A Meta-analysis of In-vehicle and Nomadic Voice-recognition System Interaction and Driving Performance

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Problem Importance. Voice-recognition systems lessen the visual-manual demands of a wide range of system interactions. However, the extent that voice-recognition systems integrated into vehicles or available in mobile phone applications affect driving performance is incompletely understood. A comprehensive meta-analysis of experimental studies is needed to guide design, guidelines, policy and research.

Search and Study Selection. A variety of search strategies were used, including the assistance of a librarian, to query PsycINFO, SPORTDiscus, Academic Search Complete, PubMed, Medline, TRID, Scopus and Google Scholar electronic databases with no limitations on publication year. Search terms included “driv*,” “performance,” “behavior*,” “voice*,” “speech*,” “voice*,” and “hands*”, which were combined with Boolean operators.

Independent and Dependent Variable Coding. To meet study inclusion criteria, drivers had to interact with a voice-recognition system while driving. Examples of voice-recognition tasks include dialing, initiating a call, texting, emailing or destination entry. Coded dependent variables included reaction time, detection, lateral position, speed and headway (see SAE, 2015 for definitions). Comparisons of voice-recognition systems with baseline driving and/or a visual-manual condition were also coded. Additional coding process details and statistical citations appear in Caird et al. (2014) and Simmons et al. (2016). Of 817 identified citations, 43 studies involving 2000 drivers and 183 effect sizes (r) were coded into the meta-analysis.

Results. Compared to baseline driving, driving while interacting with a voice-recognition system is associated with increases in reaction time to stimuli and events (r = .56). Interactions with a voice-recognition system had a smaller reaction time effect compared to interactions with visual-manual systems (r = -.23). Compared to baseline driving, drivers who interacted with a voice-recognition system detected moderately fewer targets (r = -.42), which was similar to visual-manual systems (r = .12). Compared to baseline driving, voice-recognition systems are associated with a modest increase in SDLP (r = .28) and a moderate decrease in SDLP compared to visual-manual systems (r = -.38).

Conclusions. Overall, the pattern of results across measures indicate that the negative impacts of voice-recognition system use on driving are larger in magnitude than anticipated, and the benefits of voice-recognition systems are smaller than expected. Implications of the results for voice-recognition system integration, mobile phone applications, and future research will be discussed.

References

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