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Evaluating the Effects of Integrated Training on Minimizing Driver Distraction

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Recent driving simulator studies which record driver and vehicle behaviors have focused on examining and developing specific training programs for improving driver performance across three cognitive skills that are critical to driver safety, hazard anticipation, hazard mitigation, and attention maintenance.

First, hazard anticipation (HA) is defined as the ability to scan the areas of the roadway in order to identify and react to a hazardous event, especially those events that are latent (have not yet materialized). Novice drivers glance less frequently towards areas with potential hazards, compared with experienced drivers (Pradhan et al., 2005).

Second, hazard mitigation (HM) is defined as any action that a driver undertakes in an attempt to respond to potential or actual hazards on the road. As with HA, novice drivers performed worse than experienced drivers in evaluations of HM.

Lastly, attention maintenance (AM) is defined as the ability of drivers to maintain their attention on the forward roadway. Off-road glances longer than 2 seconds elevate the risk of a crash (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). FOrward Concentration and Attention Learning (FOCAL) is a program that aims at training novice drivers to limit their glances inside the vehicle to no longer than 2 seconds.

Of current interest is the evaluation of an integrated training program, SAFE-T, developed by Hamid (2013) that has been shown to reduce the effect among nurses (all experienced drivers) that fatigue has on each of the above three critical driving skills (e.g., Hamid, Samuel, Borowsky, & Fisher, 2014). The current study addresses whether the integrated training program will prove as effective among novice drivers.

We also compare the effect size of SAFE-T with the effect size of one of the training programs, RAPT, to determine whether the decrease in exposure and potential for interference decrease the size of the effect of SAFE-T on hazard anticipation (the same skills that RAPT is designed to train).

Forty-eight students between 16 and 18 years old participated in the study. All participants held a valid driver's license including a junior operator's license. All participants completed a single driving simulator evaluation of their HA, HM, and AM skills, immediately after a training program (SAFE-T, RAPT, or placebo). In the evaluation, participants navigated a single "drive set" comprised of four virtual environments. There were 4 drive sets used in the experiment, each representing a different sequence of virtual environments (Town, Highway, Rural and Residential). Each virtual environment contained one HA, one HM, and one AM scenarios. The order of the virtual environments within a drive set was counterbalanced across participants, as was the order of the three different tests of the driving skills (HA, MA, and AM) within each of the virtual environments.

Each participant navigated a single drive set which consisted of a total of 12 scenarios, one HA, one HM and one AM scenario in each of four virtual environments (Highway, Town, Rural, and Residential). Consider first the four HA and four HM simulator evaluation scenarios. Both the HA and HM scenarios involved a latent hazard that could potentially materialize as a vehicle approaches the launch zone. The simulator evaluation scenarios required the participants to exercise while driving the same basic HA and HM skills as those that were trained.

Next consider the four AM simulator evaluation scenarios. These scenarios consisted of straight two-lane roads with no lead vehicle events, no ambient traffic, or any sort of hazard materialization. All AM tasks were in-vehicle tasks that required the driver to glance away from the forward roadway to complete the tasks. For the AM tasks, the participants were asked to perform four different tasks: a) Searching for a CD, b) Depositing Change, c) Dialing a Number,

and d) Locating a Street. Auditory instructions and beeps indicated initiation and termination (after 15s) of the AM tasks respectively. The task was initiated at a fixed location on the roadway in each scenario.

Participants were randomly assigned either to the SAFE-T, RAPT or the placebo condition. They completed the assigned training program, followed by a practice drive to get acquainted with the simulator including the AM tasks. After the practice drive, participants drove one drive set of 12 experimental scenarios on the simulator. Participants were instructed to drive as they would on an actual road following all traffic rules, signs and speed limits.

In HA tasks, compared to the placebo group, there was a 26 percentage point gain in the percentage of hazards correctly anticipated by the SAFE-T group, a difference indistinguishable from the 25 percentage point gain in the percentage of hazards correctly anticipated by the RAPT group.

The SAFE-T group also mitigated hazards earlier and more rapidly than the placebo-trained group in two scenarios and anticipated the hazards more often than the placebo group. The SAFE-T group successfully reduced the proportion of off-road glances greater than 2 seconds compared to the RAPT and placebo groups. By comparison with FOCAL, SAFE-T reduced by 11.7 percentage points the proportion of glances longer than 2 seconds while FOCAL reduced by 9.4 percentage points the proportion of glances longer than 2 seconds (e.g. Pradhan et al., 2011). These results clearly indicate the effectiveness of the AM portion of the SAFE-T program -- even with reduced exposure (15 minutes vs. 40 minutes, for SAFE-T and FOCAL, respectively) -- in minimizing especially long off-road glance durations while engaged in various in-vehicle tasks. The RAPT group did not reduce the proportion of longer glances, suggesting that the RAPT-trained drivers did not generalize the learning content of the RAPT program to the attention maintenance skills. This was somewhat surprising as RAPT encourages drivers to actively explore visual driving scenes for a potential hazard.

The current set of results suggests that younger drivers can be trained to improve various aspects of their higher cognitive performance (HA, HM & AM) within a shorter span of time using an integrated training program. Why is the SAFE-T training program effective for improving the three skills in one third of the time that each of the individual training program can take? First, it appears that SAFE-T may have identified a balance in the number of exemplars provided with respect to exposure as compared to previous programs, thereby providing a more ideal platform to help novice drivers generalize the learned skill to different road environments in an optimal manner within a shorter time span. Second, in the SAFE-T program, training of one skill could have facilitated another. This theoretical speculation raises an interesting question: what are the relationships among the HA, HM, and AM skills? The RAPT-trained drivers mitigated hazards even though they were not specifically trained to do so, showing some generalizability of the HA skill to the HM skill. Possibly, the AM skill for which the FOCAL program specifically trains drivers may help them better anticipate hazards, because FOCAL-trained drivers can maintain their attention on the forward roadway for longer period of time than the control group (Divekar et al., 2013).

The SAFE-T training program led to significant improvements in the three higher cognitive skills, HA, HM & AM. The effects were similar to those found in other similar training programs (RAPT, ACT, and FOCAL). The results clearly show that the program holds great promise for improving young drivers' safety-critical skills in a much shorter span and to a level akin to that of existing programs