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Effects of Focal on Driver Calibration of Attention Maintenance Performance Using Normalized Difference and Brier Scores

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EFFECTS OF FOCAL ON DRIVER CALIBRATION OF ATTENTION MAINTENANCE PERFORMANCE USING NORMALIZED DIFFERENCE AND BRIER SCORES

by

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ABSTRACT

EFFECTS OF FOCAL ON DRIVER CALIBRATION OF ATTENTION MAINTENANCE PERFORMANCE USING NROMALIZED DIFFERENCE AND BRIER SCORES

James Richard Unverricht
Old Dominion University, 2019
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Young drivers are specifically poor at maintaining attention to the forward roadway while driving. Additionally, drivers are poorly calibrated to their own abilities, often overestimating their driving skills. The current research examines the effect of FOCAL on a young driver's calibration using two different measures, normalized difference scores and the Brier score. Thirty-six participants received either FOCAL or Placebo training program, immediately followed by driving simulator evaluation of their attention maintenance performance. In the evaluation drive, participants had driven through four scenarios in a driving simulator with their eyes tracked. Participants were asked to perform a mock visual search task on a tablet simulating an infotainment in-vehicle system while driving in each scenario. After each drive, participants filled out a questionnaire for the Brier score. Once all drives were complete, the participant filled out one final questionnaire used for the normalized proportion of glances. FOCAL trained drivers performed better than Placebo trained drivers on attention maintenance and were greater calibrated using the normalized proportions measure. The brier score measure did not find any significant differences. Theoretical and practical implications and future directions are discussed.

For Mom, Dad, Grandma, Nini, and the countless others who helped me along the way.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Young novice drivers face disproportionally high fatal crash risk compared to experienced drivers. In 2008, young drivers aged 16-19 were found to have fatal vehicular crash rates per 100 million miles driven that were four times higher than experienced drivers aged 30-70 (IIHS, 2008). A more recent statistic has found that young drivers aged 18-24 experience almost twice as many deaths in passenger vehicles as experienced drivers aged 30-70 (IIHS, 2015). Researchers have often examined risky behaviors as a predictor of young drivers' elevated crash risk (Cestac, Paran, & Delhomme, 2011; Jonah, 1997). For example, a meta-analysis conducted in 1997 examined 40 different studies looking at the relationship between driver characteristics such as sensation seeking and found medium to large correlations with risky driving behaviors (Jonah, 1997). McKnight and McKnight (2003), however, showed that cognitive factors such as errors in attention and hazard recognition were significantly stronger predictors of crashes among young novice drivers than risky behaviors. In fact, McKnight and McKnight (2003) reported that over 60% of crashes involving young drivers were attributed to inattention to the forward roadway, poor visual search, and hazard recognition, independent of individual difference factors such as risky behaviors. This is particularly striking because this indicates a possibility that training programs can be developed to improve higher cognitive skills and thereby road safety for young drivers.

One higher cognitive skill that is critical for young drivers' road safety is *attention maintenance*. Attention maintenance is the ability to maintain visual attention to the immediate forward roadway while controlling a vehicle. Failure in maintaining attention on the forward roadway while driving has been linked with vehicular crashes (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). Engaging in secondary in-vehicle tasks can serve as an adversative to good attention maintenance skills and result in accidents. For example, a 100-car large scale naturalistic study reported that roughly 22% of all accidents can be accounted for by drivers' engagement in another task while driving (Klauer et al., 2006). In fact, the same study found that engaging in some secondary in-vehicle task accounted for 54% of driver inattention from the driving task and glancing away from the forward roadway for longer than 2 seconds significantly increased risk of crashes. Operationally, drivers with good attention maintenance skills should not execute off-road glances longer than 2 seconds, a threshold value derived from the 100-car naturalistic study (Klauer et al., 2006).

Previous driving simulator studies clearly demonstrated that young drivers are poor at maintaining attention on the forward roadway while engaging in secondary in-vehicle tasks (Pradhan et al., 2009; Chan et al., 2010; Divekar et al., 2013; Yamani, Samuel, Knodler, & Fisher, 2016). Chan and colleagues (2010), for instance, recorded eye movements of young and experience drivers as they navigated through various virtual environments in a driving simulator while they were asked to concurrently perform various in-vehicle tasks for 15 seconds each. They found that novice drivers glanced inside the vehicle longer than 2 seconds in about half of the scenarios while experienced drivers only glanced inside for 10% of the scenarios, illustrating young driver's poor attention maintenance ability.

Critically, the researchers not only found that attention maintenance performance was poorer in young drivers, they also had developed and evaluated the effectiveness of computer-based training programs on enhancing young driver's attention maintenance performance. One successful training program develop is *FOrward Concentration and Attention Learning* (FOCAL; Pradhan et al., 2009; 2011; Divekar et al., 2013). FOCAL was developed as a PC-based program to train drivers to limit their in-vehicle glances to less than 2 seconds. The trainee begins training by conducting a visual search task requiring a trainee to scan a map for a target street name or view a series of videos simulating the forward visual area (FVA) during driving. The trainee can only view either the FVA or the map and must switch between both views by pressing the spacebar on a computer keyboard. The trainee is then required to limit the duration of each "glance" towards the map eventually reducing the time to a target threshold of 2 seconds. If the trainee fails this requirement, the program provides feedback and prompts the trainee to repeat the failed trial (see Methods for a full description of FOCAL). Notably, the program employs a 3M method of training, allowing the trainee to make a **M**istake, **M**itigate the mistake by allowing practice, and then **M**aster target skills. This method has been proven effective in not only FOCAL but also other driver training programs focusing on higher cognitive skill development for young drivers (Fisher et al., 2002; Unverricht, Samuel, & Yamani, 2018).

Previous evaluation studies all confirmed FOCAL's effectiveness in decreasing proportion and number of off-road glances longer than 2 seconds (Pradhan et al., 2011; Divekar et al., 2013; Unverricht, Yamani, & Horrey, 2019). For example, a driving simulator experiment examined the effectiveness of FOCAL in reducing off-road glances longer than 2 seconds using young drivers (Divekar et al., 2016). Their eye movement data supported the effectiveness of FOCAL training by showing that FOCAL-trained drivers produced 23% fewer in-vehicle glances longer than 2 seconds while engaging in the in-vehicle task, in comparison to Placebo-trained drivers. Pradhan and colleagues (2011) performed an on-road evaluation of FOCAL and again showed that FOCAL-trained drivers executed roughly 18% fewer in-vehicle glances longer than 2.5 seconds in comparison to the placebo group. Additionally, retention of the training's effectiveness at reducing long in-vehicle glances has been shown to remain effective up to four months after treatment (Divekar et al., 2016). What psychological mechanism is responsible for the trained drivers improving their attention maintenance performance? One potential candidate is driver calibration.

Calibration

Calibration has been defined as the difference between a subjective appraisal and an objective measure of the ability of interest (Horrey et al., 2015; Roberts et al., 2016). The smaller the difference between the subjective appraisal of one's ability and the objective measure of his/her actual ability, the better calibrated an individual is. Within the driving domain, calibration is an important aspect because a driver's self-perceptions can deviate from his/her actual ability, potentially elevating their crash risk particularly among young drivers. Such miscalibration can take a form of either overestimation or underestimation of one's own ability.-A driver who *overestimates* their abilities might engage in actions or maneuvers they are unable to safely execute. For example, one might overestimate their awareness of the surrounding environment and begin texting unaware of potential hazards that can materialize. Alternatively, drivers who *underestimate* their abilities might not engage in actions that they should. For example, a driver merging onto the highway during traffic might be underestimating their ability to maintain speed and lane positioning required to successfully merge, resulting in slowing their speed and forcing them to make an abrupt and sudden movement to complete the task of merging onto the highway. Being appropriately calibrated has been reported to be an important aspect to safe driving (Kuiken & Twisk, 2001).

In the literature, self-perceptions are often studied under self-appraising. Previous research found that individuals can be poor at self-appraising their own abilities (Dunning, Heath, & Suls, 2004; Stajkovic, & Luthans, 1998; Woodman & Hardy, 2003). Overall, people tend to overestimate their own abilities in comparison to their peers. This phenomenon has been discussed using terms such as optimism bias or self-enhancement bias throughout various different domains of research including Sports, Education and learning, and Medicine. (Zell & Krizan, 2014). Within the domain of surface transportation, drivers overwhelmingly and consistently overestimate their own driving abilities (Deery, 1999; Svenson, 1981; Weinstein & Lyon, 1999; Brown, 1986; Walton, 1999; Delhomme, 1996; McCormick, Walkey & Green, 1986; McKenna, Stanier & Lewis, 1991; Brown & Groeger, 1988; DeJoy, 1989; DeJoy, 1992; Delhomme, 1991; Guppy, 1993; Freund, Colgrove, Burke, & McLeod, 2005; Amado et al., 2014; Horswill, Waylen, & Tofield, 2004; Roberts, Horrey, & Liang, 2016; Unverricht, Yamani, & Horrey, 2019). For instance, an on-road study evaluating over 150 drivers found that roughly 95% of the drivers believe their own abilities to be better than their actual performance (Amado et al., 2014). Moreover, another study asked 181 drivers to self-appraise their own driving performance and found they rated themselves higher than both their peers and the average driver across 18 different components of driving (Horswill et al., 2004).

Research consistently shows that specifically young drivers overestimate their driving abilities (Mathews & Moran, 1986; Gregersen, 1996; Horswill et al., 2004; de Craen, 2010). Not only do young drivers consistently overestimate their driving abilities, but also their miscalibration does not appear to improve for a couple of years after obtaining their driving licensure. For example, one longitudinal study (de Craen, 2010) examined 500 young novice drivers across the span of two years and found that young drivers overestimated their driving abilities when compared to older experienced drivers. Additionally, they found that driver's calibration did not improve during the first two years of their driving, meaning that they remained overestimating their abilities even with two years of driving experience. This is particularly dangerous for young drivers as overestimation of driving skills is thought to be correlated specifically with young driver's high crash risk (Gregersen, 1996; Mathews & Moran, 1986).

Various models have been developed to describe calibration in general including factors such as task demand and age. Figure 1 models a basic representation of the elements that comprise calibration and their relationships with one another based on Fuller's Task-Capability Interface Model (TACM; de Craen, 2010). In this model, as a driver adapts to different task demands, they alter the complexity of a situation and thus their perception of that complexity. This model represents calibration as a product of three intermixing factors: self-assessment of skills, perceived complexity, and adaptation to task demand.

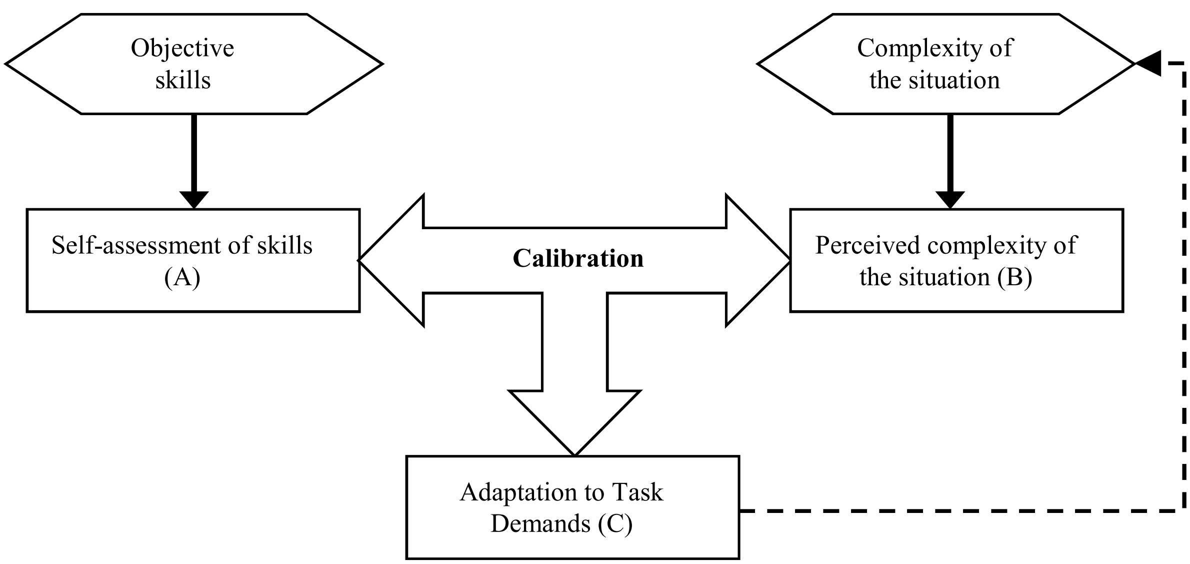

Figure 1. Model of the process of calibration

Figures 2 and 3 represent a more detailed demonstration of TACM (Fuller, 2005). TACM suggests that drivers modulate their driving behavior to maintain a certain level of difficulty. This difficulty is comprised of two elements: driving capacity and driving demands. Both figures demonstrate the possible outcomes when a driver's capacity is greater or less than driving demands. Figure 3 shows how various individual differences such as experience comprise a driver's capability and how variables such as speed comprise task demands. According to TACM, as a driver's task demands exceed their capabilities, collisions can occur.

