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Grand Test Auto

Designing Simulator Assessments of Game-based Mental Models of Automotive Safety Technology

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Abstract

Drivers often have poor conceptual understanding of new driver safety systems, such as adaptive cruise control (ACC). Older drivers tend to be more willing to learn about these systems by reading manuals, but also struggle with learning the uses and limitations these safety systems. This study investigates the effect of different materials and modes of learning – tinkering with games, solving problem scenarios and reading direct instruction – on mental models of ACC and driving performance in a driving simulator. We designed written assessments to supplement the driving measures produced in the simulator in order to understand how different forms of instruction impact the ways older and younger drivers learn about ACC systems.

Introduction: Comparing learning with games, scenarios, direct instruction

Drivers often have dangerously poor conceptual understandings of new driver safety systems such as adaptive cruise control (ACC) (Jenness et al., 2008), a form of cruise control that maintains distance between vehicles. In fact, a majority of ACC owners are not aware of any system limitations, and many are confused about when and how their ACC is operating (Jenness et al., 2008). Many drivers of ACC-enabled vehicles do not read their owner's manuals and consequently overtrust system performance (Kazi et al., 2007). Older drivers, in particular, often struggle to understand the uses and limitations of a safety system (Jenness et al., 2008).

We present a framework for assessing three different modes of mental model development about adaptive cruise control. Our assessment model compares tinkering with game-like interactives, problem-solving with case scenarios, and text-based direct instruction, and then examines mental model development using a high-performance driving simulator and a test of conceptual knowledge about the ACC system's limitations.

Theoretical Framework: Games, scenarios, mental models

Research suggests that game- and simulation-based interactive media can be powerful tools that help learners build domain-specific knowledge and skills, because they a) guide players as experience, experiment and tinker with a model of complex phenomena; and b) ask players to use concepts to solve increasingly-difficult problems (Gee, 2008). Modeling these experiences through games and scenarios is a method of building and transforming knowledge that enables individuals to focus on specific properties of a concept. Based on these models, people can make and test predictions to see if they hold true in real life. Once interrogated, these specific experiences facilitate problem solving that moves from concreteness to abstraction (Gee, 2008).

Learning across instructional formats for older drivers

Counter to the perception that older learners may be uncomfortable with technology-based materials, research suggests older individuals learn more from multimedia than from static visual material (Lin & Hsieh, 2006). Other suggestions for older learners include using interactive materials or hands-on involvement (Mayhorn et al, 2004).

Methodology

During the study, participants: (1) take a ACC mental model pretest; (2) are randomly assigned to one of three instructional formats; (3) take a second ACC mental model test; (4) complete a 30-minute simulator drive; and (5) take a post-drive assessment. We use 2x3x3 repeated measures design, with Age (younger/older) and Instruction (text, scenario, interactive) as between-subjects variables, and Assessment (pretest, post-instruction test, post-driving test) as a within-subjects variable. We will also compare driving performance measures to a post-driving assessment about ACC limitations and system function.

Characterizing Modes of Learning: Games, scenarios, and direct instruction

The game condition involves tinkering with an interactive game-like toy (see Figure 1) in which the user can manipulate parameters such as driving speed, traffic speed and road curves, and observe how ACC responds. The scenario condition involves sequenced, text-and-graphic problem-based scenarios of driving situations using ACC. The direct instruction condition is similar to reading a car manual, with text and graphics.

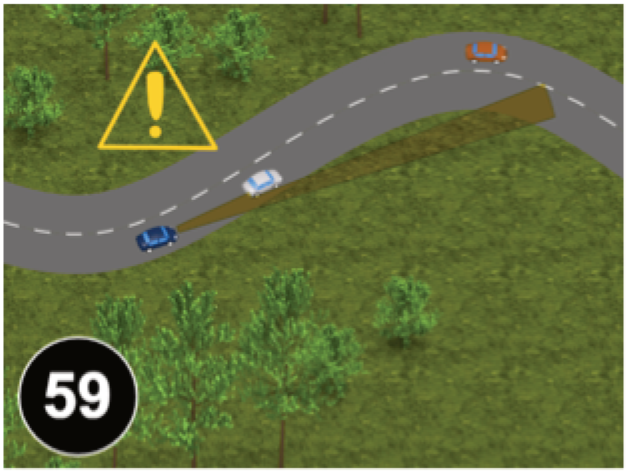

Figure 1. (left) ACC interactive game-like toy. Figure 2. (Right) Virtual driving simulator

Driving Simulator

In the driving simulator task, subjects are asked to complete one drive that features a 5-minute warm-up drive and a 30-minute ACC challenge drive. Throughout the 30-minute challenge drive there are events that test the driver's ability to utilize and understand ACC (see Figure 2). A participant's performance in the driving simulator is logged and then processed into standard driving performance measures (e.g., initial response time, time to collision) and event-specific measures (e.g., steering response, vehicle position).

Assessment of Mental Models

We constructed a written assessment to evaluate drivers' mental models of ACC (based on Beggiato & Krems, 2013). This measure is comprised of 40 5-point Likert-scale items. 30 of these items require the participant to indicate their degree of agreement with statements about ACC functioning, and 10 items require the participant to indicate how well the ACC system would help them to avoid a collision in various situations.

Significance and future research

This framework investigates the relationship between generational ways of learning with different forms of media, mental model development, and driving performance in an effort to better understand the relationship between a person's conceptual knowledge and their capacity to use that knowledge in timely action.

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