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Evaluation of a Risk Awareness Perception Training Program on Novice Teen Driver Behavior at Left-Turn Intersections

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Abstract

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Collisions at left turn intersections are among the most prevalent types of teen driver serious crashes, with inadequate surveillance as a key factor. Risk awareness perception training (RAPT) has shown effectiveness in improving hazard anticipation for latent hazards. The goal of this study was to determine if RAPT version 3 (RAPT-3) improved intersection turning behaviors among novice teen drivers when the hazards were not latent and frequent glancing to multiple locations at the intersection was needed. Teens aged 16–18 with 180 days of licensure were randomly assigned to: 1) an intervention group (n=18) that received RAPT-3 (Trained); or 2) a control group (n=19) that received no training (Untrained). Both groups completed RAPT-3 Baseline Assessment and the Trained group completed RAPT-3 Training and RAPT-3 Post Assessment. Training effects were evaluated on a driving simulator. Simulator (*gap selection* errors and *collisions*) and eye tracker (*traffic check* errors) metrics from six left-turn stop sign controlled intersections in the Simulated Driving Assessment (SDA) were analyzed. The Trained group scored significantly higher in RAPT-3 Post Assessment than RAPT-3 Baseline Assessment ($p < 0.0001$). There were no significant differences in either *traffic check* and *gap selection* errors or *collisions* among Trained and Untrained teens in the SDA. Though Trained teens learned about hazard anticipation related to latent hazards, learning did not translate to performance differences in left-turn stop sign controlled intersections where the hazards were not latent. Our findings point to further research to better understand the challenges teens have with left turn intersections.

Keywords

Driving simulation; hazard anticipation; hazard recognition; intersection crashes; novice teen drivers; risk awareness training

INTRODUCTION

Motor vehicle crashes are the leading cause of death in teens. The most serious crash types for teen drivers include rear-end events, right-side road departures, and left turns at intersections, accounting for almost 40% of teen driver serious crashes (1–3). Inadequate surveillance is a critical factor in teen driver crashes, particularly in left turns at intersections (2; 4). Inadequate surveillance can be related to a simple failure to scan (5), the “looked but didn’t see” phenomenon (e.g. scanning is adequate but the hazard is not detected; or selective attention limits processing of hazard (6)), and distractions (e.g. did not look because engaged in another activity) (7). Moreover, as teen drivers navigate an intersection, they may not recognize or know how to respond to other vehicles or road users. Thus, given the complexities of traffic patterns, right of way, and field of view, left turn intersections are often hazardous for teens.

Recognition of hazards is an important skill for drivers, and research indicates that experienced adult drivers have better hazard recognition skills than novice teens (8–10). Training programs have been developed to teach teens how to anticipate hazards on the roadway through PC-based programs, viewing of videos, commentary driving and simulator based training (8; 11–13). Overall, some programs have shown promise for improving hazard recognition skills of novice teens both in a driving simulator and the field over the short and long term.

One training program in particular, Risk Awareness Perception Training (RAPT), addresses hazard anticipation by training teens to look for latent (potential, hidden, or covert) hazards that are obscured by the built or natural environment (13; 14). In RAPT training, the latent hazards are usually static in nature, obscured by a parked vehicle or vegetation, and generally do not materialize. RAPT trains drivers on tactical scanning skills in scenarios which contain latent hazards, such as using environmental cues to anticipate potential hazards (e.g., a parked vehicle). The scanning skill in RAPT is referred to as tactical because it is used for a specific scenario; that is, the driver is trained at a particular point in the scenario to glance towards a location from which a latent threat might emerge (15). By scanning critical regions on the road, even with no visible threats, teen drivers can become aware of potential hazards and have information from the environment that contributes to their subsequent driving actions.

Different versions of RAPT have been developed (v. 1, 2, 3, SIMRAPT, Road Aware) (12; 13; 16–18). As in the previous versions, RAPT Version-3 (RAPT-3) is a PC-based program that trains drivers to glance for hazards. The categories of risk addressed in RAPT-3 include latent hazards that are obscured by the built or natural environment (A and B described in this paragraph) as well as latent hazards that are visible and become a hazard only because the driver has not recognized that the scenario contained elements that would cause the latent hazard to become an actual hazard (C below). These categories are (A) Complete Obstruction of Latent Threat (a vehicle or other traffic elements obscured participant driver's view of a risk in an area where one would expect other vehicles to emerge-e.g. a truck obscures a pedestrian where there is a visible marked pedestrian crosswalk); (B) Advance Obstruction of Latent Threat (there is an obstructed threat but the environment contains advance warning-e.g., a road entering from the left is obscured until the last minute, but the driver had advance warning – i.e., a sign); and (C) No Obstruction of Latent Threat (no obstruction-e.g., a vehicle immediately ahead of the driver and turning might stop suddenly because a pedestrian is in the crosswalk) (15). RAPT-3 has shown training effects in driving simulator (18) and on-road (19) evaluations that has led to near (scenarios very similar to those in training) and far (scenarios that were not in the training) transfer.