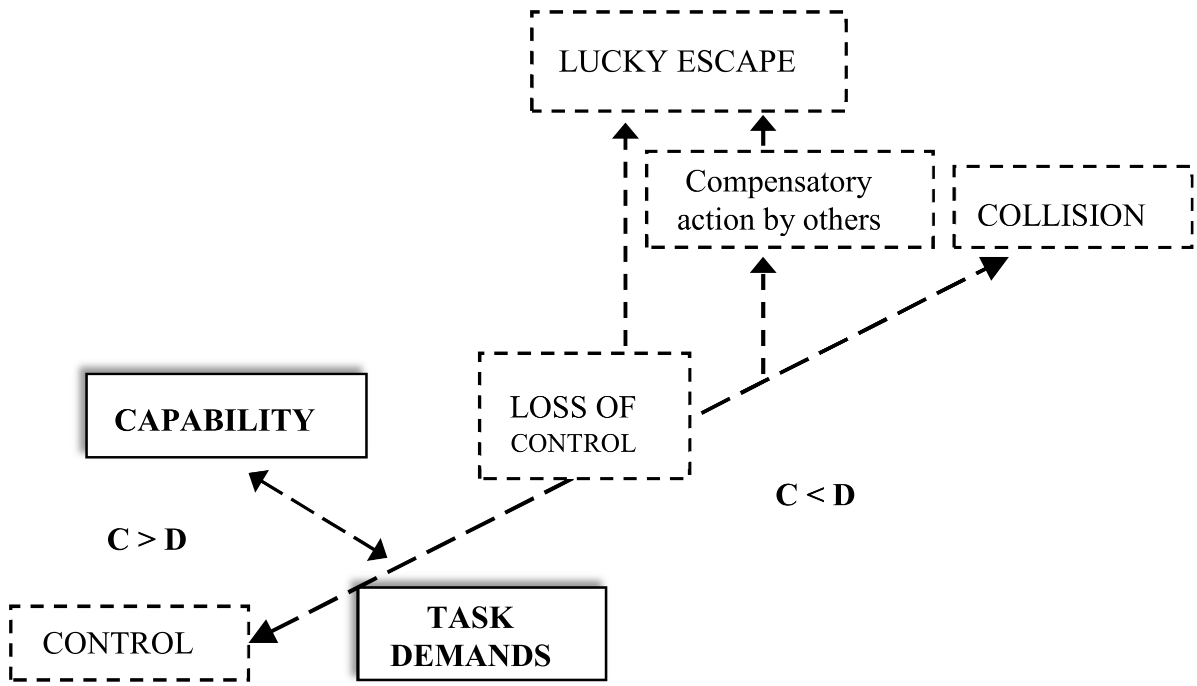

Figure 2. Outcomes of losing control using Task-Capability Interface Model

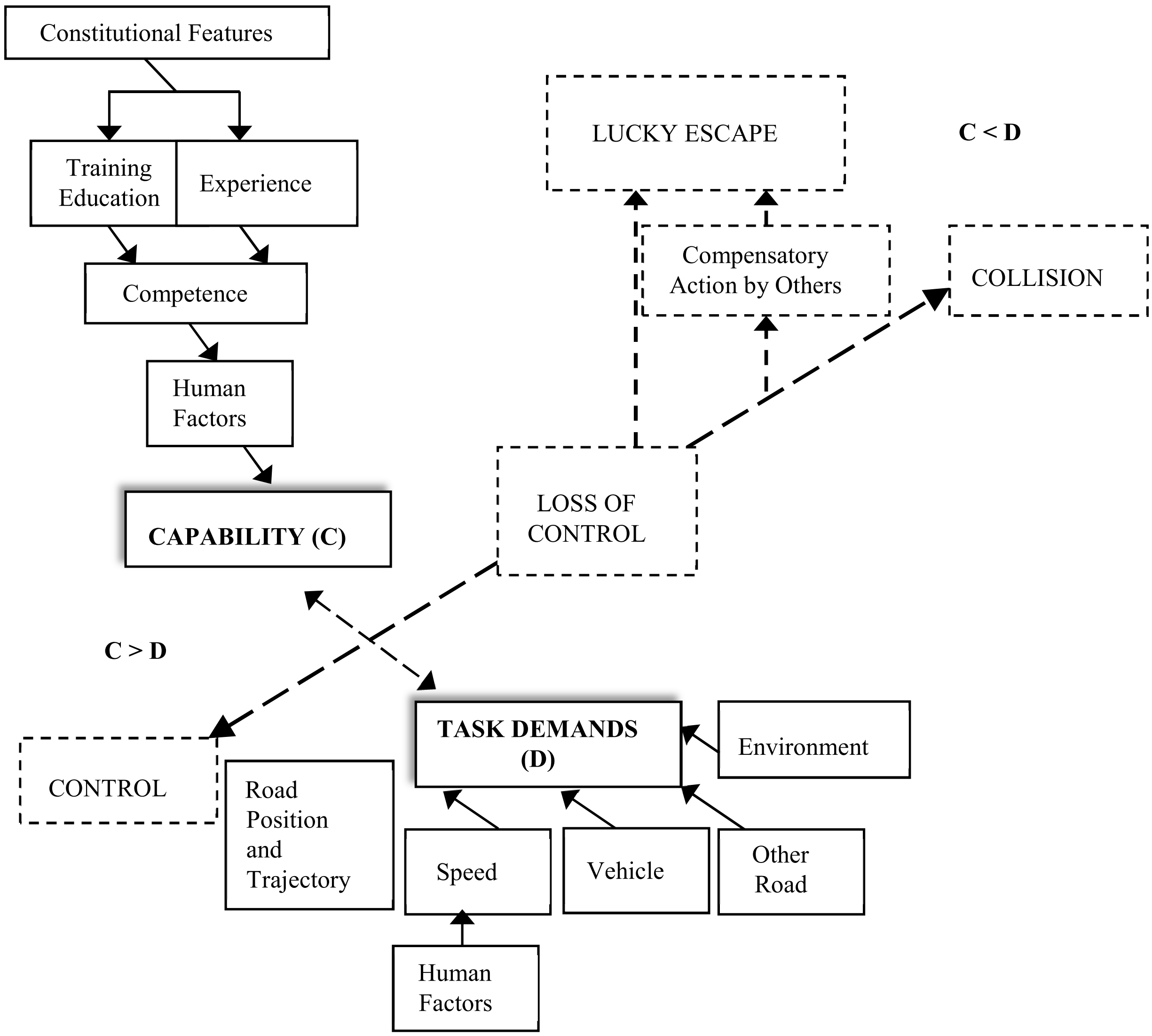

Figure 3. The Task-Capability Interface Model

Horrey and colleagues (2015) proposed a theoretical framework to describe driver calibration based on a human information-processing model (Wickens, Hollands, Banbury, & Parasuraman, 2016), situational factors such as driving demands and task demands, global factors such as personality traits and age, and the lens model (See figure 4; Horrey et al., 2015).

This framework examines the stream of information that a driver processes from selection, processing, integration to response execution impacting their perception of the state of the world and driver's "current performance". Note that the framework features a closed-loop system where a driver's perception of current performance and actual abilities influence later calibration processes. This can be especially important for examining the poor driving performance of young drivers as their global factors might influence their ability to correctly calibrate themselves, thus their ability to drive safely.

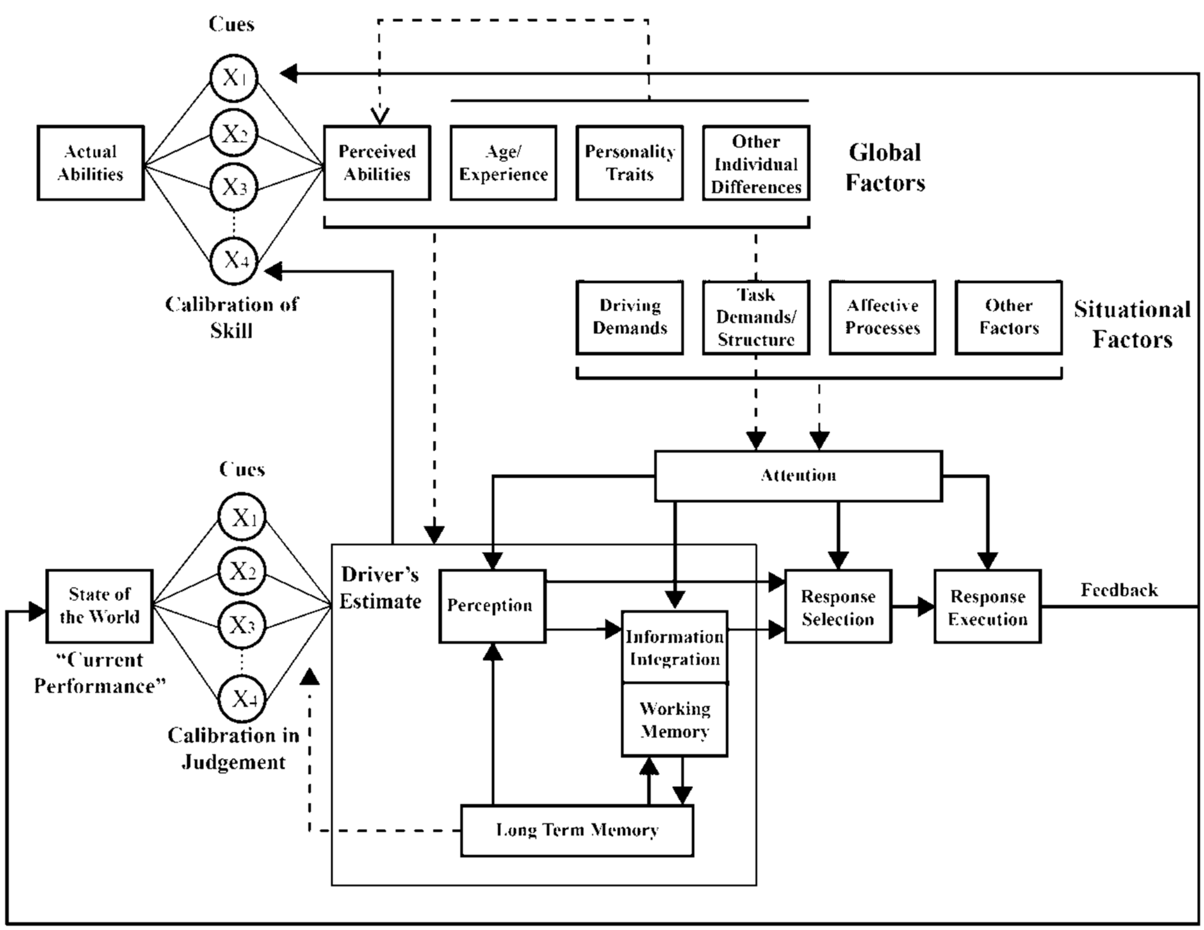

Figure 4. Driver calibration framework proposed in Horrey et al. (2015)

Previous research has shown driver calibration can be improved via driver training programs (Hay, Adam, Bocca, & Gabaude, 2016; Unverricht, Yamani, & Horrey, 2019). Unverricht and colleagues (2019) recently examined whether FOCAL improves driver calibration. Participants first completed either FOCAL or the Placebo training program. Then, participants navigated through various different scenarios within a driving simulator with their eyes tracked. In each scenario, the participant was asked to complete one visual search task that simulated an in-vehicle task for 15 seconds. At the end of all four simulations, the participants rated their performance on limiting their in-vehicle glances to less than 2 seconds. Strikingly, analysis of normalized subjective and objective performance data showed some evidence that FOCAL in fact improves their calibration when compared to Placebo condition. Consistent with the literature, the Placebo-trained drivers overestimated their attention maintenance ability while the FOCAL trained group did not, suggesting that FOCAL may help drivers better calibrate themselves to their attention maintenance skills.

