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Spoken Dialog Planning to Reduce User Distraction in Mobile Environments

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As speech technology becomes a significant modality in the vehicle environment, it is essential to develop and assess mechanisms that can reduce driver distraction. Although speech-based interfaces are natural candidates for hands-busy, eyes-busy environments such as the vehicle, they also present a potential safety hazard. Since language is inherently a cognitive process, the more attention that is required by the speech interface, the less that is available for the task of driving. Due to inevitability of vehicle-based speech interfaces, the question becomes how to design and modulate the human-computer communication flow so as to minimize the extra cognitive burden on the vehicle occupants. Similar observations can also be applied to pedestrians using smartphone-based applications, where distracted pedestrians pay less attention to where they are going. This project explored both basic and applied aspects of voice based human-machine interface interaction with the goal of providing insight regarding variables and strategies that are significant for minimizing user distraction in driving or pedestrian scenarios. The results are timely as the National Highway Traffic Safety Administration is considering Phase III distraction guidelines to address demands associated with voice-activated in-vehicle controls. As detailed in the reports below, many modern voice initiated in-vehicle systems may best be considered as auditory-vocal-visual-manual-cognitive interactions (e.g. mixed mode tasks) and a comprehensive demand assessment mechanisms may need to consider the time course of tasks of this nature.

For further information on this research please see:

Mehler, B., Kidd, D., Reimer, B., Reagan, I., Dobres, J. & McCartt, A. (2015 in press). Multi-modal assessment of on-road demand of voice and manual phone calling and voice navigation entry across two embedded vehicle systems. Ergonomics. DOI: 10.1080/00140139.2015.1081412

Abstract: One purpose of integrating voice interfaces into embedded vehicle systems is to reduce drivers' visual and manual distractions with 'infotainment' technologies. However, there is scant research on actual benefits in production vehicles or how different interface designs affect attentional demands. Driving performance, visual engagement, and indices of workload (heart rate, skin conductance, subjective ratings) were assessed in 80 drivers randomly assigned to drive a 2013 Chevrolet Equinox or Volvo XC60. The Chevrolet MyLink system allowed completing tasks with one voice command, while the Volvo Sensus required multiple commands to navigate the menu structure. When calling a phone contact, both voice systems reduced visual demand relative to the visual–manual interfaces, with reductions for drivers in the Equinox being greater. The Equinox 'one-shot' voice command showed advantages during contact calling but had significantly higher error rates than Sensus during destination address entry. For both secondary tasks, neither voice interface entirely eliminated visual demand.

Link to full text: http://www.tandfonline.com/doi/full/10.1080/00140139.2015.1081412

Reimer, B., Mehler, B., Reagan, I., Kidd, D. & Dobres, J. (2015). Multi-modal demands of a smartphone used to place calls and enter addresses during highway driving relative to two embedded systems. Insurance Institute for Highway Safety, Arlington, VA. Note this report is also under review for Journal publication.

Abstract: There is limited research on trade-offs in demand between manual and voice interfaces of embedded and portable technologies. Mehler et al. (2015) identified differences in driving performance, visual engagement, and workload between two contrasting embedded vehicle system designs (Chevrolet MyLink and Volvo Sensus). The current study extends this work by comparing these embedded systems with a smartphone (Samsung Galaxy S4). None of the voice interfaces eliminated visual demand. Relative to placing calls manually, both embedded voice interfaces resulted in less eyes-off-road time than the smartphone. Errors were most frequent when calling contacts using the smartphone. The smartphone and

MyLink allowed addresses to be entered using compound voice commands resulting in shorter eyes-off-road time compared with the menu-based Sensus but with many more errors. Driving performance and physiological measures indicated increased demand when performing secondary tasks relative to "just driving", but were not significantly different between the smartphone and embedded systems.

Link to full text: http://www.iihs.org/frontend/iihs/documents/masterfiledocs.ashx?id=2088

Reimer, B., Mehler, B., Dobres, J., McAnulty, H., Mehler, A., Munger, D., & Rumpold, A. (2014). Effects of an 'Expert Mode' Voice Command System on Task Performance, Glance Behavior & Driver Physiology. Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicle Applications (AutomotiveUI '14), Seattle, WA. DOI: 10.1145/2667317.2667320.

Abstract: Multi-function in-vehicle interfaces are an increasingly common feature in automobiles. Over the past several years, these interfaces have taken on an ever-greater number of functions and the ways in which drivers interact with information have become more complex. Parallel with these technical developments, interest in ensuring that these systems minimize demand placed upon the driver has also increased. Voice command capability has become a popular and desirable feature, as interacting with a vehicle interface through auditory/vocal interactions is often hypothesized to allow the driver to keep their eyes on the road and hands on the wheel. However, research has shown that production level voice command systems may still impart considerable visual demands on the driver (Reimer et al., 2013). These demands might be due in part to screen displays associated with extensive confirmatory dialogue and the driver's desire for visual confirmation that commands were accurately recognized. This study extends this work by comparing the default mode of a production voice system with an "Expert" mode which streamlines tasks by removing several confirmatory steps. We found that, although the use of the Expert mode significantly reduces overall task completion time, it has no appreciable effect on the amount of visual engagement; drivers still glance off the road for durations that are consistent with the Default mode. Implications for interface design and driver safety are discussed.

Link to full text: http://dl.acm.org/citation.cfm?doid=2667317.2667320

Other publications supported through this project include:

Munger, D., Mehler, B., Reimer, B., Dobres, J., Pettinato, A., Pugh, B., & Coughlin, J.F. (2014). A Simulation Study Examining Smartphone Destination Entry while Driving. Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicle Applications (AutomotiveUI '14), Seattle, WA. DOI: 10.1145/2667317.2667349.

Beckers, N., Schreiner, S., Bertrand, P., Reimer, B., Mehler, B., Munger, D. & Dobres, J. (2014). Comparing the Demands of Destination Entry using Google Glass and the Samsung Galaxy S4. Proceedings of the 58th Annual Meeting of the Human Factors and Ergonomics Society. Chicago, IL. pp. 2156-2160. DOI: 10.1177/1541931214581453.

McWilliams, T., Reimer, B., Mehler, B., Dobres, J. & McAnulty H. (2015). A Secondary Assessment of the Impact of Voice Interface Turn Delays on Driver Attention and Arousal in Field Conditions: A Consideration of 4 Vehicle Systems and a Smartphone. Proceedings of the 8th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design. Snowbird, UT. pp. 414-420.

McWilliams, T., Reimer, B., Mehler, B., Dobres, J. & Coughlin, J.F. (2015). Effects of age and smartphone experience on driver behavior during address entry: a comparison between a Samsung Galaxy and Apple iPhone. Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicle Applications (AutomotiveUI '15), Nottingham, UK. DOI: 10.1145/2799250.2799275.