

A Strategy for Maintaining Driver Arousal Based on Regional Sensitivity to Airflow Stimulation

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A thermally comfortable environment in a vehicle may reduce driver alertness and increase the risk of drowsy driving, whereas lowering the cabin temperature may improve alertness but compromise thermal comfort. Therefore, maintaining both thermal comfort and driver alertness through conventional cabin temperature control is difficult. Previous studies have shown that changes in cabin temperature can help maintain driver alertness without substantially compromising thermal comfort. Based on these findings, airflow stimulation has been investigated as an alternative to cabin temperature changes. In particular, airflow directed at the neck was found to reduce whole-body thermal sensation while maintaining thermal comfort. Therefore, this study investigates whether neck-directed airflow can maintain driver alertness without changing the overall ambient temperature.

A driving simulator experiment was conducted with six participants. The participants drove on a monotonous highway course designed to induce drowsiness. They were instructed to follow a preceding vehicle at approximately 100 km/h while maintaining a sufficient following distance. Two conditions were compared: with and without airflow stimulation. In the airflow condition, air was directed toward the participant's neck for five minutes while the surrounding airflow was minimized and the ambient temperature was maintained within a comfortable range. During the experiment, participants verbally evaluated thermal comfort, Thermal Sensation Vote (TSV) for whole-body thermal sensation, and Partial Thermal Sensation Vote (PTSV) for local thermal sensation at the neck. Skin temperatures at several body locations, electroencephalographic activity, and blink-related measures were also recorded. In addition, drowsiness levels were evaluated from facial expressions.

The results showed that neck-directed airflow generally did not compromise thermal comfort; five of six participants maintained thermal comfort during airflow stimulation. A substantial decrease in neck skin temperature tended to be accompanied by decreases in both whole-body and local thermal sensation, although this relationship varied among participants, suggesting individual differences in the relationship between neck skin temperature and thermal sensation. Regarding driver alertness, airflow stimulation was associated with maintained alertness in some participants when it was initiated during a high-arousal state and accompanied by a decrease in whole-body thermal sensation. In contrast, airflow stimulation did not consistently maintain alertness when participants were initially in a low-arousal state, even when thermal sensation decreased. These results suggest that both the decrease in whole-body thermal sensation and the initial arousal state may contribute to maintaining driver alertness. Figure 1 shows the time courses of TSV, PTSV, and drowsiness level for ID1 and ID5, illustrating differences in responses according to the initial arousal state.

Overall, neck-directed airflow has the potential to maintain driver alertness while preserving thermal comfort. Further studies with more participants and different body locations are needed to clarify individual sensitivity characteristics and establish effective airflow-based strategies for maintaining driver alertness.

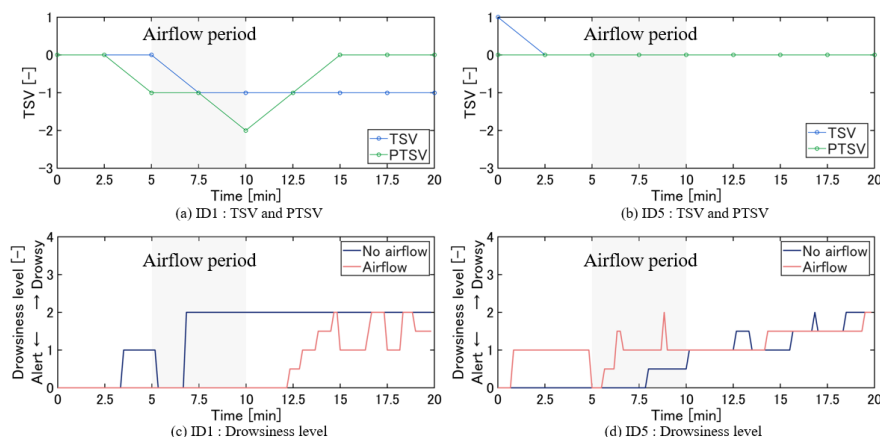


Fig. 1 Time courses of TSV, PTSV, and drowsiness level for ID1 and ID5