Of the current interest is to further extend the previous research by examining the mechanisms behind the effects of FOCAL on young driver's calibration. A literature review on measuring calibration has noted several methodological problems (Sundstrom, 2008). Particularly, driver's calibration is consistently measured by asking drivers to rate their driving behaviors in reference to the average driver, which can result in a biased estimate or an estimate that does not accurately represent their true subjective rating. Multiple explanations have been presented to why this bias occurs such as the word average denotes a negative connotation biasing their results by framing the comparison against a negative connotation (Groegar, 2001). Another explanation is that unclear definitions, of the ability that is being self-appraised, results in the individual choosing favorable aspects causing overestimation in comparison to the average (Ackerman, Beier, & Bowen, 2002). In either explanation, a driver comparing their ability against an "average" driver will report a higher estimate of their ability than they truly hold (Sundstrom, 2008).

Two suggestions were made to better measure calibration. First, to remove ambiguity, the subjective driving skill should incorporate specific actions related to the driving task. Second, elements of confidence should also be measured. Self-report inherently comes with a degree of uncertainty, therefore measuring confidence in participant's self-appraisals could elicit important information regarding a person's calibration. Previous calibration research has generally not accounted for confidence in their calibration analyses. As indicated in Unverricht et al. (2018; 2019), the normalized proportion measure of driver calibration has a limitation, it only considers a driver's objective and subjective performance without considering the confidence of each response.

One possible method to measure calibration, proposed by Roberts et al. (2016), is the application of the Brier score. The Brier score is a measure of the accuracy of a probabilistic prediction (Brier, 1950; Murphy, 1973; Lichenstein and Fischhoff, 1977; 1980) and can provide insights into the calibration process by quantifying a driver's skill and confidence as probabilistic judgments. The Brier score is a composition of three separate terms: knowledge, calibration, and resolution. *Knowledge* refers to a person's ability to classify events. *Calibration* denotes how accurate one's self-appraisals of performance match their actual performance, while taking confidence into consideration. *Resolution* means one's ability to differentiate between different levels of uncertainty. Thus, each term can elicit different components of an individual's self-appraisal. Roberts and colleagues (2016) applied the Brier Score to measure calibration within the driving domain. The participants completed a driving session in a closed-off track, performing tasks that were to simulate various demands of driving (i.e. Traffic cones to simulate a narrow road, Pace clocks to simulate merging situations). They found that feedback improved a driver's calibration in some tasks and not others, suggesting that improvements to calibration because of feedback may vary by task type. In addition, they found similar trends between normalized difference scores and Brier scores, but their statistical evidence did not converge.

In the current study, thirty-six participants were randomly assigned to receive either FOCAL or a Placebo training program. Following the completion of the assigned program, they drove through four scenarios in a medium-fidelity driving simulator with their eyes tracked. In each scenario, they performed a mock visual search task on a tablet simulating an infotainment in-vehicle system (Unverricht et al., 2019). After each drive, participants filled out a questionnaire for the Brier score (Table 2, see below). Once all drives were completed, the participant filled out a final questionnaire used for the normalized proportion of glances (Table 1, see below). I hypothesized that the proportion of off-road glances longer than 2 seconds would be lower for the FOCAL-trained drivers than the Placebo-trained drivers. Additionally, the FOCAL-trained drivers would be better calibrated than the Placebo-trained drivers on both the normalized proportion and the Brier score measures of calibration.

CHAPTER II

METHOD

Participants

Thirty-six young drivers were recruited from the community of Old Dominion University. Eighteen drivers were in the FOCAL group (14 females, mean age = 18.47 years, *SD* = .78, range = 18 – 21, mean years since licensure = 2.38 years, *SD* = .76) and eighteen drivers were in the placebo group (16 females, mean age = 18.88 years, *SD* = .79, range = 18 – 21, mean years since licensure = 2.31 years, *SD* = 1.51). All drivers held a valid drivers' license and received 2.5 research credits for their participation.

Apparatus & Materials

Driving Simulator. A medium-fidelity driving simulator (Real-time Technologies, Inc.) was used for the experiment. The simulator system consists of a leather built in cabin, three 60" screens controlled by three independent computers, and a dashboard screen (Figure 5) with 5.1 surround speaker system for simulating external and internal noise and presenting auditory instruction for the in-vehicle task. Each display projects a driving image with a resolution of 1024 by 768 pixels and generated at 120 Hz. The distance between the driver and center screen is approximately 145 cm resulting in a forward field of view of approximately 145°.

Figure 5. Image of RTI simulator.

Eye Tracker. To record participant's eye movements, a head-mounted ASL Mobile Eye (Applied Science Laboratories, Inc.) was used. The eye tracker consists of a spectacle mounted unit (SMU) and a monocle (See Figure 6). The SMU consists of two cameras, one that records the external scene image and the other that emits an infrared light source to the monocle reflecting the light into the eye by a set of LEDs. Eye Vision software was used to superimpose a crosshair indicating the driver's gaze to the scene image.

Figure 6. ASL Mobile Eye.

Calibration Questionnaire. Two questionnaires were used to measure participant's calibration. The first is modeled after the NASA-Task Load Index (NASA-TLX; Hart, & Staveland, 1988) and the driver calibration questionnaire used in the pilot experiment (Unverricht et al., 2019). The questionnaire consists of eight items asking participants to report their subjective evaluation across several dimensions such as frustration during task and self-performance during task (See Table 1). The participant responds to these questions by marking a straight line along a 10-cm visual analog scale with anchors ranging from "*low*" to "*high*". This questionnaire was used to compute the normalized difference scores between performance and self-appraisal. Additional items are included in the questionnaire to mitigate effects of demand characteristics and for exploratory analyses.

TABLE 1. Calibration and Workload Questionnaire.

Calibration Questionnaire
Mental Demand: How much mental / perceptual activity was required during the Waze task?
Physical Demand: How much physical activity was required during the Waze task?
Time Pressure: How much pressure did you feel due to the rate or pace at which the Waze task was presented?
Own Performance: Please rate your performance on limiting your in-vehicle glances to less than two seconds during the Waze task.
Own Performance: Please rate your performance on completing the Waze task accurately.
Perceived Effectiveness: How effective did you think the training was?
Frustration Level: How insecure, irritated, or stressed were you? (versus relaxed, secure, gratified)
Effort: How hard did you have to work to accomplish your level of performance?

The second questionnaire consists of eight items allowing the participant to self-appraise their performance across four metrics: attention maintenance, task performance, speed control, and lane positioning. Response options are the same as the previous questionnaire. The participant responds to the questions by marking a straight line along a 10-cm visual analog scale with anchors ranging from "*low*" to "*high*". After each self-appraisal, the participant will rate their confidence in their decision by using the same method (See Table 2). This questionnaire was used to compute the Brier Score.

TABLE 2. Brier Score Calibration Questionnaire

Brier Score Questionnaire
1. Rate your performance on limiting your in-vehicle glances to less than two seconds during the Waze task.
1a. Please rate your confidence in your decision.
2. Rate your performance on the completing the Waze task accurately.
2a. Please rate your confidence in your decision.
3. Rate your performance on lane positioning (keeping your car straight) during the Waze task.
3a. Please rate your confidence in your decision.
4. Rate your performance on maintaining the speed limit.
4a. Please rate your confidence in your decision.

Driving Scenarios

Four environments, similar to those used in previous work (Hamid et al., 2014; Yamani et al., 2016; Yamani et al., 2018) and slightly adjusted from the pilot experiment (Unverricht et al., 2019), were used. All four environments (Highway, Residential, Rural, and Town) were absent of ambient traffic and were 8,530 feet in length. Each scenario featured a variety of different environmental configurations and speed limits to better resemble their environmental counter-parts (See Figure 7). The rural scenario consisted of vegetation on both sides of the road and three curves with a speed limit of 45 mph and two 4-way stop-sign-controlled intersections. The highway scenario consisted of a four-lane straight road with no buildings or vegetation on either side, but with one construction site and two billboards with the speed limit of 45 mph. The residential scenario consisted of a two-lane road, one three-way stop-light intersection, one three-way stop-sign intersection, and a curved road with the speed limit of 35 mph. On each side of the road, there was vegetation, residential houses, and some commercial buildings such as fast food restaurants. The town scenario consisted of a two-lane straight road, commercial and government buildings along with parking lots, high-rise buildings, three four-way stoplight intersections, and two-obstacles blocking the driver's lane. The obstacles were presented to cause the driver to interact with the vehicle during the trial and were only present during the town scenario. The first obstacle was a parked car with their lights blinking and traffic cones placed around the vehicle. The second obstacle was a construction site with an excavator slightly impeding the driving lane and traffic cones blocking off the driver's path. A visual message appeared in the top right quadrant of the center screen informing the driver to pass along the left-hand side as they approached the obstacle and then return to their right-hand lane after they passed the obstacle.

FIGURE 7. Top left: Residential scenario. Top right: Town scenario. Bottom left: Rural Scenario. Bottom right: Highway scenario.

In-vehicle Task

Participants used a navigation application (Waze) via a Samsung Galaxy Tab E lite (Samsung Electronics America, Inc.) to report the distance between ODU and a target location. This task was adjusted from the pilot experiment (Unverricht et al., 2019) and reflected those used in previous experiments (Yamani et al., 2016, in press; Bicaksiz et al., 2017). Each trial took place approximately half-way through the drive (3,280 feet) on a straight road with no distractions or dynamic objects. As the participant began the trial, they received an auditory instruction asking them to find the target location. After receiving the instruction, an auditory beep sounded, indicating the 15-second interval the participant had to complete the task. The participant had to manually navigate the google maps system using their finger by entering in the target location into the touch screen search bar (See Figure 8).

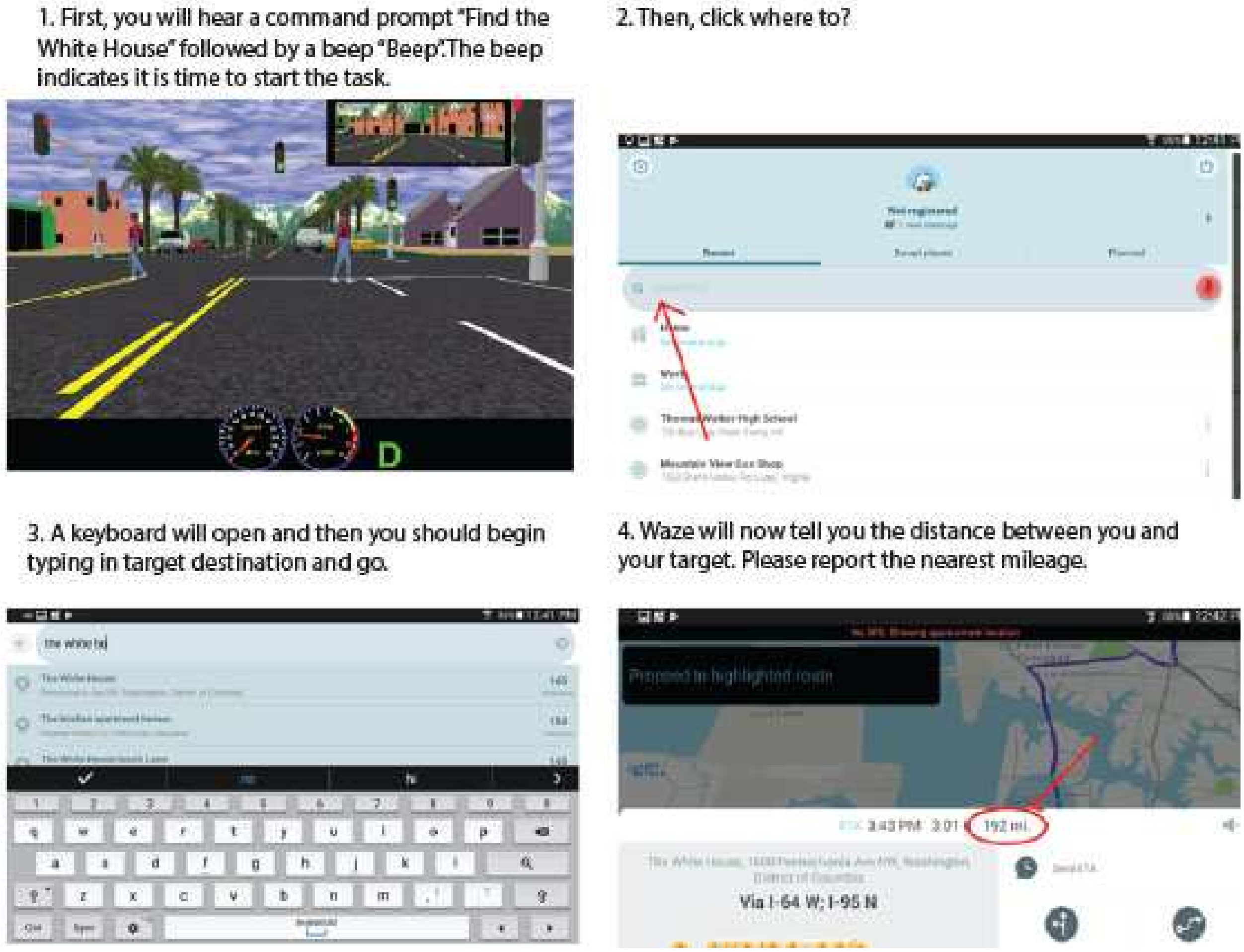

FIGURE 8. Driving task informational sheet.

