

AGE-RELATED FACTORS EFFECTING THE PERCEPTION OF ESSENTIAL INFORMATION DURING RISKY DRIVING SITUATIONS.

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ABSTRACT

The aim of this research project was to develop and test a potential methodology for studying age differences in driving situation awareness. Young, middle and older aged adults completed a battery of psychological tests as well as several trials using a realistic driving simulator. A concurrent memory probe technique was used to measure someone's ability to attend to important information while driving. Participants were randomly stopped and were explicitly cued to recall what was important to their driving task at the exact moment of the stop, such as current speed, or lane position. Their answers were checked against the actual simulator data and a composite score was created. Preliminary results confirm the hypotheses that older adults have more difficulty attending to important information while driving when compared to young and middle-aged adults.

Keywords: Driving performance; aging; situation awareness and aging

INTRODUCTION

During this century, we have been witnessing the "graying of America," with the average age of the population steadily rising (Moody, 1994). Importantly, as our population is aging, our world is also becoming increasingly technical and complex. Driving is one of these complex tasks that we perform as part of our everyday activities. In general, good drivers are more aware of their surroundings than poor drivers. In part, because the ability to attend to important and necessary information while driving is essential for good driving performance.

This ability is embedded in the construct of Situation Awareness (SA), which is defined as the internal conceptualization of the current situation (Endsley, 1997). Thus, I believe a person's ability to attend to important information during driving is related to the work on SA. Borrowing from the research in SA, we need to know if the driver is capable of perceiving, comprehending and understanding all that is around them, and if they are able to guide their future actions based on their understanding of the current situations.

Bolstad and Hess (in press) believe that age differences in SA will be greatest during its initial formation: in the ability to perceive what is important in the surrounding. For instance, while driving a car, such important information can be lane position, speed, location of other cars, buildings, pedestrians or assessment of the weather. If drivers are not attending to the necessary information, it seems logical that performance will ultimately suffer. However, SA is closely related to experience. Thus, it seems likely that an experienced older driver in certain situations and with certain tasks can perform as well as younger driver. There may come a time, however, when the experience will no longer insulate the driver from performance decrements.

We can hypothesize that several cognitive and physical abilities are needed for the ability to attend to important information. These include vision, perception, memory, attention, and time sharing abilities. We know that these abilities change with age (Laux, 1995; Salthouse, 1985; Smith & Earles, 1996; Craik, 1994; Korteling, 1993) and are more pronounced as the task difficulty increases (Craik, 1994; Tun & Wingfield, 1997).

We can therefore speculate that the ability to attend to important information (initial formation of SA) will also change with age due to changes in these cognitive abilities. Therefore, older drivers that have deficits in certain cognitive and physical abilities will also be deficient in their ability to attend to important information. In particular, older drivers who have difficulties in certain cognitive and visual abilities will also have reduced ability to attend to and process the necessary information in the environment when compared with middle aged and younger adults. This result should be most apparent in complex driving situations, due to the demands of the task, when compared with low workload environments.

A concurrent memory probe technique was used in this study to measure the ability to attend to important information while driving. This research tested the efficacy of this technique to discriminate between. The work presented here is pilot study and a more extensive study is currently being conducted.

METHODS

Participants

Three age groups of drivers were recruited for this study: young (ages 16-25) middle-aged (40-50) and old (65-80). Twenty-four adults (10 males and 14 females) participated in this study and they ranged in age from 19 to 83. The young adult group consisted of 6 participants (mean age 20.5, mean driving experience 5 years). The middle-aged adult group consisted of 10 participants (mean age 43.9, mean driving experience 31.2 years) and the older adult group consisted of 8 participants (mean age 76.6, mean driving experience 60.0 years). All participants held valid drivers' licenses and currently drove at least 5 days a week.

Design

A 3 x 2 mixed factor design with age (young, middle and old), and complexity level (moderate and high) will be used. Complexity level was a within group variables.

Tasks and Materials

Simulator Trials. This research used a PC-based, high fidelity, fully interactive driving simulator called STISM (Systems Technology Interactive Simulator). The simulator provides both immediate visual and auditory feedback to the user as well as steering torque. It contains driving hardware, a steering wheel and brakes system and is completely reconfigurable.