At an intersection when a driver needs to turn left, hazards such as cross traffic may not be hidden or obstructed, nor may a hazard ever materialize (e.g. if there is no cross traffic). However, teens have difficulty at left turn intersections resulting in serious crashes. Therefore, it is critical to better understand how hazard anticipation training programs like RAPT-3 may address teen driving performance in left turn intersections. Examining left turn intersections goes beyond an evaluation of hazard anticipation skills when the view to the left or right is obscured at an intersection. Rather, this involves an evaluation of RAPT-3 training on a skill unrelated to its original goal-a single glance towards a single area where a hazard may or may not materialize. Specifically, it involves determining whether RAPT-3 training as is generalizes to scanning behaviors at intersections where the hazard (cross traffic) is visible and multiple glances at several critical regions is needed in order to determine whether there is a safe gap in the cross traffic. The aim of this study was to determine if RAPT-3 training, as is, improves intersection turning behaviors among novice teen drivers. It was hypothesized that if RAPT-3 training does generalize to left-turn stop

sign controlled intersections, then trained teens would have fewer traffic check eye errors, gap selection errors, and collisions in these scenarios.

METHODS

Participants

We recruited 16–18 year old teen drivers who received a Pennsylvania (PA) provisional license 180 days prior to study enrollment. Individuals were excluded for self-reported history of migraines, motion sickness, pregnancy, non-English speaking or if they previously participated in another driving simulator study or teen driving intervention study at CHOP. Participants were recruited via mailings from pediatric primary care facilities, driving schools, and word of mouth. All study procedures were approved by the Institutional Review Board at the Children's Hospital of Philadelphia and an administrative agreement with the University of Pennsylvania.

Design and Training

We used a randomized two group design (ClinicalTrials.gov: NCT01619202) with follow up assessment in a driving simulator to examine the effects of the training. Participants were randomly assigned to: 1) an intervention group that received Risk Awareness and Perception Training Version 3 (RAPT-3) (Trained); or 2) a control group that received no training (Untrained).

RAPT-3, a web-based intervention developed by the University of Massachusetts Amherst, contains three components: a baseline component (RAPT-3 Baseline Assessment), a training component (RAPT-3 Training) and a post-assessment component (RAPT-3 Post Assessment). RAPT-3 Training consists of training on hazard and risk awareness in nine scenarios in which there was an inherent risk of a collision with another vehicle or pedestrian (RAPT-3 Training) (15). In our study, both Trained and Untrained teens completed the RAPT-3 Baseline Assessment. Only Trained teens received the RAPT-3 Training and RAPT-3 Post Assessment. Both Trained and Untrained teens completed the portions related to RAPT-3 via web-based delivery and a study team member monitored the participants' completion of the program in person (Untrained) or through a shared screen mechanism (Trained) to ensure the teen was completing the program and answered any questions related to the program.

In the RAPT-3 Baseline Assessment, teens assigned to both the Trained and Untrained groups were presented with the nine still photographs and used mouse-clicks to identify areas of potential risk. Mouse-click coordinates were internally recorded by the program for scoring and no feedback was given for the RAPT-3 Baseline Assessment performance (15).

Only teens assigned to the Trained group received RAPT-3 Training and RAPT-3 Post Assessment. For the RAPT-3 Training, teens were shown a top-down schematic view of a scenario accompanied with explanations about risks. For a given scenario, the participant was presented with a sequence of perspective view still photographs and was instructed to click on areas of the still photographs to which they would have to glance at if they were actually driving through the scenario. Each still photograph in the sequence appeared for

approximately the same time it would appear if the driver were navigating the scenario (typically 2–3 seconds). Mouse-click coordinates in still photographs were internally recorded as correct if positioned in the critical area. If the participant successfully identified the critical areas, the program moved onto the next scenario. If not, the user was taken back to the training part of the scenario with the schematic view and corresponding explanations. The participants had up to four opportunities to correctly identify areas of risk (15).

Immediately upon completing RAPT-3 Training, the Trained group were presented with the RAPT-3 Post Assessment. Similar to the Baseline Assessment, participants were presented with the nine still photographs and used mouse-clicks to identify areas of potential risk. Mouse-click coordinates were internally recorded by the program for scoring and no feedback was given for the RAPT-3 Post Assessment performance (15).