After successfully entering the location and navigating through the system, they were required to verbally report the distance in miles between their current position at ODU and the target location. The target locations were: The Denver Art Museum (1,761 miles to ODU), Christopher Newport University (26 miles to ODU), Mountain View Gun Shop (212 miles to ODU), and Thomas Walker High School (500 miles to ODU). After 15 seconds had passed, the simulator's speaker system sounded another auditory beep indicating the end of the trial and to stop performing the task. If the participant has not reported the correct distance by the second beep, their answer was coded as incorrect. An experimenter manually recorded the participant's verbal response each trial.

Training Programs

FOCAL. FOCAL training program was created to train novice drivers to reduce the number of off-road glances longer than 2 seconds. Created at University of Massachusetts at Amherst, this program consists of two separate programs, Attention Maintenance Assessment Program (AMAP) and FOCAL. Each trainee will experience three stages of training, a pre-test stage (AMAP), training (FOCAL), and post-test stage (AMAP). The segmentation of the program allows the trainee to establish a baseline of attention maintenance ability, provide training to improve the trainee's attention maintenance ability, and compare a post-training measure of attention maintenance with the pre-training one. FOCAL applies a 3M training method, allowing trainees to Make mistakes, Mitigate those mistakes, and ultimately Master targeted skills. The pre-test stage consists of four videos filmed from the driver's perspective in downtown Amherst, Massachusetts, approximately 1-minute in length. The videos contain road signs, pedestrians, other vehicles, and passing vegetation all simulating a normal driving experience. Each video is presented using the horizontal upper half of the screen and a map is presented on the bottom half. The map consists of roadway patterns and street names as seen in a normal road map. At any point in time, only half of the screen is visible with the other half blacked out, showing either the video of the forward visual area (FVA) or the map. Trainees may switch back and forth between both halves by pressing the space button on the keyboard to access the map or enter to access the video. Each portion represented either the primary task of driving (video) or a secondary in-vehicle task (map). Each trial begins with the video presented and the map masked. While viewing the video, trainees are asked to click either pedestrians, vehicles, or road signs pass through two superimposed vertical bars. This is to ensure their engagement in the primary task. The secondary task is assessed by the trainees engaging in a visual search task of three different street names that are presented at the beginning of the trial. At the end of the video, the trainee was asked to report which streets were present on the map and which ones were not. Not all street names were present on the map.

FOCAL training follows the completion of the pre-test. This portion of the training consists of four modules: feedback, timer, three-second in-vehicle glance training, and two-second in-vehicle glance training. All four modules were presented to all participants in the same order. In the first module, the participant is given feedback about their performance during AMAP. The video with the longest single glance away from the FVA, indicating their poorest performance, is played back to the participant. The playback only shows the video portion with no map task present, only for the duration during which the trainee viewed the FVA in the pre-test. The trainees are then informed that when they are engaging in the secondary tasks, they are unaware of what is happening on the forward roadway to make them cognizant of the dangers of especially long glances. The second module is identical to the first module except during the blacked out phases a visible timer counts how long each glance off-road is. The third module trains the trainee to reduce glances at the map to lower than three seconds. Training is separated into two sub-modules, one automatically obscuring the map and returning glances back towards the video if the trainee viewed the map for longer than three seconds, and in the other trainees had to manually toggle different viewpoints as seen during AMAP. In addition, the trainee is told before the training to keep glances less than three seconds, perform the map task, and perform the video task during each trial. The trainees were instructed that poor performance in any of these three metrics would result in repeating the trial. Trainees could repeat each trial up to a maximum of three times to conserve total training time. However, during the first sub-module, the trainee would only have to repeat the trial if they incorrectly identified the street name. In the second sub-module, trainees repeat the trial if they either incorrectly identified the street name or glanced at the map for longer than three seconds (poor video task performance was not penalized unknown to trainees). The fourth module was identical to the previous module except the threshold for glances were reduced from three seconds to two seconds. In both the third and fourth modules, the first submodule (automated) contained three video tasks and the second submodule (manual) contained four video tasks. After completing the FOCAL training, their performance was measured again using the identical AMAP used in the pre-test. The full training will take approximately 45 minutes to complete (See Table 3).

TABLE 3. FOCAL Training

Program	Module	Submodules and content
AMAP	Pretest	Baseline task watching four pre-recorded videos
FOCAL	1. Feedback	Participants view the pre-test video with the longest glance away. The glances away are represented by blacking out the screen.
	2. Timer	Participants view the pre-test video with the longest glance away. The blacked out screen has a timer showing the driver how long each glance away was.
	3. Three-second in-vehicle glance training	Participants perform task to three videos while glances away are restricted to 3 seconds. After 3 seconds, the FVA is automatically restored.

		Participants perform task to four video clips while glances away are restricted to 3 seconds. After 3 seconds, the participant must manually toggle the FVA or repeat trial.
	4. Two-second in-vehicle glance training	Participants perform task to three videos while glances away are restricted to 2 seconds. After 2 seconds, the FVA is automatically restored.
		Participants perform task to four video clips while glances away are restricted to 2 seconds. After 2 seconds, the participant must manually toggle the FVA or repeat trial.
AMAP	Posttest	Repeat baseline task

Placebo program. The Placebo program consists of information from the Virginia Driver's Manual (Sections 1, 4, and 5). Participants navigated PowerPoint slides manually by clicking the space button on the keyboard. The participant was instructed to read the slides as thoroughly as possible to successfully answer a series of multiple-choice questions at the end of the training. The Placebo program includes information such as vision standards, seat belt usage, and penalties of breaking driving laws; all unrelated to attention maintenance skills. The Placebo training program took approximately 45 minutes to complete.

Procedure

All participants were provided an informed consent sheet before participating in the experiment. After their consent was obtained, they completed a demographics questionnaire and a Motion Sickness Susceptibility Questionnaire (MSSQ; Golding, 1998). Participants who scored an MSSQ score over 19 were not eligible for the study because of high risk for simulator sickness. Eligible participants were randomly assigned to either the Placebo or FOCAL training group and received the respective training program. After training, the participant was given an instruction for the Waze task. Participants completed three practice trials for the Waze task where they were asked to find the distance between ODU and a target location using Waze on the tablet. The three practice locations were, the empire state building, Disneyland, and the pentagon. Then, participants completed two practice drives to familiarize themselves with the driving simulator and completing both the primary driving task and the secondary in-vehicle Waze task. The participant was instructed to drive as they normally would, obeying all traffic laws and to complete the Waze tasks after hearing the command. The participants completed two separate drives to minimize driving error due to lack of experience with the driving simulator. In addition, since the driver must navigate different environments, the first practice scenario consists of a curve and various stop signs and the second scenario consists of curves, stop signs, and also a stoplight. The average distance of both practice drives was 8,530 feet long and took approximately three minutes to complete. After completion of the practice drives, the participant was given the Simulator Sickness Questionnaire pre-test (SSQ; Kennedy, Lane, Berbaum, & Lilienthal, 1993). Then, the participant was equipped with a head-mounted eye-tracker and calibrated using a 9-dot calibration system. Once the eye tracker was calibrated, the driver completed four experimental drives in a pre-determined randomized order. Participants were instructed to navigate the virtual environments obeying normal traffic laws. At the end of each individual drive, the participant completed the 6-item calibration questionnaire. After completing the experimental drives, the participant filled out the 8-item calibration questionnaire, driving history questionnaire, and the SSQ post-test. Then, participants were compensated and exited the lab. The experiment took approximately two hours to complete.

Dependent Variables

Attention maintenance. The ability to maintain attention to the forward roadway was measured by proportions of off-road glances longer than 2 seconds calculated for each trial. Each glance duration was defined as a time interval between the frame that the driver removes their eyes from the forward roadway and the frame that the driver's eyes return to the forward roadway. Proportions of glances was measured by dividing the total number of glances longer than 2 seconds by the total number of glances executed per trial. Eye glance data was only analyzed for the 15 second task interval during each driving scenario.

Driver calibration. Calibration scores were calculated using two different methods, normalized proportion of glances (Roberts et al., 2016; Unverricht et al., 2019) and the Brier Score (Roberts et al., 2016). The first measure of calibration required normalizing both the subjective and objective attention maintenance scores (proportion of glances longer than two seconds) using the formula below.

$$100 \times \left(\frac{score - \min(score)}{\max(score) - \min(score)} \right)$$

Then the difference between those two normalized scores will determine the participant's calibration score. The difference score was calculated by subtracting the normalized objective performance proportion from the normalized subjective performance proportion. Negative proportions produced by this equation suggest the driver is underestimating their performance while positive proportions suggest the driver is overestimating their performance. The closer to zero the participant's score is, the better calibrated they are.

Subjective attention maintenance scores were collected through the Calibration questionnaire. A ruler measured the distance between the beginning of the visual analog scale and the participant's mark. The resulting distance in cm represented the subjective attention maintenance score.

The Brier Score. The second measure of calibration used the Brier Score (Brier, 1950). This measure is divided into three separate components: knowledge, calibration and resolution. The formula presented below will be used to calculate the Brier Score as seen in (Roberts et al., 2016).

$$Brier\ Score = c(1 - c) + \frac{1}{N}\sum_{t=1}^{T} n_t\,(r_t - c_t)^2 - \frac{1}{N}\sum_{t=1}^{T}(c_t - c)^2$$

In the formula above, c represents the overall proportion of self-appraisals correctly identified compared to objective performance, N represents the total number of self-appraisals given, T represents the number of categories, t represents the category of objective performance, n represents the number of self-appraisals assigned to t, r_t represents the participant's confidence in their self-appraisal, and c_t represents the proportion of self-appraisals correctly identified compared to objective performance for each level of t. This equation can be broken down into each of its sub-sections as seen below.

$$Brier\ Score = knowledge + calibration - resolution$$

The first section, knowledge, measures the participant's ability to classify events. Calibration measures how accurate one's self-appraisals of performance match their actual performance, while considering confidence. Last, resolution determines one's ability to differentiate between different levels of uncertainty. Total Brier Scores can range between 0 – 1 with 0 being the desired score. The application of the Brier Score required the driver to be able to make incorrect or correct subjective assessments. Therefore, the Brier Score questionnaire's response options were categorized into two different categories during coding, 0 – 50, 50 – 100. The Brier Score requires a large data set to stabilize the results. Therefore, each participant completed four brier score questionnaires.

CHAPTER III

RESULTS

Total Off-Road Glances

FOCAL-trained drivers made a total of 570 off-road glances during the experimental trials (*M* = 31.66, *SD* = 7.50, range = 20 – 50) while Placebo-trained drivers made a total of 409 glances (*M* = 22.74, *SD* = 7.83, range = 5 – 35). FOCAL-trained drivers made significantly more off-road glances than Placebo-trained drivers, FOCAL, 95% CI = [27.32, 36.01], Placebo, 95% CI = [21.10, 27.57], mean difference = 8.93, 95% CI = [1.14, 16.72], independent-samples $t(34) = 3.49$, $p < .001$.

Performance accuracy in the Waze task.

FOCAL-trained drivers' performance in the Waze task did not differ than Placebo-trained drivers, *M* = .40, 95% CI = [.28, .53] for the FOCAL group, *M* = .30, 95% CI = [.19, .40] for the Placebo group, mean difference = .11, 95% CI = [-.09, .31], independent-samples $t(34) = 1.64$, $p = .11$.

