

Effect of Forward Field-of-View Width on Motion Sickness During Fixed Gaze Inside a Car

Masateru Amano ¹⁾ Kazunori Higuchi ¹⁾ Yoshikazu Hattori ¹⁾

*1) Toyota Central R&D Labs., Inc.
41-1 Yokomichi, Nagakute, Aichi, 480-1192, Japan (E-mail: m-amano@mosk.tytlabs.co.jp)*

KEY WORDS: Human engineering, Car sickness, Field of vision, Rear passenger, Visual task(C1)

In this study, we evaluated the effect of the forward field of view on motion sickness under a condition simulating rear-seat passengers in a minivan viewing an in-vehicle display while the vehicle was in motion.

Six healthy adults (five males and one female, aged in their 20s to 50s) were recruited from within the company and participated in the experiment. Eligibility criteria required that participants had no history of disorders related to the autonomic nervous, metabolic, respiratory, or cardiovascular systems (e.g., hypertension, diabetes mellitus, or arteriosclerosis). The mean age of the participants was 40.7 years (standard deviation: 11.3 years). This study was conducted with the approval of the company's institutional ethics review board (Approval No. 24-12).

During the experiment, participants were seated in the rear seat in a natural posture. To simulate the viewing of an in-vehicle display, they were instructed to fixate on a visual target marker positioned on the headrest such that it could be viewed with a natural downward gaze (viewing distance: 82 cm; downward gaze angle: approximately 4.2°). The forward field-of-view conditions were established by controlling the occluded region of the forward view using plastic boards, as shown in Fig. 1. Four experimental conditions were examined: (a) no occlusion, (b) occlusion of the visual field within $\pm 30^\circ$, (c) occlusion of the visual field within -45° to $+30^\circ$, and (d) complete occlusion. Here, the angles represent horizontal visual angles relative to the forward direction, referenced to the eye point of a rear-seat occupant seated behind the driver.

The driving course consisted of a figure-eight track formed by connecting two circles with a radius of 15 m and a center-to-center distance of 40 m. The vehicle was driven around the course for five laps at a speed of approximately 19 km/h. Each lap took approximately 1 min, resulting in a maximum lateral acceleration of approximately 0.1 G and a maximum yaw rate of approximately 15 deg/s.

Subjective motion sickness was evaluated using the Misery Scale (MISC)[1], and ratings were collected at the end of each lap. The MISC is an 11-point ordinal scale ranging from 0 to 10 that quantifies the severity of motion sickness symptoms. Participants were informed in advance that they could request termination of the experiment at any time if they felt unable to continue and that the experiment would be terminated if their MISC rating reached 6 or higher. To minimize order effects, the presentation order of the four experimental conditions was counterbalanced across participants. Furthermore, each condition was conducted on a different day to eliminate carryover effects from previous trials.

Figure 2 shows the proportion of participants whose MISC score reached 2 or higher, corresponding to the onset of subjective motion sickness symptoms, for each lap. As shown in Fig. 2, the proportion increased with successive laps under conditions (a), (c), and (d), whereas no participants reached a MISC score of 2 or higher under condition (b) throughout the five laps. These results suggest that an appropriate range of forward visibility may exist for reducing motion sickness when rear-seat passengers fixate on an in-car object.

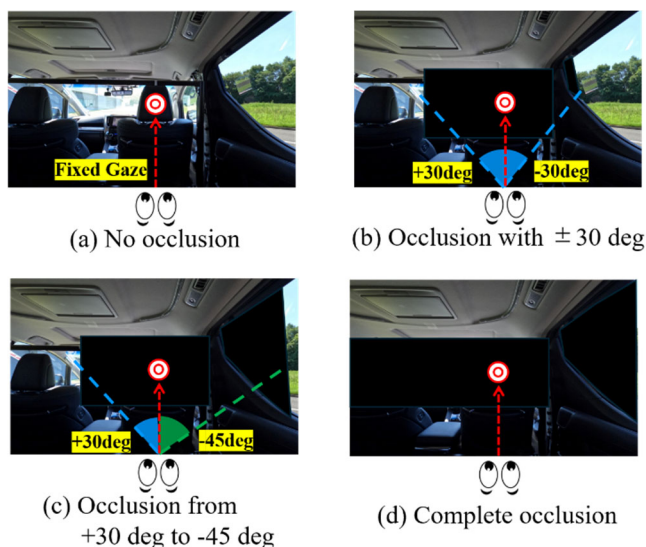


Fig.1 Visibility conditions inside the vehicle

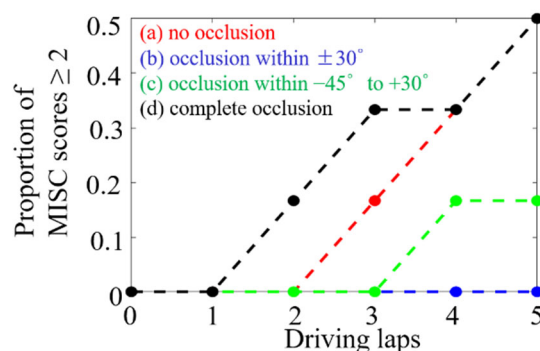


Fig.2 The proportion of participants whose MISC is 2 or higher at each lap. Red line: (a) no occlusion, Blue line: (b) occlusion within ± 30 deg, Green line: (c) occlusion from -45 deg to $+30$ deg, Black line: (d) complete occlusion.

[1]Bos JE, MacKinnon SN, and Patterson A.: Motion sickness symptoms in a ship motion simulator: effects of inside, outside, and no view, Aviat Space Environ Med. 76(12), 1111-1118, 2005