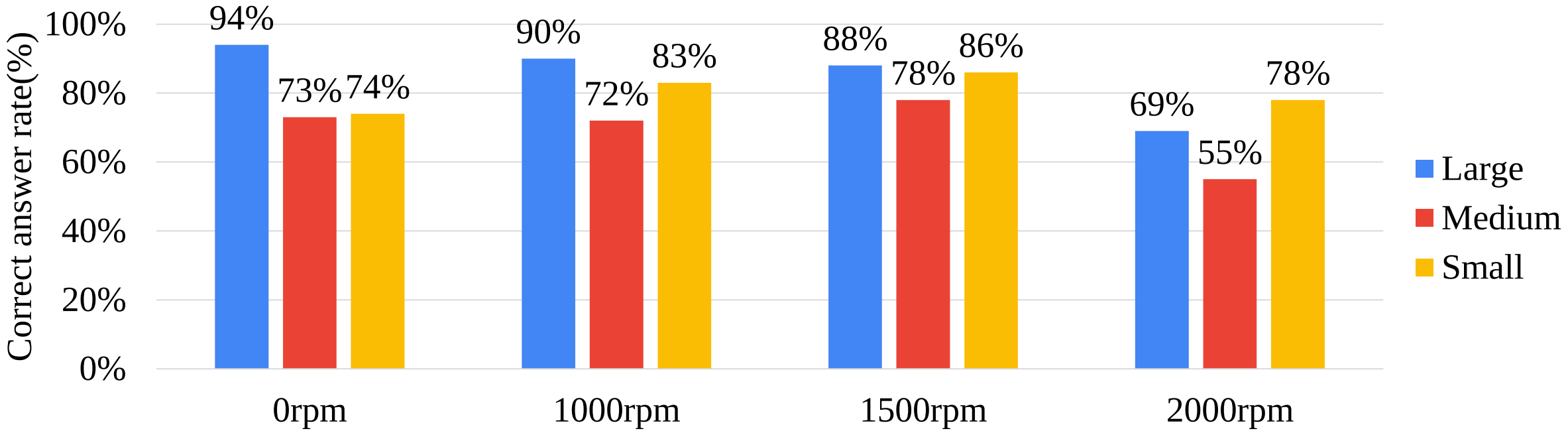
1. Engine rotation
   - 0rpm, 1000rpm, 1500rpm, 2000rpm
2. Wind
   - 0km/h
     Stable experiments
   - 60km/h
     ③～①
   - 80km/h
     ①～②
   - 100km/h
     ②～③





Experimental results under the influence of engine vibration

Correct answer rate for strength levels



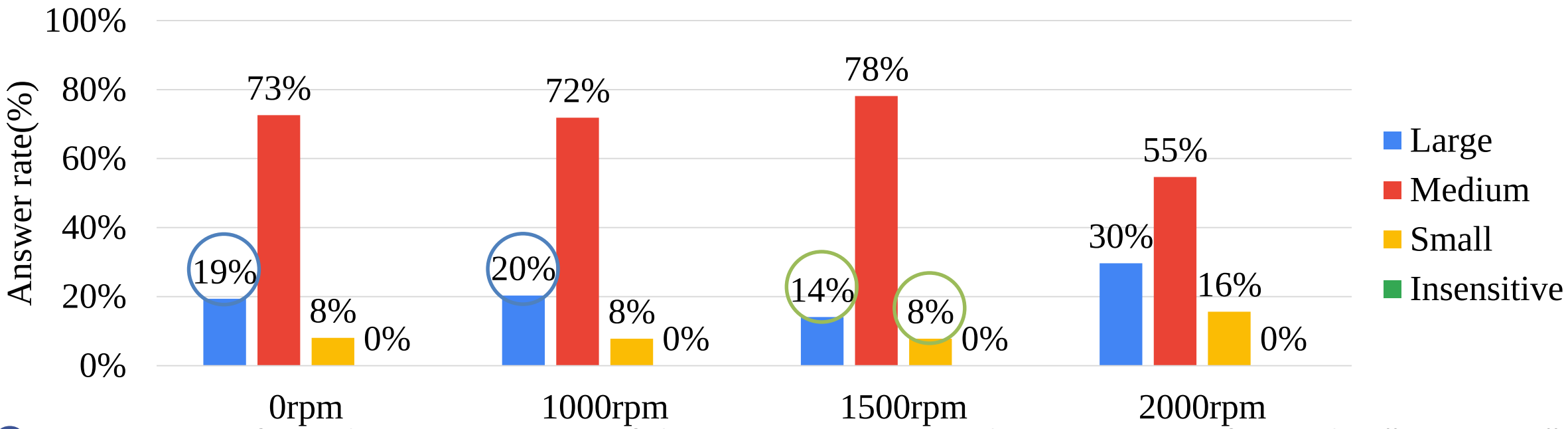
✓Under 1500 rpm, the percentage of correct answers for "medium" and "small" increased

✓At 2000 rpm, all the correct answers are low and not identified

⇒This may be due to the high engine rotation causing stronger vibration and noise from the motorcycle, obscuring the vibration from the actuators.

