The Long-Term Effects of Active Training Strategies on Improving Older Drivers' Scanning in Intersections: A Two-Year Follow-Up to Romoser and Fisher (2009)

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Objective: To determine the long-term effects of active training on older drivers' scanning in intersections, the present article reports the results of a 2-year follow-up with drivers who had previously participated the older driver training study reported in Romoser and Fisher.

Background: Customized feedback coupled with active learning in a simulator has been shown to be an effective means of significantly improving the intersection scanning behavior of older drivers. However, the long-term effect of such training has not been established.

Method: Older drivers from the active learning and control groups from Romoser and Fisher were invited to participate in a 2-year follow-up field drive in their own vehicle starting at their home. Secondary looks, defined as looking away from the path of the vehicle while entering the intersections toward regions to the side from which other vehicles could appear, were recorded.

Results: Two years after their training, older drivers in the active learning group still took secondary looks more than one and a half times as often as 2009 pretraining levels. Control group drivers saw no significant change in performance over the 2-year period.

Conclusion: Customized feedback and active learning in a simulator is an effective strategy for improving the safe driving habits of older drivers over the long term. It provides drivers a means by which to reincorporate previously extinguished behaviors into their driving habits.

Application: These results can guide the development of older driver retraining programs that could have the potential to reduce intersection crashes.

Keywords: aging, driver behavior, surface transportation systems, training technologies, training, education, instructional systems, older drivers, situation awareness, attentional processes, older driver performance, road scanning, intersection crashes, training strategies, simulator training

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INTRODUCTION

Older drivers are at increased risk of crashing in intersections. This is especially true while turning (Bryer, 2000; Garber & Srinivasan, 1991; Ryan, Legge, & Rosman, 1998). There is growing evidence that there is a marked decrease in side-to-side scanning for cross-traffic in older drivers when compared to middle-aged and younger drivers (Bao & Boyle, 2009; Keskinen, Ota, & Katila, 1998; Romoser & Fisher, 2009). Bao and Boyle (2009) found that older drivers' scanning was primarily confined to an area directly in front of the vehicle while negotiating an intersection. Romoser et al. (2005) found that experienced adult drivers were 3 times more likely to scan to the sides in intersections than older drivers. Regardless of an older driver's speed of processing and useful field of view, declines in which have been linked to increased crashes (Ball, Beard, Roenker, Miller, & Griggs, 1988; Ball & Owsley, 1991), if drivers fail to scan for peripheral hazards outside of their field of view, the likelihood of a crash can only increase.

The 2009 study by Romoser and Fisher published in *Human Factors* investigated whether older drivers looked less often for potential threats that could emerge from the sides when compared to experienced adult drivers and compared the effectiveness of active versus passive training strategies on older drivers' scanning while negotiating intersections. In a simulator-based experiment, older drivers were found to take significantly fewer glances to the sides (secondary looks) than middle-aged drivers after entering an intersection, increasing their risk of a crash with vehicles approaching from the sides. Older drivers tended to look only in the direction of their vehicle's path through the intersection. In the training experiment, s*econdary looks* were defined as glances aimed toward traffic in the periphery away from the path of the vehicle *after* the driver had entered the intersection. Glances prior to turn commitment were called *primary looks.* There were three treatment groups—active training, passive training, and control. Participants were drivers 70 to 89 years of age living independently in their homes. All participants scored within clinical norms on a battery of cognitive and physical tests. Participants' road scanning behaviors were recorded in both simulator and field drives using a head-mounted camera system. In separate sessions before and 6 to 8 weeks after training, all participants drove a series of intersections both in the simulator and in field drives starting and ending at their homes. During the training, the active training group received feedback in the form of a video review of their driving performance followed by active practice of secondary glances in a driving simulator. The passive training group received a classroom-style lecture covering the importance of secondary glances and a demonstration of proper secondary glances. The control group received no training.

On average, active training increased the likelihood of taking a secondary look by nearly 100%. Passive training and control group drivers saw no significant increase in secondary looks. Presented here is a short report documenting the results of a 2-year follow-up with drivers from the active training and control groups to investigate whether the learning effects measured 2 years before were maintained or decayed over time.

