

Consideration of an Alert Method Using Positional Correspondence Between Seat Vibration and Attention Targets (Third Report)

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In recent years, the rising number of traffic accidents involving elderly drivers has become a serious social issue, necessitating countermeasures against age-related declines in cognitive and auditory functions. Traditional alert systems relying on visual and auditory stimuli can interfere with the primary information processing channels required for driving, potentially leading to cognitive delays. To address this, the authors have investigated the effectiveness of spatial attention effects (the Posner effect) using seat vibration, which is less likely to interfere with visual and auditory tasks. Spatial attention effects refer to the phenomenon in which reaction times to a target are significantly reduced when a cue is presented in the same direction as the target prior to its appearance, compared to when cues are presented in different directions. While previous reports (First and Second Reports) confirmed these effects in static environments, real-world driving involves various visual distractions and physical operations.

This study aims to investigate the applicability of seat vibration-induced spatial attentional orienting in a simulated driving environment involving dynamic visual loads and physical movements, and to clarify age-related effects on attentional processes and multisensory integration. Furthermore, by dividing elderly participants into younger-old and older-old subgroups, this study clarifies age-related differences in response characteristics and optimal information presentation modalities. Participants

(31 younger, mean age 22.3; 34 elderly, mean age 71.6) performed simulated steering and pedal responses while viewing drive-recorder footage on a 55-inch monitor. Four cue conditions were presented 2 seconds prior to target onset: (1) combined vibration and auditory, (2) vibration-only, (3) auditory-only, and (4) simultaneous bilateral vibration (baseline). Figure 1 shows the experimental setup.

The results revealed significant main effects for the cue factor in both age groups. In the younger group, all congruent conditions (1–3) significantly reduced reaction times compared to baseline, with combined stimuli (1) showing a greater facilitation effect than vibration-only or auditory-only conditions (Figure2). In contrast, the elderly group showed significant reaction facilitation only in the combined (1) and vibration-only (2) conditions, while the auditory-only condition (3) did not significantly differ from baseline (Figure3). Subgroup analysis indicated age-related differences in strategies: the younger-old group (up to 74 years) showed significant facilitation only in the combined condition (1), whereas the older-old group (75 years and older) showed significant facilitation in both combined (1) and vibration-only (2) conditions.

These findings suggest that seat vibration effectively induces spatial attentional orienting even under dynamic visual loads and driving-like physical movements. The results further suggest that attentional strategies differ across stages of aging. The younger group effectively integrated both vibration and auditory information. Among elderly participants, the younger-old group relied primarily on multisensory integration, whereas the older-old group utilized direct, highly reliable body-presented vibration information while also using multisensory integration. Multiple regression analysis supported this interpretation, showing that both modalities significantly predicted responses in the younger group, whereas only vibration showed a significant positive effect in the elderly group. This indicates that sensory information weighting shifts with advancing age toward highly reliable modalities such as vibrotactile information. Therefore, driver assistance systems should incorporate adaptive alert designs tailored to age-related attentional characteristics—specifically combining vibration and auditory stimuli appropriately—to support safe driving performance.



Figure1 Experimental view

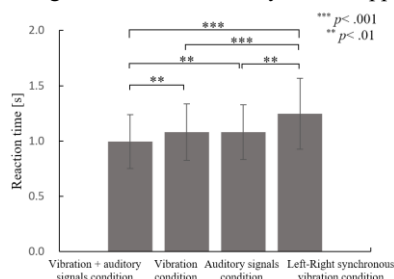


Figure2 Multiple comparisons in the young group

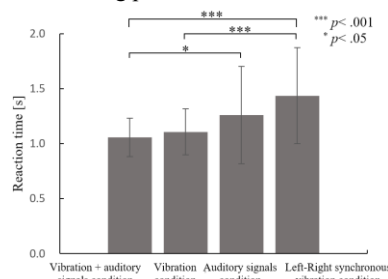


Figure 3 Multiple comparisons in the older group