Proportions of long off-road glances and attention maintenance performance

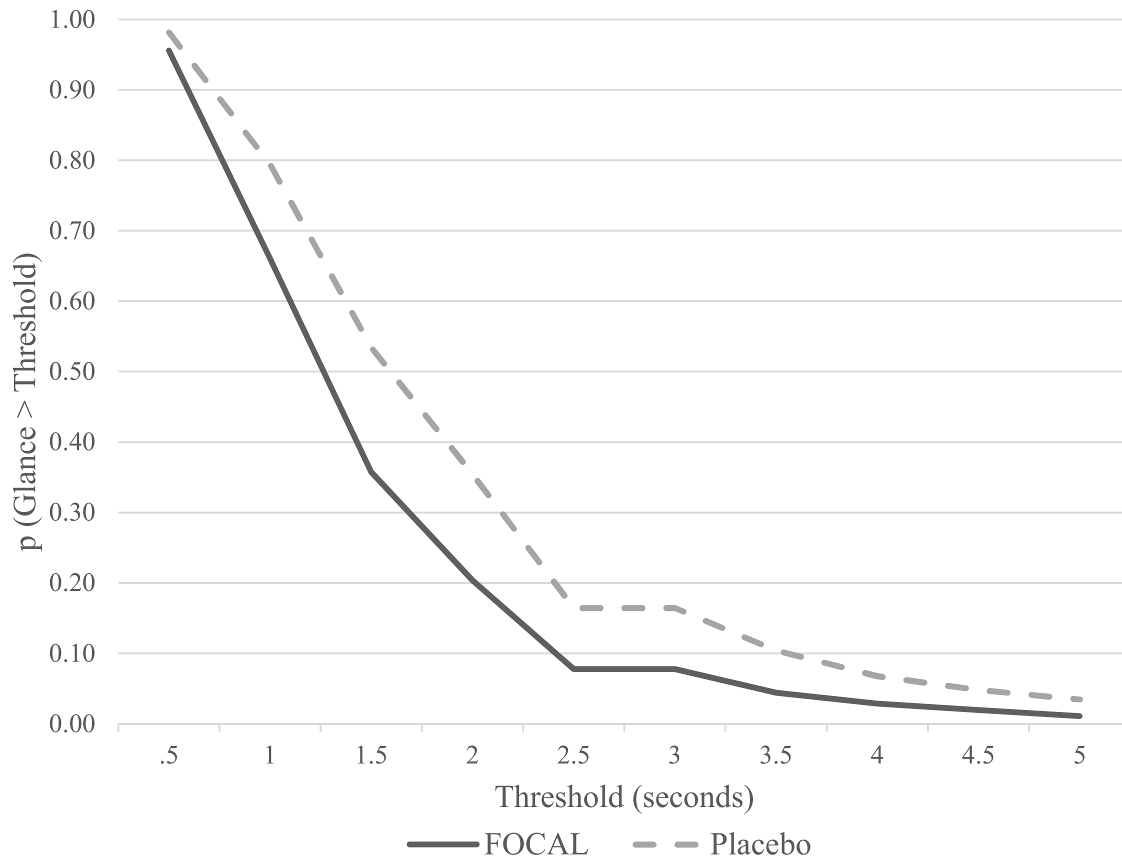

Figure 9. A complementary cumulative distribution function (CDF) displaying the probability that off-road glance duration was longer than or equal to each threshold glance duration for each of the Placebo- and FOCAL-trained drivers.

FOCAL-trained drivers executed fewer off-road glances longer than 2 seconds in comparison to Placebo-trained drivers, FOCAL, M = .20, 95% CI = [.12, .28], Placebo, M = .36, 95% CI = [.26, .45], mean difference = .15, 95% CI = [-.05, -.25], independent-samples $t(34) = -2.99$, p = .005. Also, FOCAL-trained drivers executed fewer off-road glances longer than 1.5 seconds, FOCAL, M = .41, 95% CI = [.30, .51], Placebo, M = .53, 95% CI = [.12, .28], mean difference = .13, 95% CI = [-.01, -.24], independent-samples $t(34) = -2.27$, p = .029, replicating Pradhan et al. (2011). Visual inspection of the complementary CDF (Figure 9) indicates that FOCAL produced shorter off-road glances than Placebo across varying threshold levels, generalizing the current findings. The absolute number of off-road glances made by FOCAL trained drivers for 0 to 1 second and 1 to 2 second intervals was greater than those by placebo trained drivers, complementing the observation above (218 vs 102 glances for 0 – 1 second interval, 260 vs 208 glances for 1 – 2 second interval; see figure 10).

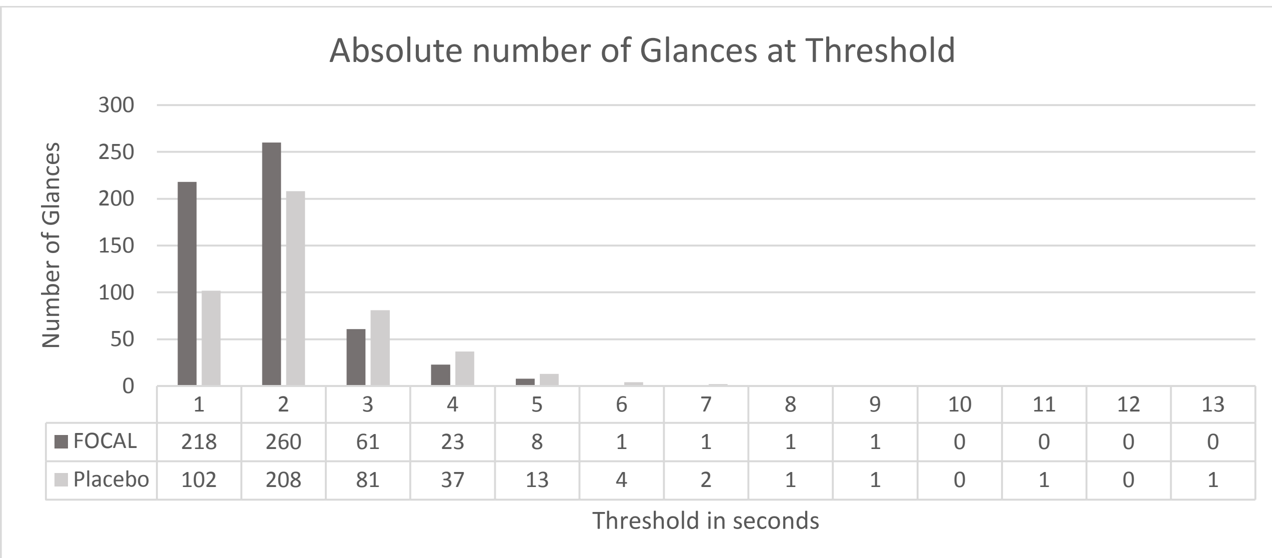

Figure 10**.** A histogram on the absolute number of off-road glances at each threshold.

Driver calibration.

Normalized Proportions of glances. FOCAL-trained drivers showed lower calibration scores than Placebo-trained drivers, suggesting better calibration for FOCAL-trained drivers, *M* = -.16, 95% CI = [-.37, .05] for the FOCAL group, *M* = 24%, 95% CI = [.02, .47] for the

Placebo group, mean difference = .38, 95% CI = [-.14, -.64], independent-samples $t(34) = 3.04$, $p = .004$. Note that the scores differed significantly from zero and in the positive direction for Placebo-trained drivers, indicating over-estimation of their attention maintenance skills, one-sample $t(34) = 2.68$, $p = .01$. This was not observed for FOCAL-trained drivers, one-sample $t(34) = 1.66$, $p = .11$, see Figure 10.

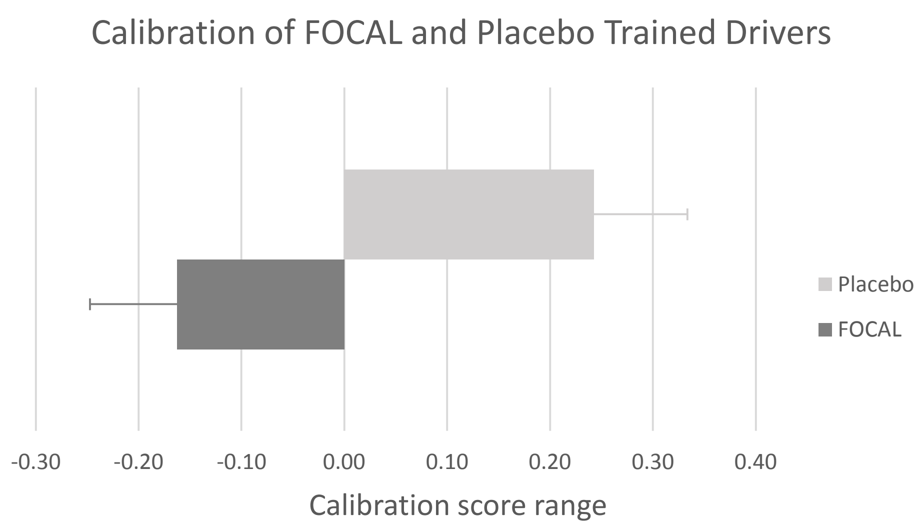

Figure 10. Both FOCAL and Placebo's mean calibration scores and their distance from zero. Further right indicates over-calibration, further left indicates under-calibration.

Brier Score. Brier Scores of FOCAL-trained drivers did not significantly differ from those of Placebo-trained drivers, FOCAL, $M = .18$, 95% CI = [.10, .27], Placebo, $M = .15$, 95% CI = [.08, .21], mean difference = .4, 95% CI = [-.09, .17], independent-samples $t(34) = .88$, $p = .39$. Note that the scores did differ significantly from zero indicating poor calibration for both Placebo-trained drivers, one-sample $t(34) = 5.52$, $p < .001$, and FOCAL-trained drivers, one-sample $t(34) = 5.48$, $p < .001$.

Subcomponents of Brier score.

Knowledge. Knowledge scores of FOCAL-trained drivers did not significantly differ from those of Placebo-trained drivers, FOCAL, $M = .15$, 95% CI = [.09, .21], Placebo, $M = .13$, 95% CI [.08, .19], mean difference = .02, 95% CI = [-.08, .12], independent-samples $t(34) = .53$, $p = .59$.

Calibration. Calibration scores of FOCAL-trained drivers did not significantly differ from those of Placebo-trained drivers, FOCAL, $M = .08$, 95% CI = [.03, .13], Placebo, $M = .08$, 95% CI [.01, .16], mean difference = -.01, 95% CI = [-.12, 11], independent-samples $t(34) = .16$, $p = .87$.

Resolution. Resolution scores of FOCAL-trained drivers did not differ from those of Placebo-trained drivers, FOCAL, $M = .04$, 95% CI = [.01, .07], Placebo, $M = .05$, 95% CI [.02, .09], mean difference = -.001, 95% CI = [-.07, .05], independent-samples $t(34) = .50$, $p = .62$.

Exploratory analyses. To explore the effect of order on Brier scores, a between-subject ANOVA with Training (FOCAL vs. Placebo) and Order (1st, 2nd, 3rd or 4th trial) was conducted on self-appraisal scores on the questionnaires for Brier scores. FOCAL trained drivers rated their attention maintenance performance significantly lower ($M = 5.47$) than the placebo trained drivers ($M = 6.38$), $F(1,134) = 4.04$, $p = .04$, $\eta^2 = .029$. However, no other effects were statistically significant (both *ps* > .12).

CHAPTER IV

DISCUSSION

Through the current study, I examined the effect of FOCAL on drivers' calibration of their attention maintenance performance in a driving simulator, using two different measures, normalized proportion of glances and the Brier Score. Participants drove in four different simulated scenarios and completed an in-vehicle attention maintenance task during each drive. In the attention maintenance task, participants were asked to find a target location on a mounted tablet using a navigation application based on auditory instruction with their eyes tracked. Immediately after the completion of each drive, the participants filled out a calibration questionnaire rating levels of their subjective performance on the driving and in-vehicle tasks. Results replicated Pradhan et al. (2011), showing attention maintenance performance better in FOCAL-trained drivers than Placebo-trained drivers. FOCAL-trained drivers executed approximately 16% fewer in-vehicle glances longer than 2 seconds than Placebo-trained drivers. Additionally, the results replicated the findings of the pilot study (Unverricht et al., 2019) showing FOCAL-trained drivers better calibrated than Placebo-trained drivers measured via normalized proportion of glances. In the current study, the FOCAL-trained drivers were calibrated towards their attention maintenance performance while the Placebo-trained drivers overestimated their attention maintenance performance. The Brier Score, however, did not detect any significant differences in their calibration skills between the FOCAL- and Placebo-trained drivers including the three components, knowledge, calibration, or resolution.

Attention Maintenance Performance

The effect of FOCAL on decreasing the proportion of excessively long in-vehicle glances is consistent across the current study, the pilot study (Unverricht et al., 2019), and Pradhan et al. (2011; see table 4).

