論　文　内　容　要　旨

Spatial navigation ability is associated with the assessment of smoothness of driving during changing lanes in older drivers
（空間ナビゲーション能力は高齢ドライバーの車線変更中における運転の滑らかさに関与する）
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In this study, we assessed the relationship between spatial navigation and driving smoothness, and tested whether a driving simulator can be used to evaluate smooth lane changes in older drivers. Age-related changes affect driving ability, including smoothness of driving. This operation requires the use of both allocentric strategies (based on world-centered representations) and egocentric strategies (based on self-centered representations); however, with age, a greater preference for egocentric strategies is evident when driving. Furthermore, an age-related decline occurs in both driving ability and spatial navigation. We therefore assessed the relationship between spatial navigation and driving smoothness, and tested whether a driving simulator can be used to evaluate smooth lane changes in older drivers.

A total of 34 healthy older drivers (mean age: 68.2 ± 5.4 years old) and 20 younger drivers (mean age = 20.2 ± 5.4 years old) participated in this study. Smoothness of driving was assessed using a driving simulator and spatial navigation was assessed using the Card-Placing Test-A/B. We also assessed visual perception and general intellectual function using standard neuropsychological tests. For the DS, which has been previously described in detail, we used a revised version of the Honda Safety Navi system (Honda Motor Co, Tokyo, Japan) (right handed drive version). DS used in this study was a modified version, which is a DS used for instruction in efficient, safe driving. Information such as steering and pedal operation, vehicle body coordinates, and speed, as well as events such as the scenario type, were stored as logs at sampling intervals of 10ms. When using part of the course of the scenario provided by the main software for the experiment, it is necessary to keep the log even if it is forcibly terminated in the middle of the scenario. Therefore, we used User Datagram Protocol communication to transmit the coordinates, speed, steering angle, accelerator pedal, brake pedal depression amount, turn signal status, and signal state.

Older drivers had significantly worse spatial navigation and exhibited less smooth driving than younger drivers. Furthermore, we found a negative correlation between smoothness of driving and spatial navigation within both groups.

The variance values of RMS Δ 3 and RMS Δ 3 were larger in the older group than in the young group. It has been reported that the entropy of the steering wheel operation when changing lanes at a constant vehicle speed is analyzed and the change of the speed in the lateral direction can be used as an index of driving skill. Furthermore, the first derivative of speed and the second derivative of speed when doing clockwise curves at the timing of the driver within statutory speed of the vehicle are related to the smoothness of driving and the level of skill. Therefore, we can propose that the value of RMS Δ 3 calculated from the change in the position in the lateral direction can be used as an indicator of the smoothness of the natural driving operation of the driver. In this study, we assume that the operation is smoother as the sum of RMS Δ 3 in each run is smaller. The older people had a large change in RMS Δ 3 and a lower ability to smoothly

control the vehicle. It has been reported that a driver predicts the future vehicle position based on the current vehicle information and operates while taking the distance from other vehicles into account. When assuming that acquisition density decreases with age, and that older people can accurately memorize the arrangement of a certain object in the room, rotate the positional relationship of the object [36], driving skills are influenced by caution, reaction time, memory, cognitive function, mental state, visual function, disability of body function, and self-monitoring during driving. Among these factors, we think that self-monitoring is important when changing the lane. The driver's perceptions the positional relationship between one's own and other vehicles predicts the distance feeling to other vehicles and the position of the own vehicle after lane change. For older people to perform these processes, they must access working memory of the frontal lobe several times, use the spatial navigation ability to make a situation judgment and to drive, and monitor the trajectory at the time of lane change from an allocentric viewpoint. Therefore, when changing lanes, the evaluation value of RMS Δ 3 of the older group and the variance value of RSM Δ 3 are advantageously larger than those of young; although cognitive function is within the normal range, it can be compensated consciously or unconsciously to secure safety. By adopting this strategy, the change in smoothness of the lane change is significant. We propose that older people cannot cope with the speed change of the car body and the spatial navigation ability decrease.

One of the limitations of this research is that it was not able to compare with actual car data. This means that we do not yet know if the smoothness of driving found in the present DS study applies to that of an actual car. Thus, we aim to conduct future experiments using actual cars to verify the present results. By doing so, there is a possibility that this will allow us to measure smooth driving trajectories with actual car, and thus overcome this limitation. Assessments of spatial navigation should be conducted using appropriate evaluation indices. Diversion to community-dwelling older, the purpose is to be able to participate in society safely in each region in a car society. It is expected that making the elderly driver aware of the spatial navigation ability from the physiological function test and the education and training stages will be a form of preventive safety to prevent traffic accidents caused by meandering driving. At the same time, as a function for cognitive and physical function support, it may be a necessary index for automakers to strengthen the accident prevention function for the elderly. It is expected that the creation of a common index for such a variety of occupations will facilitate cooperation. Furthermore, we want to extend the target to healthy people and use it as a support measure.