Contact: Laura B. Dunn
ldunn@aaafoundation.org
(202) 638-5944, Ext 9
AAAFoundation.org

AAA Foundation for Traffic Safety

FACT SHEET

The Smartphone and the Driver's Cognitive Workload: A Comparison of Apple, Google, and Microsoft's Intelligent Personal Assistants

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Background

- Nearly every vehicle sold in the U.S. and Europe can now be optionally equipped with voice-controlled functions, to allow drivers to maintain their eyes on the road and hands on the wheel.
    - A large and growing body of literature cautions that auditory/vocal tasks may have unintended consequences that adversely affect traffic safety.
- The AAA Foundation for Traffic Safety's previous research with the University of Utah reported on a methodology for assessing cognitive distraction in the vehicle and subsequently measuring cognitive workload on six 2013 vehicles with voice-based technology, and Apple's personal assistant (Siri).

Objective

- The objective of this research was to examine the impact of voice-based interactions using three different intelligent personal assistants (Apple's *Siri*, Google's *Google Now*, and Microsoft's *Cortana*) on the cognitive workload of the driver.

Methods

- The selected tasks and experimental structure were designed to extend prior work using embedded vehicle systems:
    - Evaluated cognitive demands of number dialing, contact calling, and music selection, that included:
        - 31 subjects; average age of 42 with an average of 26 years of driving experience
        - Comparison to low workload baseline single-task (just driving) and high workload baseline math and memory tasks.
    - Evaluated the cognitive demands associated with voice-based text messages, that included:
        - 34 subjects; average age of 42.5 with an average of 26.8 years of driving experience
        - Comparison to low workload baseline single-task (just driving) and high workload baseline math and memory tasks.

Key Findings

4 Major Findings:

1. Performance while "on task," or manipulating the phone, was associated with surprisingly high levels of workload, based on on/off task DRT (Detection Response Task) data. In many instances the "on-task" levels of workload experienced by the driver were very close to the mentally challenging OSPAN (baseline math and memory tasks) task.
    - This high level of workload should serve as a caution that these "hands-free" voice-based interactions can be very mentally demanding and ought not to be used indiscriminately while operating a motor vehicle
2. Using the voice-based personal assistants to place calls, select music, or send text messages was associated with a significant increase in the distraction of the driver, compared to just driving.
    - Overall workload ratings reflected a moderate to high level of distraction.
3. There were significant differences in the distraction experienced by the driver when they used the different smartphones to perform the same tasks in the same driving conditions.
    - Distraction was directly related to the number of system errors, time on task, intuitiveness and complexity of the different systems.
    - Generally, robust, error-free systems tend to have lower workload than rigid, error-prone phones; difference in mental workload between the smartphones was associated with the number of system errors, the time to complete an action, and the complexity and intuitiveness of the devices.
4. "Off-task," or not manipulating the phone and just driving, DRT data showed evidence of lingering distraction, for up to 20 seconds, after the driver finished interacting with the device. It takes the brain a few seconds to reset itself after such high levels of distraction.

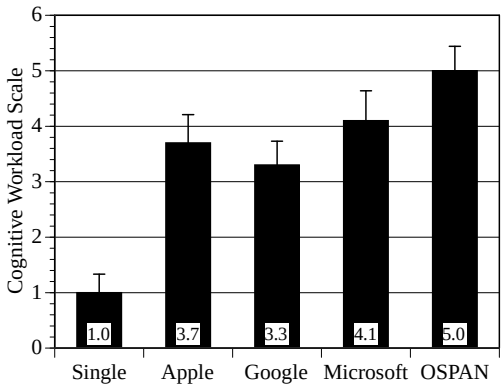

Figure 15. The cognitive workload scale for the Apple, Google, and Microsoft systems compared to single-task (category 1) and OSPAN (category 5). Error bars reflect 95% confidence intervals around the point estimate.

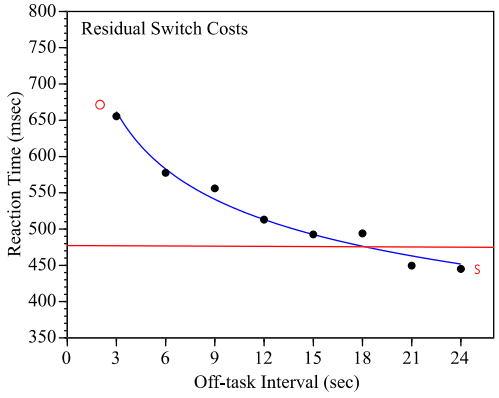

Figure 14. Residual switch costs in transitioning from on-task to off-task performance. Residual switch costs are significantly different from the single-task baseline up to 18 seconds after the on-task interval had terminated.

For more information on this study and the AAA Foundation's other traffic safety research and materials, please visit AAAFoundation.org.

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607 14th Street, NW, Suite 201 | Washington, DC 20005 | AAAFoundation.org | 202-638-5944