TWO-YEAR FOLLOW-UP

Method

Participants. Individuals from the *active* and *control* groups who participated in the training study (Experiment 2) reported in Romoser and Fisher (2009) were recruited. After the 2009 study, written permission was received from each participant to potentially follow-up for a longitudinal study. Participants were contacted individually for recruitment to this study. Between 23 and 26 months (24.4 months average) had passed between when the participants completed the 2009 study and their participation in the present study. All 12 participants from the active learning group who participated in the 2009 field drives were contacted, and 11 volunteered to participate in the follow-up study (age range = 73–82, avg. = 77.4, $SD = 3.47$). Of the 12 participants from the 2009 control group, 11 were contacted and 10 volunteered to participate in the follow-up study (age range = 72–81; avg. = 76.5, $SD = 3.20$). Of the three individuals who did not participate in the follow-up, one had passed away from natural causes, one had moved from the area, and the other cited a lack of time to participate. All participants self-reported that they were still living in their homes and had no changes to their legal driving status between studies, and none had reported accidents within the 2-year period.

Apparatus. The same apparatus that was used for the field drives in Romoser and Fisher (2009) was employed for the present study. Participants drove their own vehicle. The apparatus consisted of four cameras. One camera, worn on the head using a lightweight headband, recorded the participant's head movements. Three other bullet cameras—one straight ahead, one to the left, and one to the right—were installed on the roof of the participant's vehicle. The outputs of these four cameras were recorded digitally for later analysis and scoring. The camera system as installed can be seen in Figure 1.

Procedure. This study consisted of a single 60-minute session with each participant at his or her home. The session replicated the post-training field drive from the study 2 years prior (Session 6 for the active group, Session 5 for the control group; see Romoser & Fisher, 2009). Upon arrival, participants provided their informed consent. They were then instructed that they would be participating in a follow-up field drive and that the camera system would be installed in their vehicle. To avoid biasing participants' performance, no mention was made of the training the participants received 2 years earlier or of the purpose of the field drive. Participants were told only that they would be repeating their final field drive from 2 years prior.

The experimenter then reviewed the route the participant had driven during his or her previous field drives (it had been recorded using GPS). Each route took approximately 30 minutes to complete and included several left and

Figure 1. Four-camera system employed for field drive. One was worn on the head, and three were mounted to the roof of the vehicle using a bracket with a heavy-duty felted magnet.

right turns. After the participant could recite his or her route using a map, the camera system was installed in the vehicle and the participant was fitted with the headband camera. The participant then drove the route. The experimenter did not accompany the participant during the drive. After the participant returned home, the vehicle- and head-mounted cameras were removed. The participant was invited to ask questions regarding the follow-up study and was given the opportunity to view an informal video replay of his or her drive. In the event secondary looks were not seen, the experimenter pointed them out.

Scoring of drive videos was conducted by two blinded experimenters who did not participate in the data collection. A secondary look was defined as a head turn made by the driver either at the onset of the turn or within 2 seconds of entering the intersection away from the path of his or her vehicle and toward areas from which other vehicles could conflict with his or hers from the side. Videos from participants were parsed into short clips showing individual intersection maneuvers, and the presentation of clips for scoring was randomized across all participants. At each intersection a binary yes or no determination was made as to whether the driver made a correct secondary look at the intersection. An overall percentage of secondary looks, defined as the number of intersections where the driver took a proper secondary look divided by the total number of intersections the driver navigated, was calculated for each participant. Interrater reliability was very good ($\kappa = .84$, $p < .001$).

RESULTS

Secondary looks for the follow-up field drive compared to those taken by the same participants as reported in Romoser and Fisher (2009) are summarized in Figure 2. In the 2009 study, older drivers in the active learning group took secondary looks in 46.3% of intersections prior to active training in a simulator and in 79.6% of intersections 6 to 8 weeks after training. Two years after training, on average, these same active learning group drivers continued to execute secondary looks in intersections 72.7% of the time—a result that was still significantly higher than their 2009 pretraining performance, $F(1, 10) = 11.11$, $p < .05$ (repeated measures ANOVA). The 6.9% decrease from the 2009 posttraining performance to 2-year posttraining performance was not statistically significant.

In contrast, in the 2009 study, older drivers in the control group who received no training took secondary looks in 40.7% of intersections during the first field drive and in 38.5% of intersections 6 to 8 weeks later. As reported in Romoser and Fisher (2009), those results were not significantly different. Two years later, these same control group drivers took secondary looks in 42.9% of intersections—again, no statistically significant change in performance.

