Do You Need Your Ears to Drive?
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Abstract
Situational awareness in driving may sometimes rely on monitoring for key auditory events (e.g., emergency vehicle sirens). When hearing is impaired (naturally or artificially), drivers may employ compensatory visual strategies. There is little research investigating this area, so we tested how hearing deprivation affects normal-hearing drivers’ performance and to what degree they are capable of adapting. As expected, hearing-deprived participants performed worse than hearing-normal controls, but this performance difference decreased with practice.

Background

Hearing impaired drivers:
• Have been advocated for by global organizations since the 1960s.¹
• Are at least as safe as non-impaired drivers.² ³ ⁴
• Are still discriminated against in commercial driving.⁵

Vision appears to be the primary sense used while driving:
• Vision appears to be the primary sense used while driving:
  • Vision impairment is not correlated with driving performance.⁶

However, drivers are able to compensate for vision impairments:
• Some people can naturally compensate.⁷
• People can be taught to compensate to mitigate the performance decrement from their vision impairment.⁸

What about hearing impairments?
• There has been little to no research on compensatory strategies in drivers with a hearing impairment.
• There is a significant body of research regarding drivers with distracted hearing. Some people can compensate for that.⁹

Questions
Is hearing required in our driving task?
It is possible that drivers rely on the auditory nature of the emergency vehicle (EV) stimulus and thus will perform more poorly without sound. It is also possible that drivers use the siren to identify EV onset, but effortlessly switch to peripheral visual detection when sound is removed.

Can participants compensate for hearing loss in our driving task?
If a performance decrement is observed in the hearing impaired condition, drivers may or may not be able to compensate and adjust. If drivers can adjust, hearing-impaired driving will approach hearing-normal driving over the course of task practice.

Predictions
Hearing
The artificially hearing-impaired drivers will perform worse at a driving task than drivers without the artificial hearing impairment.

Practice
The artificially hearing-impaired drivers’ performance will improve faster to approach the performance of the drivers without the artificial hearing impairment.

Method
Thirty-four participants (32% female) completed the task and were paid (based on their performance) in order to motivate maximal performance.

Participants drove a low fidelity driving simulator across two 1-hour sessions. Their task was to respond to a red emergency vehicle (EV) approaching from behind (in rear view mirror) as quickly and accurately as possible by steering their vehicle out of the way. Those in the Hearing condition were able to hear a loud EV siren, whereas those in the No Hearing condition could not hear the siren.

EV onset detection performance was indexed using response time and accuracy (movement to the appropriate lane). Driving error was assessed by comparing the driver’s heading and the position of visual target.

Results: Emergency Error

As predicted, the hearing manipulation had a significant effect on the performance of the participants in the No Hearing condition as compared to the participants in the Hearing condition, \( F(1, 32) = 18.34, p < .001 \). The participants in the No Hearing condition were, overall, about 150 ms slower than the participants in the Hearing condition at responding to the emergency vehicle.

There was also a significant interaction between time and hearing condition, \( F(1, 174) = 5.90, p = .026 \). Participants in the Hearing condition improved at a rate of 3.40 ms per block, whereas participants in the No Hearing condition improved at a rate of 9.85 ms. Although both participant groups responded more quickly over time as a result of practice, the 300% increased rate observed in the No Hearing condition is most likely evidence of those drivers’ attempts to drive while monitoring EV onset visually rather than auditorily.

Results: Driving Error

Also as predicted, participants in the No Hearing condition produced greater mean driving error than those in the Hearing condition, \( F(1, 32) = 9.58, p = .004 \). The participants in the No Hearing condition had about .06 more degrees of error than the participants in the Hearing condition. There was no interaction between hearing condition and block condition for driving error.

General Discussion

In summary, drivers in the No Hearing condition exhibited performance decrements both in their overall driving performance (about 10% more driving error) and in their ability to respond quickly to an emergency vehicle (about 35% slower) as compared to the participants in the No Hearing condition. However, this performance difference began to minimize after only two hours of practice, as the participants in the No Hearing condition improved their ability to respond to the emergency vehicle at a much quicker rate than the participants in the Hearing condition (about three times faster).

Although the present data suggests that some type of strategy change occurs over the course of practice for those in the No Hearing condition, the experiment was unable to identify the exact nature of that change. We did notice that the drivers in the No Hearing condition had more driving error than drivers in the Hearing condition, which we believe may be due to an increased visual scanning pattern to incorporate the information lost from hearing. A future version will employ an eye-tracker to verify this prediction. Whatever strategies are used by auditorily deprived drivers, they may differ from those strategies adopted by deaf drivers. Further experiments will focus on comparing deaf drivers to hearing drivers.

References
4. Bay City News Service (June 26). Deaf drivers reach proposed settlement with UPS.