Experimental results under the influence of engine vibration

Answer rate for "medium" at each strength levels

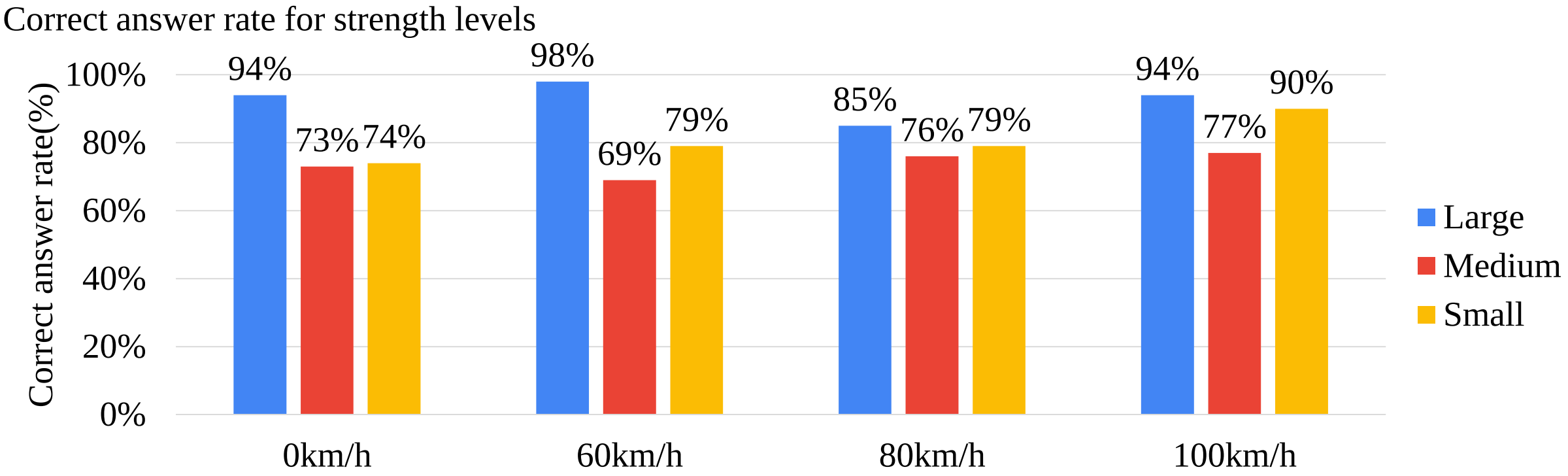


○ : We can confirm that participants felt as more strong vibration identifying the ”medium” strength level because participants answered ”large” more often than they did ”small”.

○ : The answers for "large" and "small" was about the same, indicating that the intensity of "medium" was appropriate.

There's going to be an appropriate vibration strength depending on the engine rotation.

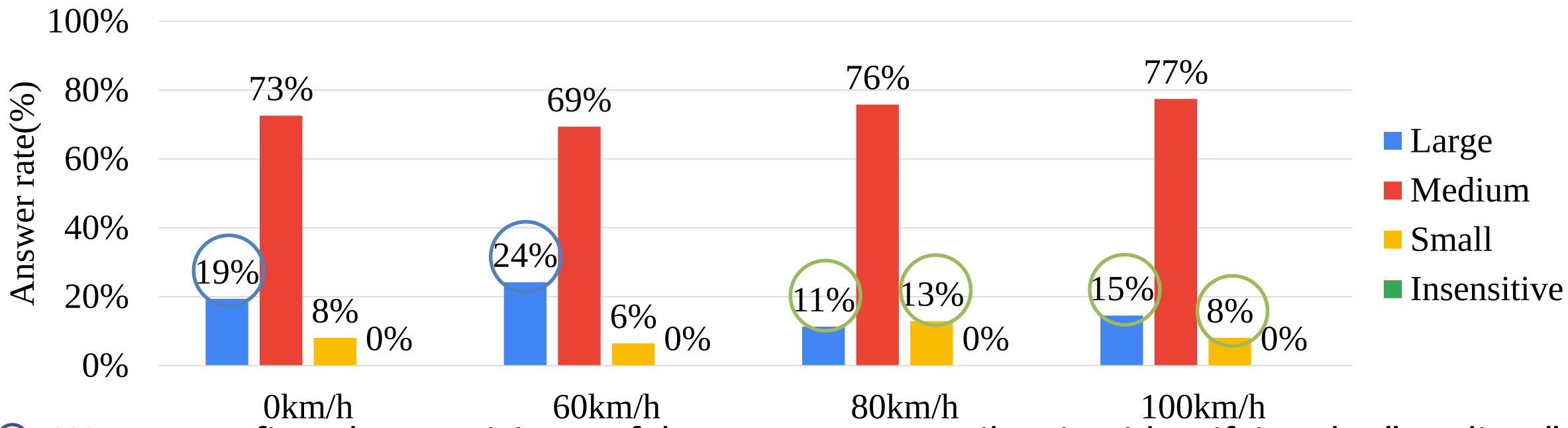
Experimental results under the influence of wind



✓The correct answer rate for the "small" category increases as the effect of the wind increases.

Experimental results under the influence of wind

Answer rate for "medium" at each strength levels



○ : We can confirm that participants felt as more strong vibration identifying the ”medium” strength level because participants answered ”large” more often than they did ”small”.

○ : The answers for "large" and "small" was about the same, indicating that the intensity of "medium" was appropriate.

There's going to be an appropriate vibration strength depending on the under windy.

Conclusion

- We proposed a notification system for motorcycles based on previous works for four-wheeled vehicles.
- In our system, parts of the helmet vibrate corresponding to direction of a hazard, the category of an object, and the level of risk.
- We considered the strength of vibration to determine three strength levels.
- We evaluated the accuracy of our proposed notification method for motorcycles using haptic actuators in windy and idling situations.
- We demonstrated the effectiveness of our notification method even for winds of 100km/h.

- We expect improved notification accuracy can be achieved by adjusting vibration strength according to the motorcycle's speed.
- Various types of helmets will be studied in the future.