Individual performance in the 2009 study and in the 2-year follow-up is summarized in Figure 3. In the active learning group, the 2009 average

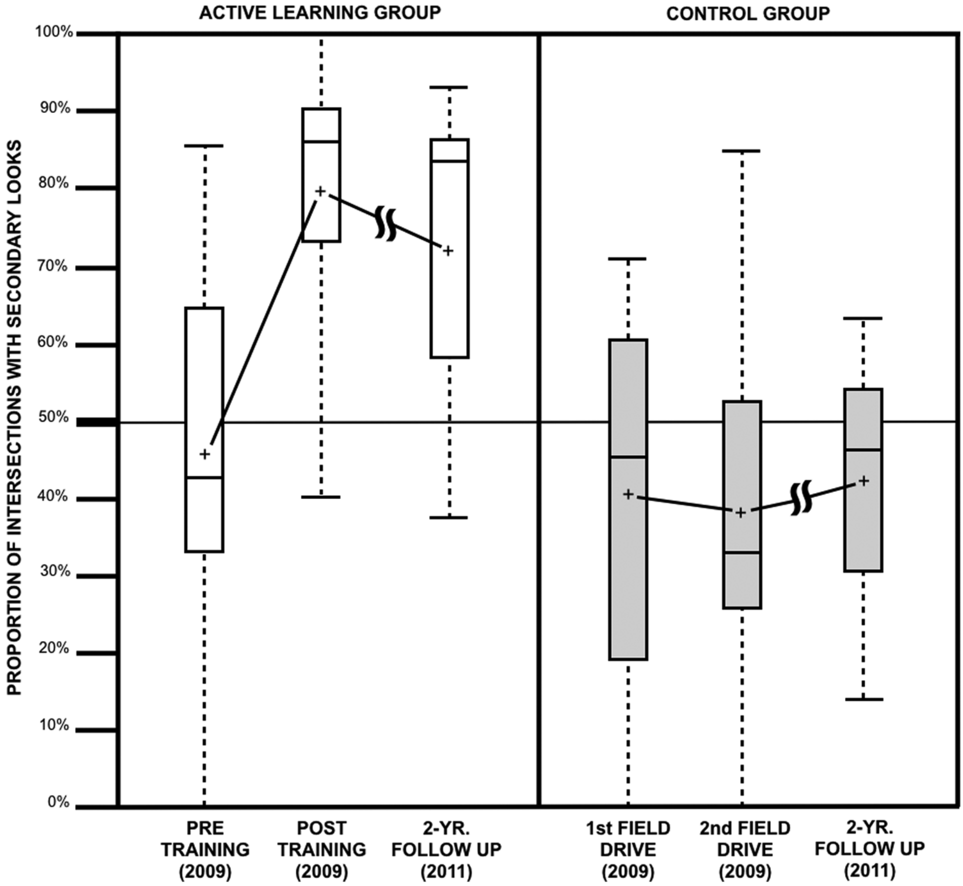

Figure 2. Secondary looks reported in Romoser and Fisher (2009) and during the 2-year follow-up (2011).

pre- to posttraining improvement in secondary looks was 77.0% (discarding one driver who started with 0% looks pretraining, resulting in a divide by zero) with 9 out of 11 drivers recording an increase of 20% or more in secondary looks 6 to 8 weeks after training. At the 2-year follow-up, only 3 of those 9 drivers "regressed" by more than 10% from their 2009 posttraining performance. However, despite the regression, their 2-year follow-up performance still exceeded their pretraining performance 2 years prior by an average of 24.0%. The remaining 6 drivers remained within 10% of their posttraining performance 2 years later. Those 2 drivers in the active learning group who did not improve pre- to posttraining in 2009 did not record any substantial decrease in performance at the 2-year follow-up. Cognitive and physical functioning, as measured in the 2009 study, was not significantly correlated with the likelihood of regression.

DISCUSSION

The goal of this research was to assess the long-term learning retention of active simulator-based practice for older drivers. Age-related issues such as diminished useful field of view (Ball & Owsley, 1991), cognitive and physical decline (Braitman, Kirley, Ferguson, & Chaudhary, 2007), and increased difficultly with selective attention (Hakamies-Blomqvist, Sirén, & Davidse, 2004) have been shown to contribute to increased driving risk. However, the results of Romoser and Fisher (2009) and Pollatsek, Romoser, and Fisher (2011) found that even healthy drivers for whom these issues have not yet begun to interfere with their ability to

