SYS 6007 – Assignment A5

Title: The Effects of Texting on Reaction Time in Autonomous Driving Safety

Introduction

Tesla Model X driver struck a safety barrier on March 2018 and was hit by several other vehicles and later died from his injuries. The autopilot was engaged, and the Tesla’s autosteer vision system lost track of the lane markings that it used to maintain lane position. The driver did not respond to the error because he was distracted by a mobile phone game (NTSB, 2020). Automated driving can cause distraction that can delay responses through reduced feedback, passive monitoring, and poor mental models (Lee & Seppetl, 2012). Therefore, we would like to study how the introduction of an autonomous driving feature in automobiles affect driver performance and workload. We hypothesize that driver distraction by texting and driving will lead to longer reaction times, which may increase the risk of accidents and reduce overall safety in autonomous driving. This study explores the influence of cognitive resources on the text and driving using the Multiple Resource Theory (MRT) and mental workload measures using TLX ratings.

Background

Texting requires additional manual tasks (pressing the keyboard) and verbal processing (composing the contect) to an already demanding activity (Wickens 2009). The additional manual and verbal tasks of texing cause the delayed reaction time. This study will implement Multiple Resource Theory (MRT). MRT is a cognitive psychology model that helps to understand and predict human performance in multitasking environments. It suggests that human cognitive resources are divided into multiple channels or “pools,” which can be classified based on processing strategies (perception, cognition, and response), code (spatial or verbal), and modality (visual or auditory). When tasks require different resources, they can be performed concurrently with little interference. However, when tasks compete for the same resources, performance may decline due to resource limitations.

Research Method

Participants: A sample of 34 licensed drivers from the general population aged 25-65 who have some experience with autonomous driving technology. The sample size is calculated with a Cohen’s f of 0.25, power of 0.80 and an alpha level of 0.05.

Independent Variables: The independent variable is the driving condition: autonomous driving without texting (control condition), and autonomous driving while texting (experimental condition).

Dependent Measures: The dependent measures will include driver reaction time, errors, and near collision incidents, NASA-TLX ratings.

Procedures/Protocols:

1. Pre-experiment: Provide participants with an overview of the experiment, obtain informed consent, and collect demographic information. Ensure participants are familiar with the autonomous vehicle’s features and controls.
2. Training: Allow participants to familiarize themselves with the autonomous vehicle and its operation in a safe, controlled environment. Offer practice sessions for both control and experimental conditions.
3. Control Conditions: Instruct participants to drive the autonomous vehicle on a designated route or visual simulation, focusing on monitoring the environment and the vehicle’s performance. Record baseline performance measures, such as reaction times, error rates, and near collision incidents.
4. Experimental Condition: Instruct participants to drive the autonomous vehicle on virtual simulation while engaging in a texting task. The texting task involves reading and responding to text messages on a smartphone. Record performance measures.
5. Post-experiment: After completing both conditions, administer the NASA-TLX questionnaire to assess participants’ perceived workload for each condition.

Data Analysis

During the experiment, we gather the participants’ performance data for each task and condition. This includes:

1. Reaction time: Measure the time it takes for participants to respond to events or stimuli (e.g., warnings or obstacles) during the driving task. This can be done using the driving simulator software.
2. Error rates: Record the number and types of errors made by participants, such as missed warnings, incorrect responses, or late reactions.
3. Near-collision incidents: Count the number of incidents in which the participant’s vehicle comes dangerously close to colliding with another vehicle, pedestrian, or obstacle.

The study will use within-subject ANOVA to determine significant differences. Analyze NASA-TLX scores to access perceived workload in both conditions. Compare scores across the six TLX dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration. The researchers use MRT to analyze task overlap and resource competition between driving-related tasks and the text task. Identify specific resource bottlenecks that contribute to increased workload or decreased performance in experimental conditions. Then, investigate correlations between performance measures, NASA-TLX socres, and MRT related findings. This will identify factors that may moderate the relationship between texting, workload, and driving performance driver experience or driving complexity. Based on the results of this experiment, researchers can implement driver monitoring systems, or developing public awareness campaigns.

Potential Limitations

One potential limitation is that the study may not be fully ecologically valid, as the experimental drives may not perfectly replicate real-world driving conditions. To address this limitation, future studies could incorporate more realistic driving scenarios, such as on-road testing. Additionally, participants may have different levels of familiarity with the autonomous driving feature, which could affect their performance and workload. Future studies could assess participants’ familiarity with feature and explore its potential effects on performance and workload.

References

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