VISUAL AND COGNITIVE DEMANDS OF USING APPLE'S CARPLAY, GOOGLE'S ANDROID AUTO AND FIVE DIFFERENT OEM INFOTAINMENT SYSTEMS

INTRODUCTION

Many in-vehicle information systems (IVIS), also known as infotainment systems, involve complex interactions to perform a task that requires the press of a button, a touch screen or a voice command. These interactions may distract motorists from driving by diverting their eyes and attention from the road and hands from the steering wheel. Prior research sponsored by the AAA Foundation for Traffic Safety provided a comprehensive assessment of 30 vehicles from a variety of manufacturers and the demand generated by the built-in (native) IVIS when using it to do things like give a voice command to send a text message. However, many manufacturers now provide access to Apple's CarPlay® and Google's Android Auto®, which allow the driver to pair a smartphone with the vehicle to perform IVIS tasks through the vehicle's interface.

As part of AAA's Center for Driving Safety and Technology, the AAA Foundation for Traffic Safety partnered with the University of Utah to examine these systems and address the following questions:

- How demanding are CarPlay and Android Auto in comparison with built-in (native) infotainment systems?

- How demanding are these systems when performing different tasks? Tasks include: calling/dialing, sending a text message, programming audio entertainment or programming navigation.

- What level of demand is associated with completing these tasks using voice commands, touchscreens or other interactive technologies (e.g., buttons, dials)?

- How does the demand vary across different types of vehicles?

KEY FINDINGS

With respect to the overall system comparison:

RESULTS

- Both CarPlay and Android Auto systems were less demanding than built-in (native) infotainment systems for the tasks employed.

- CarPlay and Android Auto systems generated an overall moderate level of demand, whereas the built-in (native) systems led to overall very high levels of demand.

With respect to different types of tasks (calling or dialing, text messaging, programming audio entertainment or programming navigation):

RESULTS

- For most tasks, both CarPlay and Android Auto systems were less demanding than built-in (native) infotainment systems.

- CarPlay had lower overall demand than Android Auto for sending text messages.

- Android Auto had lower overall demand than CarPlay for programming navigation and was much less demanding than built-in (native) infotainment systems.

Visual and Cognitive Demands of Using In-Vehicle Information Systems

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With respect to mode of interaction (using a center stack display, auditory/vocal commands):

RESULTS

- Visual demand associated with CarPlay and Android Auto was lower for both auditory/vocal and center stack interactions when compared to built-in (native) systems.
- For CarPlay, demand levels were nominally lower with center stack interactions than for auditory/vocal interactions.
- For Android Auto, demand levels were lower with auditory/vocal interactions than for center stack interactions.

With respect to different vehicle makes and models:

RESULTS

- Of the five built-in (native) infotainment systems tested, two generated very high levels of demand overall and three generated moderately high levels of overall demand.
- For both CarPlay and Android Auto, three vehicles generated overall high levels of demand and two vehicles generated overall moderate levels.
- The CarPlay and Android Auto systems also varied in overall demand when they were deployed in different vehicles.

IMPLICATIONS

Consumers should know that just because technologies, like those tested, are compatible with or built into a vehicle does not mean industry testing has proven them safe to use while driving. Motorists should only use these technologies for legitimate emergencies or urgent, driver-related purposes.

Technology companies and automakers can leverage these results to isolate the most significant sources of driver demand generated by use of their products, and to enhance their designs to minimize the demands placed on drivers.

METHODOLOGY

Five vehicles from different manufacturers were tested in the current study (model year 2017–2018). Vehicles were selected for inclusion in the study based on whether the vehicle's built-in (native) system supported both CarPlay and Android Auto. Depending on the available features, each vehicle offered up to two modes of interaction, including auditory/vocal commands and center stack display. Four types of tasks were evaluated using the different systems and modes of interaction, including: (a) selecting or programming audio entertainment, (b) calling and dialing, (c) text messaging, and (d) programming navigation.

Participants included 64 licensed drivers ages 21 to 36, who had normal or corrected-to-normal vision and a clean driving history. A total of 24 drivers were tested in each vehicle in the study and the majority of drivers were tested on multiple vehicles on separate occasions.

Testing and evaluation took place on a two-mile stretch of residential roads with a posted speed limit of 25 mph and generally low traffic patterns. A study investigator was present in the passenger seat during the entire session for safety monitoring and data collection. After familiarization with the road, vehicle, systems, tasks and modes of interaction, testing commenced. Participants were instructed to drive the designated route from one end to another, repeating the assigned tasks several times on each drive.

Drivers also completed three benchmark trials. The first was a single-task baseline condition, where participants drove without performing any IVIS tasks. The second was a highly demanding cognitive task that has been used in many previous laboratory and on-road studies. The third was a highly demanding visual task — also used in many previous studies — that was presented on an in-vehicle display.

A number of objective and subjective measures were gathered both during and after each drive to generate the demand scores, including two variants of the Detection Response Task (DRT, International Organization for Standardization #17488) and the NASA Task Load Index.