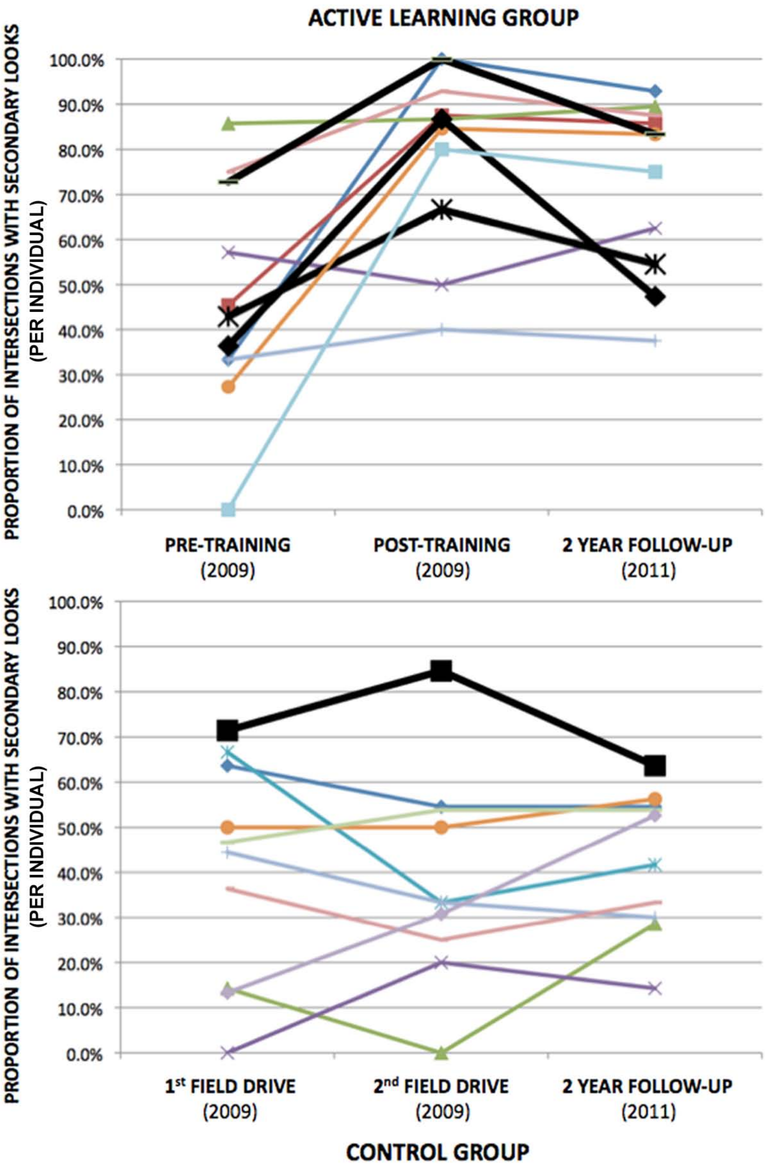

Figure 3. Secondary looks for individual participants in active training and control groups participating in 2-year follow-up. Participants regressing more than 10% from posttraining (2009) to the 2-year follow-up (2011) are emphasized with black, heavier weighted lines.

function independently begin to scan less effectively in intersections when compared to middle-aged drivers.

One possible explanation for this is as cognitive and physical decline sets in, drivers compensate by simplifying the driving task as driving places an increasing load on working memory. There is growing evidence that older drivers shift from parallel to serial control of driving processes to compensate for declines in cognitive workload capacity (Boer, Cleij, Dawson, & Rizzo, 2011; Cooper, 1990; Langford & Koppel, 2006). When serialization occurs, one might expect older drivers to focus primarily on the prepotent tasks of (a) focusing on what is directly in front of them and (b) maintaining their vehicle on the desired path through the intersection. Providing video-based feedback and an opportunity to practice secondary looks in a simulator appears to be a effective means of helping older drivers reincorporate these critical skills into their driving habits. These results suggest that this strategy can be an effective means of changing long-term older driver behavior.

More research is required to determine if such gains in scanning behavior translate into reductions in crashes in older drivers. Future research should focus on collecting a long-term sample of driver scanning behavior over time rather than relying on a one-time in-vehicle observation. One weakness of the present study is that it is possible that having the technology installed in their vehicle and wearing the head-mounted camera may have prompted drivers to look around more often than they normally would. Another is the relatively small sample size. Camera-equipped GPS and g-force-triggered in-vehicle monitoring devices are less invasive and can be configured to collect video of scanning behavior over the course of several months. Devices could be deployed in sufficient numbers to improve the power of the study. There were also some control group drivers who did improve. This improvement may be the result of communication between trained and untrained drivers through social interactions in the community.

However, despite the obvious presence of the cameras in the car and small sample size, large main effects were achieved and members of the control group showed no significant increase in secondary looks. The decrease in scanning by some actively trained drivers suggests the potential for skill atrophy and that follow-up refresher courses would be useful to help drivers maintain skills over the long term. Overall, the results of this study demonstrate that customized feedback and active learning methods can be very effective in realizing long-term positive changes in older driver behavior.

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KEY POINTS

- Customized feedback coupled with active training of secondary looks in a simulator has long-term training effects lasting up to 2 years.
- Most older drivers in the active learning group maintained scanning performance at or near post-training levels 2 years after training.
- Older drivers can successfully reincorporate previously extinguished behaviors into their day-to-day safe driving habits.

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