Table 4. Proportion of off-road glances over threshold across studies.

Current Study	**Proportion of glances >2 sec.**	**>2.5 sec.**	**>3 sec.**

FOCAL	0.2	0.12	0.08
Placebo	0.36	0.25	0.16
Pradhan - non-vehicle task	**Proportion >2**	**>2.5**	**>3**
FOCAL	0.2	0.13	0.08
Placebo	0.29	0.19	0.12
Pradhan - overall	**Proportion >2**	**>2.5**	**>3**
FOCAL	0.25	0.16	0.09
Placebo	0.32	0.2	0.12
Pilot Study (Unverricht et al., in press)	**Proportion >2**	**>2.5**	**>3**
FOCAL	0.24	0.16	0.08
Placebo	0.45	0.28	0.22

Both the current study and the pilot study exclusively employed a map navigational task because it involves effortful visual search and interaction with an application on the tablet, demanding their eyes off the forward roadway. Although the task structure was similar using the Google Maps application (used in the pilot study) and Waze application (used in the current study), the in-vehicle task using Google Maps elevated the proportion of off-road glances longer than 2 seconds roughly four percentage points greater than that using Waze. Previous research indicates that visual demand of in-vehicle tasks increases the proportion of excessively long in-vehicle glances (Yamani, Horrey, Liang, & Fisher, 2015). Perhaps the visual demand for the Google Maps task in the pilot study was greater than that required for the Waze task in the current study. Recent work that manipulated information bandwidth of in-vehicle technology showed that if information-processing demand is high even experienced drivers can exhibit a greater number of excessively long in-vehicle glances (Yamani et al., 2018). Therefore, it is not surprising that a task that sets higher visual demand would lead to a greater proportion of excessively long glances inside the vehicle. Alternatively, the Google Maps application took a longer time to load than the Waze, and this difference in their capabilities could have impacted their glance patterns when performing the in-vehicle task.

It is surprising that in all four data sets roughly 8% of in-vehicle glances are longer than three seconds, even for drivers who are trained with FOCAL. That is, FOCAL-trained drivers looked down longer than three seconds for more than 8% of the time when performing a variety of in-vehicle tasks while controlling the vehicle. This is alarming because this pattern of off-road glances appears regardless of the participants' age and driving experiences.

Note that the large individual differences between drivers emerged in each of the three studies, the current study, pilot study, and Pradhan et al. (2011). For example, in the current study, two Placebo trained drivers made fewer than 10% in-vehicle glances over 2 seconds indicating great performance with no training. Moreover, three FOCAL-trained drivers made greater than 37% in-vehicle glances over 2 seconds indicating poor performance with training. Though FOCAL-trained drivers should make 0% in-vehicle glances greater than 2 seconds, they consistently perform from 7% to 21% better than Placebo trained drivers at the 2 second threshold. More research is needed to eliminate such excessively long off-road glances when performing a secondary task while driving.

Secondary Task Performance

Our pilot study using the same experimental set-up except that drivers interacted with the Google Maps application showed that FOCAL-trained drivers performed reliably better in the in-vehicle task than Placebo-trained drivers (Unverricht et al., *in press*). Instead of the Google Maps application, participants in the current study interacted with the Waze application due to technical issues and did not show significant differences in in-vehicle task performance between the groups. Post-hoc analysis of their subjective ratings that FOCAL trained drivers in the pilot study found the secondary task to be significantly less physically demanding in-comparison to the current study (M = 4.56 vs. 1.78; independent-samples $t(24) = 3.29$, $p = .003$). Perhaps the Google maps task required fewer physical demands and higher visual demands than the Waze task. This might account for the FOCAL-trained drivers' better secondary task performance and poorer attention maintenance performance seen in the pilot study than the current study.

Calibration – Normalized Proportion of Glances

Using the normalized proportion of glances measure, FOCAL-trained drivers did not demonstrate the same trend of overestimation of their attention maintenance performance as Placebo-trained drivers. In fact, FOCAL-trained drivers' scores were closer to zero, indicating almost perfect calibration. Placebo-trained drivers however significantly overestimated their own performance, replicating the results of the pilot study (Unverricht et al., 2019).

There are at least two different interpretations of these results. First, FOCAL may not increase calibration, but rather the improved calibration is a biproduct of the increased attention maintenance performance. That is, FOCAL-trained drivers might still overestimate their abilities, but they also increase their performance to match with their overestimated ability. This interpretation is not supported by the data. FOCAL-trained drivers in the pilot study had poorer attention maintenance performance than the current study. Yet, FOCAL-trained drivers in the pilot study significantly underestimated their abilities (M = -.31) while those in the current study only trended towards underestimation (M = -.16). If FOCAL was only increasing driver's attention maintenance performance but not increasing their calibration, then FOCAL-trained drivers who perform poorer should be better calibrated or over-calibrated than those who perform better, a trend not observed here. Instead, trained drivers in the pilot study performed poorer and underestimated their performance more than those in the current study.

Second, FOCAL might improve both attention maintenance skills and calibration skills through the 3M feedback training. Recall that FOCAL requires trainees to make mistakes (e.g., looking down longer than 2 seconds), explains why it is a problem (e.g., looking down longer than 2 seconds elevates crash risk), and provides opportunities to learn the target behavior (e.g., looking down shorter than 2 seconds). Through the training process, trainees may realize their miscalibration between their perceived performance and actual performance. For example, trainees may well perceive that they looked down less than 2 seconds but in reality, they did so longer than 2 seconds. This way, FOCAL may provide an opportunity to improve not only attention maintenance skills but also calibration skills via feedback mechanism. However, the present study does not provide direct evidence that this process occurred, and future research should focus to further identify the psychological mechanisms that explain how FOCAL improves driver calibration.

Considering an information processing approach, psychological process of calibration may require attentional resources to compute the differences between perceived performance and actual performance and adjust later information-processing strategies. That is, a calibration "task" is resource-limited, meaning that calibration improves as additional resources are invested. Perhaps FOCAL-trained drivers showed better calibration than Placebo-trained drivers in the current study because they were able to mobilize attentional resources that were used to support the in-vehicle task to the calibration process. Presumably, FOCAL-trained drivers can invest less resources to the in-vehicle task because of the training (Logan, 1988). This implies that the improvement of calibration through FOCAL is facilitated by decreasing the attentional demands of the in-vehicle task, thus allowing the driver to spend those additional resources on calibration.

Alternatively, it is also possible that calibration is instead data-limited meaning that calibration improves based on the quality of incoming data. As discussed above, FOCAL may help trainees realize their misperception of their own performance, which might improve their calibration without investing additional resources to the calibration process. By providing feedback on their performance, drivers may form a more accurate perception of their performance making the calibration process more accurate. Additional research is necessary for characterizing how calibration process is controlled.

Calibration - Brier Score

Using the Brier Score measure of calibration, FOCAL trained drivers were not significantly different from Placebo-trained drivers. However, both were significantly different from zero indicating poor calibration. To implement the brier score to this domain, responses on a continuous scale (e.g., time duration of off-road glances) had to be categorized into two discrete categories, scores less than 50 or scores greater than 50. The lack of variance because of using only two categories could have prevented detection of differences between the groups. To explore whether the number of categories influences the results, the responses were recategorized into three categories (less than 33%, 34% to 66%, and 67% to 100%) and four categories (less than 25%, 26% to 50%, 51% to 75%, and 76% to 100%) and the brier scores were recalculated for each. Though the responses were recategorized, the brier scores did not show any significant differences.

Because of the design of the experiment, the participants completed the questionnaire for the Brier score following each of the four drives, and the order effect might have affected the results. The exploratory analysis on the raw self-appraisal scores showed no evidence for such effect. However, the exploratory analysis revealed that, on self-appraisal scores on the questionnaires for Brier scores, placebo trained drivers rated their attention maintenance performance significantly higher than FOCAL trained drivers. Placebo trained drivers rated themselves higher, even though they performed worse, indicating a similar trend of overestimation seen with the normalized proportions measure.

Historically, the brier score has required using many data points (Lichtenstein & Fischoff, 1980). Roberts and colleagues (2016) first implemented the brier score in the driving domain using 720 data points. The results of the brier score trended similarly towards the normalized proportion scores but statistical results did not converge. The current study attempted to implement the brier score within the driving domain to measure calibration of attention maintenance performance. Each participant completed a brier score questionnaire after each of the four scenarios. Additionally, the sample size was doubled what the power analysis required. Even with the repeated measures and increased sample size, it still only amounted to 144 data points, substantially lower than what was done in Roberts et al. (2017). Though no significance differences were found in the data for the brier score, the results are still informative for future studies. Specifically, successful implementation of the brier score might require a study with multiple trials across days to supply enough data points.

Limitations & Future Research

As with other driving simulator studies, the current findings may not generalize to real-world driving environments. Also, because of the design of the current experiment, drivers were instructed to perform the in-vehicle task at a given location for exactly 15 seconds. However, drivers may strategically engage in such in-vehicle tasks while driving (strategic attention maintenance; Krishnan et al., 2015). For example, a driver detecting a latent threat such as a pedestrian occluded by a parked truck may refrain from engaging in a secondary task.

Additionally, more time spent looking towards the forward roadway does not indicate sufficient visual sampling for detecting imminent hazard. Future research may directly examine whether drivers detect latent hazard during the time they were engaged in the in-vehicle task.

Future research should use a variety of tasks to test the limits of improvement in drivers' attention maintenance performance. In addition, the improvement to in-vehicle task performance observed in the pilot study was not present in the current study. Future research should vary the levels of visual demand for the secondary in-vehicle task (Yamani et al., 2015) and examine its effect on attention maintenance performance following the completion of FOCAL. How the effect of FOCAL on calibration arises needs to be further examined potentially exploring whether the calibration process is either resource-limited or data-limited. Additional explanations for FOCAL's effect on calibration should be examined incorporating theories of time perception such as Scalar Expectancy Theory (Gibbon, Church, Fairhurst, & Kacelnik, 1988) or Learning to Time Theory (Machado, 1997). In addition, measures of attention maintenance should collect data regarding the sufficiency of visual information sampled. For example, a study might include hazard anticipation scenarios as an unobtrusive way of indicating if an on-road glance is meaningful.

REFERENCES

Ackerman, P. L., Beier, M. E., & Bowen, K. R. (2002). What we really know about our abilities and our knowledge. *Personality and individual differences*, *33*, 587-605.

Amado, S., Arıkan, E., Kac¸ A, G., Koyuncu, M., & Turkan, B. N. (2014). How accurately do drivers evaluate their own driving behavior? An on-road observational study. *Accident Analysis & Prevention, 63*, 65–73

Brier, G.W., 1950. Verification of forecasts expressed in terms of probability. *Monthey Weather Rev*iew, *78*, 1–3.

Cestac, J., Paran, F., & Delhomme, P. (2011). Young drivers' sensation seeking, subjective norms, and perceived behavioral control and their roles in predicting speeding intention: How risk-taking motivations evolve with gender and driving experience. *Safety Science*, *49*, 424-432.

Chan, E., Pradhan, A. K., Pollatsek, A., Knodler, M. A., & Fisher, D. L. (2010). Are driving simulators effective tools for evaluating novice drivers' hazard anticipation, speed management, and attention maintenance skills? *Transportation research part F: Traffic psychology and behaviour*, *13*, 343-353

Cohen, J. T., & Graham, J. D. (2003). A revised economic analysis of restrictions on the use of cell phones while driving. *Risk Analysis, 23*, 5-17.

De Craen, S. (2010). The X-factor: A longitudinal study of calibration in young novice drivers. *Proefschrift Technische Universiteit Delft TUD*.

Deery, H. A. (1999). Hazard and risk perception among young novice drivers. *Journal of Safety Research*, *30*, 225-236.

DeJoy, D. M. (1989). The optimism bias and traffic accident risk perception. *Accident Analysis & Prevention*, *21*, 333-340

Divekar, G., Pradhan, A. K., Masserang, K. M., Reagan, I., Pollatsek, A., & Fisher, D. L. (2013). A simulator evaluation of the effects of attention maintenance training on glance distributions of younger novice drivers inside and outside the vehicle. *Transportation Research Part F: Traffic Psychology and Behaviour, 20*, 154-169.

Divekar, G., Samuel, S., Pollatsek, A., Thomas, F. D., Korbelak, K., Blomberg, R. D., & Fisher, D. L. (2016). Effects of a PC-based attention maintenance training program on driver behavior can last up to four months: Simulator study. *Transportation Research Record: Journal of the Transportation Research Board*, *2602*, 121-128.