Three 11-min test trials and one 15-min practice simulator trial was created for this study. The test trials contained both complexity levels as well as a one-minute no complexity scenario. The practice trial began with 5 minutes of no complexity followed with 5 minutes of moderate complexity and 5 minutes of high complexity. Complexity was manipulated by varying the content of the scenarios. In the no complexity condition, the scenario was a four-lane road with no other traffic, buildings, or pedestrians in the scene. In the moderate complexity condition, the scenario contained a nominal number of other cars and buildings, and also incorporated a few speed limit changes, and both a school and work zone. In the

high complexity condition, the road was also a four-lane road, but it contained 4 times the amount of traffic, buildings and intersections with crosswalks.

Perception of Important Information Measure. The first part of the study involved the development of the concurrent memory probe. The queries were created by using a cognitive task analysis with the aid of subject matter experts (SME's). The analysis occurred in two stages; the first used unstructured interviews and the second stage used a goal-directed task analysis. Unstructured interviews were conducted with five experienced drivers. These drivers had a minimum of 18 years of driving experience. They were asked, "What would you want to know to have perfect driving performance?" The goal-directed task analysis was created to assure that the information obtained through the unstructured interviews was complete and representative of the requirements needed for good driving behavior. From these two analyses a structured questionnaire was created that contained a comprehensive list of possible important driving elements, such as weather, speed and lane position. Twenty-five participants (mean age 55.0 and mean driving experience 38.8 years) rated the importance of these items in terms of good driving behavior. Eight items with the highest mean ratings were used to create the queries for use during the driving scenarios. Seven of these queries are shown in Table 1. The last query is a map in which the participant indicates their lane position and the position of any neighboring cars.

Table 1. Queries used at each simulator stop.

Please indicate your current speed. (Circle your choice) A. 0-5 mph L. over 65 mph
How fast is the closest driver in front of you going? (Circle your choice) A. Faster than me B. Slower than me C. About the same speed D. No cars in front
Please indicate how close the pedestrians are to you. (Circle your choice) A. Within 1 second of travel time in front of me B. Between 1 – 5 seconds of travel time in front of me C. Between 6-10 seconds of travel time in front of me D. Just past pedestrians within the last 10 seconds (in back of me) E. No pedestrians in sight
What is current color of the closest traffic signal in front of you? (Circle your choice) A. Red B. Yellow C. Green D. None
Can you legally get through the next intersection without stopping? (Circle your choice) B. Yes C. No D. No intersection in sight
Are you currently travelling? (Circle your choice) A. Above the speed limit B. At the speed limit C. Below the speed limit
What is the road like ahead of you in the next 30 seconds? (Circle your choice) A. Straight B. Left subtle curve

- | | |
|----|---------------------|
| C. | Right subtle curve |
| D. | Left curve (sharp) |
| E. | Right curve (sharp) |

Procedure

Participants completed two hours of testing in one day. Upon arrival to the lab, they completed an informed consent sheet and background questionnaire. This was followed by a vision test designed to measure Useful Field of View, a perceptual speed task and a dynamic memory task (WAIS-III letter number sequencing task).

After completing the paper and pencil tests, the participants received a half-hour of training on using the STISM simulator as well as how to complete the queries (perception of important information). Participants were instructed to follow all the roadway signs (speed limits, stop lights) and warnings, as they would in the actual world. After training, each participant completed three 11-min driving trials in the simulator.

During each trial, the simulator was stopped four times to administer the queries (twice during each complexity level), for a total of 12 stops, 6 per complexity level. The stops occurred at random times after the participant completed at least two minutes of driving to ensure they had adequate time to build up their perception of the environment. After completion of all the research requirements, participants were fully briefed on the purpose of this research.

RESULTS

At random intervals in the trial (2 to 4 min), the simulator was stopped and the participants were asked to complete a random list of the queries with regards to what was important to their driving task at the exact moment of the stop. Participant's answers were recorded and compared against the actual information. Data analysis revealed that the data from the pilot study was not significant at the .05 level, but the trends are being reported. As expected, participants answered fewer queries correctly when driving in the more complex scenarios (see Figure 1). As shown in figure 2, at the moderate complexity levels older adults had the lowest percentage of correctly answered queries while middle aged adults had the highest performance. In comparison younger adults had the best performance under the high complexity level, while older adults still had the lowest performance (see Figure 3).

