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Driving Simulator Log Analysis in Rehabilitation for Resuming Driving

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In regional cities where cars are vital for daily activities, the inability to drive owing to conditions such as brain injury (primarily stroke) can severely affect the quality of life. Consequently, there is an increasing demand for rehabilitation programs that facilitate a return to driving. However, current assessments of driving eligibility lack clear criteria and depend on physicians' subjective judgment and experience, highlighting the need for objective evaluation. This study analyzed log data from driving simulators (DS) used in driving rehabilitation to establish objective indicators for assessing the feasibility of resuming driving after brain injury.

Fig.1 Analyzed scene: vehicle approaching from the right

The study involved 145 patients with brain injuries who underwent DS training and received a physician's assessment regarding driving resumption (73 in the resumer group and 72 in the non-resumer group). The DS recorded driving operation data, including the steering angle, speed, accelerator pedal position, and brake pedal position, at 10 ms intervals. Previous studies did not standardize the timing and spatial relationships of vehicle entry, which hindered the appropriate evaluation of group differences (Hashimoto and Kohama, 2022). Moreover, direct comparisons between the resumer and non-resumer groups were insufficient. In contrast, this study defined a reference time based on vehicle entry events and conducted an analysis after standardizing the vehicle entry timing and inter-vehicle distance. Scenarios in which vehicles entered from the left and right sides were selected for analysis. In scenarios involving vehicle entry from the left, no significant differences were observed between the two groups, and as no significant difference in accident rates was found between the resumer and non-resumer groups, it suggests that the tendency to overlook the left-side space is likely similar in both groups. Conversely, in scenarios involving entry from the right (Fig.1), the non-resumer group showed greater variability in steering operations immediately before vehicle entry (Mood's test: $p<0.05$). To evaluate steering stability, the cumulative absolute steering angular velocity (Fig.2) and maximum steering angle (Fig.3) was calculated and compared between the two groups. The results indicated that the non-resumer group had significantly higher values for both indicators than the resumer group (permutation test: $p<0.05$). Additionally, the analysis of steering direction revealed that more participants in the non-resumer group swerved to the right than in the resumer group (Fig.4), suggesting that they may have employed maladaptive evasion strategies. It is known that sequelae of brain injury often include neglect of the side opposite the injured cerebral hemisphere and a tendency toward an attentional bias toward the ipsilateral side. Differences in responses to intruding vehicles on the left and right are thought to reflect differences in spatial attentional function. These results revealed that the non-resumer group tended to exhibit greater steering instability and more pronounced steering responses to sudden vehicle intrusions, suggesting that these characteristics could serve as important indicators of the feasibility of resuming driving after brain injury.

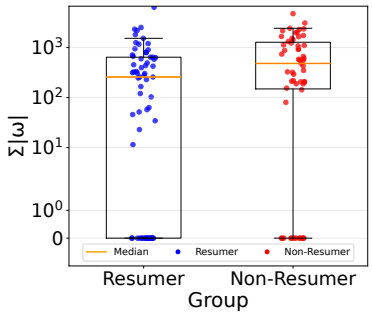

Fig.2 Distribution of cumulative absolute steering angular velocity

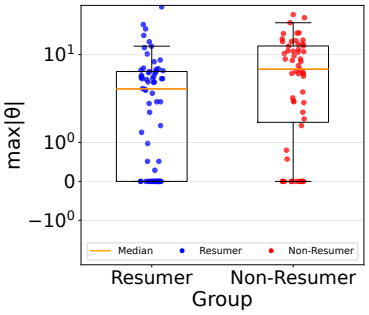

Fig.3 Distribution of maximum absolute steering angles

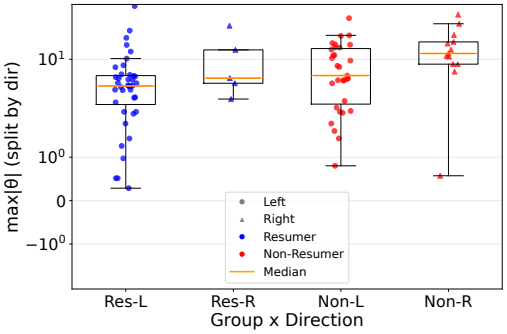

Fig.4 Lateral distribution of maximum steering angles