Dunning, D., Heath, C., & Suls, J. M. (2004). Flawed self-assessment: Implications for health, education, and the workplace. *Psychological Science in the Public Interest*, *5*, 69-106.

Fisher, D. L., & Pollatsek, A. (2007). Novice driver crashes: Failure to divide attention or failure to recognize risks. In A. F. Kramer, D. A. Wiegmann, & A. Kirlik (Eds.), *Attention: From theory to practice, 134*, pp. 134 - 156. New York, NY: Oxford University Press.

Fisher, D. L., Laurie, N. E., Glaser, R., Connerney, K., Pollatsek, A., Duffy, S. A., and Brock, A. (2002). The Use of an advanced driving simulator to evaluate the effects of training and experience on drivers' behavior in risky traffic scenarios. *Human Factors*, *44*, 287–302.

Freund, B., Colgrove, L. A., Burke, B. L., & McLeod, R. (2005). Self-rated driving performance among elderly drivers referred for driving evaluation. *Accident Analysis & Prevention*, *37*, 613-618.

Gibbon, J., Church, R. M., Fairhurst, S., & Kacelnik, A. (1988). Scalar expectancy theory and choice between delayed rewards. *Psychological review*, *95*, 102.

Gregersen, N.P. (1996). Young drivers′ overestimation of their own skill: An experiment on the relation between training strategy and skill. *Accident Analysis & Prevention*, *28*, 243□250.

Groeger, J. A. (2013). *Understanding driving: Applying cognitive psychology to a complex everyday task*. Routledge.

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock, & N. Meshkati (Eds.), *Advances in Psychology*, *52*, pp. 139-183.

Hay, M., Adam, N., Bocca, M. L., & Gabaude, C. (2016). Effectiveness of two cognitive training programs on the performance of older drivers with a cognitive self-assessment bias. *European Transport Research Review*, *8*, 20.

Horrey, W. J., Lesch, M. F., Mitsopoulos-Rubens, E., & Lee, J. D. (2015). Calibration of skill and judgment in driving: Development of a conceptual framework and the implications for road safety. *Accident Analysis & Prevention*, *76,* 25-33.

Horswill, M. S., Waylen, A. E. & M. I. Tofield. (2004). Drivers' ratings of different components of their own driving skill: A greater illusion of superiority for skills that relate to accident involvement. *Journal of Applied Social Psychology*, *34*, 177-195.

Insurance Institute for Highway safety. (2008). *Distracted driving*. https://www.iihs.org/iihs/topi cs/t/older-drivers/fatalityfacts/older-people

Insurance Institute for Highway safety. (2015). *Distracted driving*. https://www.iihs.org/iihs/topics/t/teenagers/fatalityfacts/teenagers

Jonah, B. A. (1997). Sensation seeking and risky driving: a review and synthesis of the literature. *Accident Analysis & Prevention*, *29*, 651-665.

Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J. D. & Ramsey, D. J. (2006). *The impact of driver inattention on near-crash/crash risk: An analysis using the 100-car naturalistic driving study data*. (Report No. DOT HS 810 594). Washington, DC: National Highway Traffic Safety Administration.

Krishnan, A. (2015). Evaluation of a Training Program (STRAP) Designed to Decrease Young Drivers Secondary Task Engagement in High Risk Scenarios.

Kuiken, M., & Twisk, D. (2001). Safe driving and the training of calibration. *SWOV Institute for Road Safety Research, Leidschendam*.

Logan, G. D. (1988). Toward an instance theory of automatization. *Psychological review*, *95*, 492.

Machado, A. (1997). Learning the temporal dynamics of behavior. *Psychological review*, *104*, 241.

Mathews, M.L. & Moran, A.R. (1986). Age differences in male drivers′ perception of accident risk: The role of perceived driving ability. *Accident Analysis & Prevention*, *18*, 299□313

McKnight, A. J., & McKnight, A. S. (2003). Young novice drivers: careless or clueless? *Accident Analysis & Prevention*, *35*, 921-925.

Norman, D. A., & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive psychology*, *7*, 44-64.

Pradhan, A. K., Hammel, K. R., DeRamus, R., Pollatsek, A., Noyce, D. A., & Fisher, D. L. (2005). Using eye movements to evaluate effects of driver age on risk perception in a driving simulator. *Human Factors, 47*, 840-852.

Pradhan, A. K., Divekar, G., Masserang, K., Romoser, M., Zafian, T., Blomberg, R. D., ... & Fisher, D. L. (2011). The effects of focused attention training on the duration of novice drivers' glances inside the vehicle. *Ergonomics*, *54*, 917-931.

Pradhan, A., Masserang, K. M., Divekar, G., Reagan, I., Thomas, F. D., Blomberg, R., Pollatsek, A., & Fisher., D. (2009). Attention maintenance in novice drivers: Assessment and training. *Proceedings of the Ninth International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design*, *2009*, 349 - 355.

Roberts, S. C., Horrey, W. J., & Liang, Y. (2016). Measurement of driver calibration and the impact of feedback on drivers' estimates of performance. *Accident Analysis & Prevention, 88*, 150-158.

Stajkovic, A. D., & Luthans, F. (1998). Self-efficacy and work-related performance: A meta-analysis. *Psychological bulletin*, *124*, 240 - 261.

Sundström, A. (2008). Self-assessment of driving skill–A review from a measurement perspective. *Transportation Research Part F: Traffic Psychology and Behaviour*, *11*, 1-9.

Svenson, O. (1981). Are we all less risky and more skillful than our fellow drivers? *Acta Psychologica*, *47*, 143-148.

Unverricht, J., Samuel, S., & Yamani, Y. (2018). Latent hazard anticipation in young drivers: Review and meta-analysis of training studies. *Transportation Research Record*, 0361198118768530.

Unverricht, J., Yamani, Y., & Horrey, W. J. (2018). Calibration in older and middle-aged drivers: Relationship between subjective and objective glance performance at complex intersections. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *62*, 1913-1917.

Unverricht, J., Yamani, Y., & Horrey, W. (2019). Effects of a Training Program on Driver Calibration in Attention Maintenance [Extended Abstract]. *Proceedings of the Transportation Research Board 98th Annual Meeting*, Washington, D.C.

Unverricht, J., Yamani, Y., Yahoodik, S., Chen, Jing., & Horrey, W. (in press). Attention maintenance training: Are young drivers getting better or being more strategic? *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*.

Wickens, C. D. (1980). The structure of attentional resources. *Attention and performance VIII*, *8*, 239-257.

Wickens, C.D., Hollands, J.G., Banbury, S., & Parasuraman, R., (2016). *Engineering Psychology and Human Performance*, 4th ed. Prentice Hall, Upper Saddle River, NJ.

Woodman, T. I. M., & Hardy, L. E. W. (2003). The relative impact of cognitive anxiety and self-confidence upon sport performance: A meta-analysis. *Journal of Sports Sciences*, *21*, 443-457.

Yamani, Y., Bıçaksız, P., Unverricht, J., & Samuel, S. (2018). Impact of information bandwidth of in-vehicle technologies on drivers' attention maintenance performance: A driving simulator study. *Transportation Research Part F: Traffic Psychology and Behaviour*, *59*, 195-202.

Yamani, Y., W. J. Horrey, Y. Liang, & D. L. Fisher. (2015). Sequential in-vehicle glance distributions: An alternative approach towards analyzing glance data. *Human Factors, 57*, 2015, 567-572.

Yamani, Y., Samuel, S., Knodler, M. A., and Fisher, D. L. (2016). Evaluation of the effectiveness of a multi-skill program for training younger drivers on higher cognitive skills. *Applied Ergonomics*, *52*, 135–141.

Zell, E., & Krizan, Z. (2014). Do people have insight into their abilities? A metasynthesis. *Perspectives on Psychological Science*, *9*, 111-125.

APPENDICES

APPENDIX A

INFORMED CONSENT DOCUMENT
OLD DOMINION UNIVERSITY

PROJECT TITLE: Evaluation of training programs for higher cognitive skills among young novice drivers.

INTRODUCTION

The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES. This research project, *Evaluation of Training Programs for Higher Cognitive Skills among Young Novice Drivers,* will be conducted in Applied Cognitive Performance Laboratory (MGB 325B) at Old Dominion University.

RESEARCHERS

The responsible project investigator for this project is Yusuke Yamani, Ph.D. from College of Science, Department of Psychology at Old Dominion University.

DESCRIPTION OF RESEARCH STUDY

This research is designed to investigate drivers' visual scanning patterns while driving and examine effectiveness of novel training programs to facilitate control of visual attention on the forward roadway. We will record your driving performance and eye movements in various driving scenarios. We aim to recruit 300 subjects for this project. The task will take approximately 2 hour to complete.

1) At your session, you will be given a copy of this consent/assent form and have the opportunity to read it or ask any questions.

2) Questionnaire. Once the consent/assent form has been signed, you will receive a short (5-10 minute) questionnaire gathering information on your driving history (total number of miles driven per year, date when you obtained your driver's license and driver's permit), and personal characteristics (age, gender, race, whether you wear glasses while driving). You can skip any question on the questionnaire that you do not feel comfortable answering.

3) Training Program. You will be asked to do a driver training program on a personal computer at the lab. The training program is expected to take you 30-45 minutes.

4) Eye Tracking Calibration. You will be fitted with eye tracking glasses that allow your eye movements to be recorded as you drive on the driving simulator. The eye tracking system will be calibrated for your eyes. This calibration procedure typically takes 5-10 minutes. You will be asked to keep your head still during the calibration procedure and move only your eyes. You can move your head again once the calibration is complete. Video output from the eye tracking glasses will be recorded on a laptop for analyzing for the study.

5) Simulator Drives. Once the eye tracking system is calibrated, you will be given a practice drive on the driving simulator to get you used to how the driving simulator operates. Once you are comfortable on the simulator, you will be asked to do a 3 to 6 simulator drives of 4 to 6 minutes each. Your total time on the simulator will be approximately half an hour.

6) Post-Drive. After the simulator drives are completed, you will be asked to complete a brief the post-training survey, and will receive a receipt for your research credits.

EXCLUSIONARY CRITERIA

All participants in this research study must be18 years of age with normal or corrected-to-normal visual acuity and normal color perception. Participants also must hold Junior Operator's License or regular driver's license.

RISKS AND BENEFITS

RISKS: The main risk to you during this study is the possibility that you may become queasy while using the driving simulator. The researchers work to minimize this risk, but it is still present. Because of this risk, any person who experiences motion sickness while in a real car should not participate in the experiment. If during the simulator drives, you feel any discomfort or nausea, you should inform the experimenter immediately so that the simulation can be stopped. Halting the simulation should quickly reduce the discomfort. If you do not feel better soon after the simulation is halted, we can arrange for someone to drive you home or help you seek medical care if necessary.

There are no known risks related to using the eye-tracking device.

BENEFITS: There are no direct benefits for participating in the study. You may receive therapeutic benefits by participating in this study in terms of training for better on-road scanning behavior and raising awareness for potential hazard that could be encountered while drives.

COSTS AND PAYMENTS

The researchers want your decision about participating in this study to be absolutely voluntary. The main benefit to you for participating in this study is research participation points that you will earn for your class. Although they are unable to give you payment for participating in this study, if you decide to participate in this study, you will receive a Psychology Department research participation credit per hour, which may be applied to course requirements or extra credit in certain Psychology courses. Students will receive 2 research participation credits. Equivalent credits may be obtained in other ways. You do not have to participate in this study, or any Psychology Department study, to obtain this credit.

CONFIDENTIALITY

The researchers will take reasonable steps to keep private information confidential. The researchers will keep any record of your participation in locked storage in the psychology department. Furthermore, individual participants results will not be distributed in any form. The results of the study aggregated across participants will be published in professional journals and/or book chapters. Sometimes, eye video from your drives may be shown, but never in a way that your identity would be revealed.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University, or otherwise cause a loss of benefits to which you might otherwise be entitled.

COMPENSATION FOR ILLNESS AND INJURY

If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of illness arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that you suffer injury as a result of participation in any research project, you may contact Dr. Yusuke Yamani at 757-683-4457 or Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802 at Old Dominion University, or the Old Dominion University Office of Research at 757-683-3460 who will be glad to review the matter with you.

VOLUNTARY CONSENT

By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.

And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form for your records.