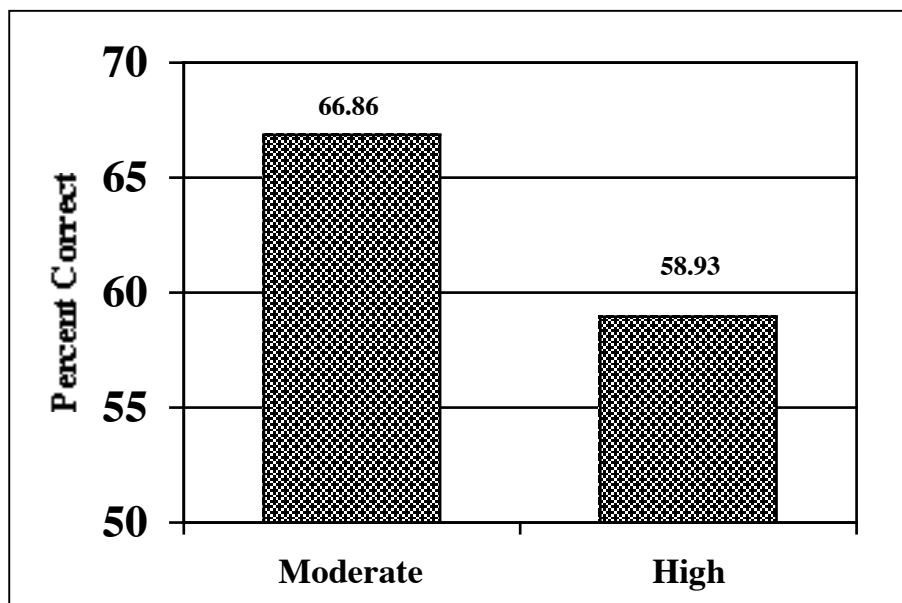


Figure 1: Percent of queries answered correctly for each complexity level.



Figure 2: Percent of queries answered correctly for the moderate complexity trials.

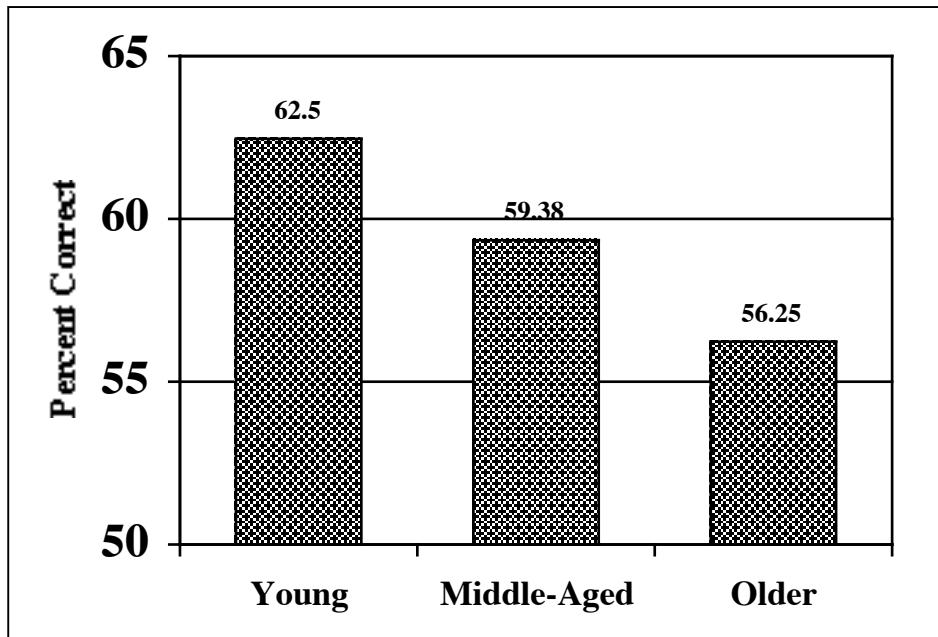


Figure 3: Percent of queries answered correctly for the high complexity trials.

DISCUSSION

Overall, age alone did account for a significant proportion of the performance variance of the dependent memory probe task in the high complexity scenarios. During the complex driving task younger adults had the highest performance. In the moderate complexity scenarios there appears to be a trade-off between cognitive abilities and experience. Older adults have the most driving experience, but typically perform lower on cognitive abilities test while young adults typically have the highest cognitive abilities and the lowest driving performance. These two group exhibited lower situation awareness, as measured by the concurrent memory probe technique than the middle aged adults who have fairly high cognitive abilities and moderate amount of driving experience. These hypotheses are currently being tested in a follow on study and should help to shed some light on the impact of normative age-related cognitive changes on driving abilities.

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