------------------------------------	------------------------------------	------------------------
Participant’s Name	Participant’s Signature	Date
------------------------------------	------------------------------------	------------------------
Investigator’s Name	Investigator’s Signature	Date

APPENDIX B

MOTION SICKNESS SUSCEPTIBILITY QUESTIONNAIRE SHORT-FORM (MSSQ-Short)

This questionnaire is designed to find out how susceptible to motion sickness you are, and what sorts of motion are most effective in causing that sickness. Sickness here means feeling queasy or nauseated or actually vomiting.

Your childhood experience only (before 12 years of age), for each of the following types of transport or entertainment please indicate

1. As a child (before age 12), how often you **felt sick or nauseated** (tick boxes).

	Not Applicable - Never Traveled	Never Felt Sick	Rarely Felt Sick	Sometimes Felt Sick	Frequently Felt Sick
Cars					
Buses or Coaches					
Trains					
Aircraft					
Small Boats					
Ships, e.g. Channel Ferries					
Swings in playgrounds					
Roundabouts in playgrounds					
Big Dippers, Funfair Rides					
	t	0	1	2	3

Your experience over the last 10 years (approximately), for each of the following types of transport or entertainment please indicate

2. **Over the last 10 years,** how often you **felt sick or nauseated** (tick boxes).

	Not Applicable - Never Traveled	Never Felt Sick	Rarely Felt Sick	Sometimes Felt Sick	Frequently Felt Sick
Cars					
Buses or Coaches					
Trains					
Aircraft					
Small Boats					
Ships, e.g. Channel Ferries					
Swings in playgrounds					
Roundabouts in playgrounds					
Big Dippers, Funfair Rides					
	t	0	1	2	3

APPENDIX C

SIMULATOR SICKNESS QUESTIONNAIRE (SSQ)

INFORMATION PROVIDED ON THIS QUESTIONNAIRE IS STRICTLY CONFIDENTIAL.
Your completion of this questionnaire is strictly voluntary and you can skip any questions that you do not want to answer.

Participant ID: __________ **Date:** ____________

THIS SECTION OF THE QUESTIONNAIRE IS COMPLETED **BEFORE** USING THE DRIVING SIMULATOR.

PRE-EXPOSURE BACKGROUND INFORMATION

1. How long has it been since your last exposure in a simulator? ______ days
   How long has it been since your last flight in an aircraft? ______ days
   How long has it been since your last voyage at sea? ______ days
   How long has it been since your last exposure in a virtual environment? ______ days

2. What other experience have you had recently in a device with unusual motion?

PRE-EXPOSURE PHYSIOLOGICAL STATUS INFORMATION

3. Are you in your usual state of fitness? (Circle one) YES NO
   If not, please indicate the reason:

4. Have you been ill in the past week? (Circle one) YES NO
   If "Yes", please indicate:
   a) The nature of the illness (flu, cold, etc.):
   b) Severity of the illness: Very Mild _________________ Very Severe
   c) Length of illness: _________________ Hours / Days
   d) Major symptoms:
   e) Are you fully recovered? YES NO

5. How much alcohol have you consumed during the past 24 hours?
   ____ 12 oz. cans/bottles of beer ____ ounces wine ____ ounces hard liquor

6. Please indicate all medications you have used in the past 24 hours. If none, check the first line:

a) NONE ____________
b) Sedatives or tranquilizers ____________
c) Aspirin, Tylenol, other analgesics ____________
d) Antihistamines ____________
e) Decongestants ____________
f) Other (specify): ______________________________

7. a) How many hours of sleep did you get last night? _____ hours
   b) Was this amount sufficient? (Circle one) YES NO

8. Please list any other comments regarding your present physical state which might affect your performance on our test.

BASELINE (PRE) EXPOSURE SYMPTOM CHECKLIST

Instructions: Please fill this out BEFORE you go into the virtual environment. Circle how much each symptom below is affecting you right now.

#	**Symptom**	**Severity**			
1.	General discomfort	None	Slight	Moderate	Severe
2.	Fatigue	None	Slight	Moderate	Severe
3.	Boredom	None	Slight	Moderate	Severe
4.	Drowsiness	None	Slight	Moderate	Severe
5.	Headache	None	Slight	Moderate	Severe
6.	Eye strain	None	Slight	Moderate	Severe
7.	Difficulty focusing	None	Slight	Moderate	Severe
8a.	Salivation increased	None	Slight	Moderate	Severe
8b.	Salivation decreased	None	Slight	Moderate	Severe
9.	Sweating	None	Slight	Moderate	Severe
10.	Nausea	None	Slight	Moderate	Severe
11.	Difficulty concentrating	None	Slight	Moderate	Severe
12.	Mental depression	None	Slight	Moderate	Severe
13.	"Fullness of the head"	None	Slight	Moderate	Severe
14.	Blurred Vision	None	Slight	Moderate	Severe
15a.	Dizziness with eyes open	None	Slight	Moderate	Severe
15b.	Dizziness with eyes closed	None	Slight	Moderate	Severe
16.	*Vertigo	None	Slight	Moderate	Severe
17.	**Visual flashbacks	None	Slight	Moderate	Severe
18.	Faintness	None	Slight	Moderate	Severe
19.	Aware of breathing	None	Slight	Moderate	Severe
20.	***Stomach awareness	None	Slight	Moderate	Severe
21.	Loss of appetite	None	Slight	Moderate	Severe
22.	Increased appetite	None	Slight	Moderate	Severe
23.	Desire to move bowels	None	Slight	Moderate	Severe
24.	Confusion	None	Slight	Moderate	Severe
25.	Burping	None	Slight	Moderate	Severe
26.	Vomiting	None	Slight	Moderate	Severe
27.	Other				

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Visual illusion of movement or false sensations of movement, when not in the simulator, car, or aircraft.
*** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

<u>THIS SECTION OF THE QUESTIONNAIRE IS COMPLETED **AFTER** USING THE DRIVING SIMULATOR.</u>

<u>**POST 00** MINUTES EXPOSURE SYMPTOMS CHECKLIST</u>

Instructions: Circle how much each symptom below is affecting you <u>right now</u>.

#	**Symptom**	**Severity**			
1.	General discomfort	None	Slight	Moderate	Severe
2.	Fatigue	None	Slight	Moderate	Severe
3.	Boredom	None	Slight	Moderate	Severe
4.	Drowsiness	None	Slight	Moderate	Severe
5.	Headache	None	Slight	Moderate	Severe
6.	Eye strain	None	Slight	Moderate	Severe
7.	Difficulty focusing	None	Slight	Moderate	Severe
8a.	Salivation increased	None	Slight	Moderate	Severe
8b.	Salivation decreased	None	Slight	Moderate	Severe
9.	Sweating	None	Slight	Moderate	Severe
10.	Nausea	None	Slight	Moderate	Severe
11.	Difficulty concentrating	None	Slight	Moderate	Severe
12.	Mental depression	None	Slight	Moderate	Severe
13.	"Fullness of the head"	None	Slight	Moderate	Severe
14.	Blurred Vision	None	Slight	Moderate	Severe
15a.	Dizziness with eyes open	None	Slight	Moderate	Severe
15b.	Dizziness with eyes closed	None	Slight	Moderate	Severe
16.	*Vertigo	None	Slight	Moderate	Severe
17.	**Visual flashbacks	None	Slight	Moderate	Severe
18.	Faintness	None	Slight	Moderate	Severe
19.	Aware of breathing	None	Slight	Moderate	Severe
20.	***Stomach awareness	None	Slight	Moderate	Severe
21.	Loss of appetite	None	Slight	Moderate	Severe
22.	Increased appetite	None	Slight	Moderate	Severe
23.	Desire to move bowels	None	Slight	Moderate	Severe
24.	Confusion	None	Slight	Moderate	Severe
25.	Burping	None	Slight	Moderate	Severe
26.	Vomiting	None	Slight	Moderate	Severe
27.	Other				

* Vertigo is experienced as loss of orientation with respect to vertical upright.
** Visual illusion of movement or false sensations of movement, when <u>not</u> in the simulator, car or aircraft.
*** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

POST-EXPOSURE INFORMATION

1. While in the virtual environment, did you get the feeling of motion (i.e., did you experience a compelling sensation of self motion as though you were actually moving)? *(Circle one)*

YES NO SOMEWHAT

2. On a scale of 1 (POOR) to 10 (EXCELLENT) rate your performance in the virtual environment: ______

3. a. Did any unusual events occur during your exposure? *(Circle one)* YES NO

b. If YES, please describe:

APPENDIX D

APPLIED COGNITIVE PERFORMANCE LAB
DRIVING HISTORY QUESTIONNAIRE

This is a ***strictly confidential*** questionnaire. Only a randomly generated participant ID number, assigned by the research administrator, will be on this questionnaire. No information reported by you here will be traced back to you personally in any way. **You can skip any questions you do not feel comfortable answering.**

Section 1: Demographics

Gender: ☐ Male ☐ Female

Date of Birth: (Month / Day / Year): _______ / _______ / _______ **Age:** ___________

Race / Ethnicity: ☐ Black / African American ☐ Asian
(check all that apply) ☐ Caucasian ☐ American Indian / Native Alaskan
☐ Hispanic / Latino ☐ Other

Have you participated in a study at this laboratory in the past? ☐ Yes ☐ No

Section 2: Driving History

Approximately how long have you had your driver's license? _______ years _______ months

About how many miles did you drive since your licensure? ____________ miles

Does your license require you to wear glasses or contacts while driving? ☐ Yes, eyeglasses ☐ Yes, contacts ☐ No

Do you have any other restrictions on your driver's license? ☐ Yes ☐ No

If yes, please describe: ____

Are you currently on any over-the-counter or prescription medications that make it difficult to drive? ☐ Yes ☐ No

If yes, please describe: ____

In the past three months, have you text messaged while driving? ☐ Yes ☐ No

Section 2: Driving History (continued)

Do you think text messaging while driving could affect your driving performance? ☐ Yes ☐ Maybe ☐ No

How frequently do you text message in a day? ☐ Over 20 ☐ 10 - 20 ☐ 5 - 10 ☐ Less than 5 ☐ Never

Within the last three years, have you had any moving violations? ☐ Yes ☐ No

If so, what type and how many?

☐ Speeding How many times? _____
☐ Running red light How many times? _____
☐ Running stop sign How many times? _____
☐ Failure to yield How many times? _____
☐ Other _____________ How many times? _____

Within the last three years, have you been involved in any automobile crashes? ☐ Yes ☐ No

If so, what type of crashes(s)?
(Please check all that apply)

☐ Head-on collision (front of car to front of car contact)
☐ Rear-end collision (front of car to rear of car contact)
☐ Side impact or angled collision (front of car to side of car contact)
☐ Sideswipe (door to door contact)
☐ Single car accident (struck tree, sign, pedestrian)
☐ Multiple car accident (more than two cars involved)
☐ Other
☐ I don't remember

Please describe each of these crashes in a few sentences below.

____
____
____
____
____
____

James Richard Unverricht

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Education

Old Dominion University
Bachelor of Science in Psychology, 2017
Major GPA: 3.97/4.00

Northern Virginia Community College
Associates of Science in Psychology, 2015
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Research/Teaching Experience

Research Assistant, Digital Senses Laboratory	2019-present
Graduate Research Assistant, Applied Cognitive Performance Laboratory	2017-present
Graduate Teaching Assistant, ODU Department of Psychology	2017-present
Graduate Mentor, Ocean Lakes Math and Science Academy Summer Internship	2017-2017
Undergraduate Research Assistant, Psych of Design Laboratory	2016-2017

Peer-Reviewed Publications

Unverricht, J., Yamani, Y., Horrey, W. J., Chen, J, & Yahoodik, S (*in press*). Attention maintenance training: Are young drivers getting better or being more strategic? *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*.

Unverricht, J., Yamani, Y, & Horrey, W. (2019). Effects of a Training Program on Driver Calibration in Attention Maintenance [Extended Abstract]. *Proceedings of the Transportation Research Board 98th Annual Meeting*, Washington, D.C.

Unverricht, J., Yamani, Y., & Horrey, W. J. (2018). Calibration in older and middle-aged drivers: Relationship between subjective and objective glance performance at complex intersections. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *62*, 1913-1917.

Yamani, Y., Bıçaksız, P., **Unverricht, J.,** & Samuel, S. (2018). Impact of information bandwidth of in-vehicle technologies on drivers' attention maintenance performance: A driving simulator study. *Transportation research part F: Traffic psychology and behaviour*, *59*, 195-202.

Unverricht, J., Samuel, S., & Yamani, Y. (2018). Latent hazard anticipation in young drivers: Review and meta-analysis of training studies. *Transportation Research Record*, 0361198118768530.