In order to evaluate the effects of RAPT-3, both Trained and Untrained teens were invited to complete an assessment in a driving simulator. The Trained teens completed the assessment in the driving simulator a median of 11 days after completing RAPT-3 (IQR 8.5–14, range 7–28). Three Trained participants came in for the simulated assessment more than two weeks after training. The Untrained teens completed RAPT Baseline the day of scheduled study visit for the simulated assessment.

Materials and Apparatus

The Realtime Technology, Inc. (RTI)® driving simulator system used in this study included: a driver seat; three 46" LCD panels (160° field of view); rearview, left and right mirror inlaid images; active brake and accelerator pedals; and a steering system. Visual rendering and graphics were delivered at 1280 × 1024 resolution at 60 Hz. Raw simulator data (e.g., velocity, position) were collected at 60 Hz. Digital videos of the participant's driving behavior were also recorded by three cameras (over the right shoulder, over the right foot and towards the face).

An Applied Science Laboratories (ASL) Mobile Eye® was used to capture eye movements on the forward scene at 30 Hz. Participants wore a pair of glasses (or goggles worn over eyeglasses) with two video cameras (one to record the forward image and the other to record the right eye of participant) to capture the gaze location over the duration of the simulated assessment. Video data from the two cameras were integrated into a single video with cross hairs superimposed on the video to indicate eye gaze location.

Simulated Scenarios

Simulated Driving Assessment (SDA)—We have previously outlined the methods to develop the SDA scenarios (3; 20). The simulated scenarios were developed based on potential serious crash configurations derived from analysis of the National Motor Vehicle Crash Causation Survey (NMVCCS) (21). These potential crash configurations included rear-end collisions, left turn intersection collisions, and right side run-off the road events – representing approximately 40% of teen crash configurations in NMVCCS (3). Prior to completing the SDA, participants drove an unscored familiarization segment (~7–10 minutes) to adjust to simulator dynamics. The SDA lasted approximately 35–40 minutes and

included three modules presented in random order. If the participant drove the SDA safely, collisions were avoidable. Although the SDA contained rear-end collisions, left turn intersection collisions, and right side run-off the road events, our analysis focused on the six left-turn stop sign-controlled intersections.

Left Turn Stop-Sign Controlled Intersections the SDA—We chose to focus on these left turn scenarios for the evaluation of RAPT-3 based on the research question: Do drivers trained with RAPT-3 generalize the skill of scanning for latent hazards generalize to left turn intersections? In the studied left-turn stop sign controlled intersections, on approach, the view of the intersection in four scenarios, cross traffic from the left was not obscured, but frequent glancing to the left and right was needed to assess cross traffic across several lanes of traffic. In two scenarios, cross traffic from the left was obstructed—one with a static obstruction and the other with a dynamic obstruction. However, if the participant waited and made multiple glances, the cross traffic conflict vehicles were no longer obscured.

Table 1 describes the six left turn stop sign-controlled intersections used in this analysis. In all scenarios, the participants approach the intersection with the instructions to turn left at the intersection. Of note, the SDA did not include any scenarios that were exactly trained for by RAPT-3 as the SDA was developed based on the most frequent serious teen crash scenarios, and not developed to test any one type of training program. Therefore, near-transfer training effects of RAPT-3 could not be examined. Scenarios #1 and #2, however, could assess far transfer of training in the risk category of Complete Obstruction of a Threat because they included an obstructed threat (i.e., the cross traffic was not visible due to a large truck or a construction site (in RAPT 3, the obstruction was due to curvature in the road and heavy vegetation)). Scenarios 3–6 could be considered yet farther-transfer of training as none of these scenarios contained obstructed views of hazards and all required multiple glances rather than a single glance to determine whether a latent threat would materialize into an actual threat.

Dependent Variables

For this study, we had three key driving performance safety metrics of interest for dependent variables at the left turn stop-sign controlled intersections: *traffic check*, *gap selection* and *collisions*.

Traffic Check—A correct traffic check was defined as a left-right-left glance sequence at the left turn stop-sign controlled intersection (20). ASL Mobile Eye video data with superimposed cross-hairs were used for coding. Research assistants, blind to the condition, were trained to record all eye glance locations (left, right, center) starting at 5.5 meters from the stop-sign controlled left turn intersection until turn initiation. Recorded glance locations were coded to determine if sequences of left-right-left were made (For example, a sequence of left, center, right, center, left was coded as a sequence of left-right-left). Failure to make a glance sequence of left-right-left within 5.5 meters of an intersection prior to turn imitation was recorded as a *traffic check* error. A study team member checked 10% of all stop sign controlled left turn intersections coding and found 100% inter-rater reliability for designation of traffic check error. For a minority of cases with device calibration failure,

traffic check could not be calculated (missing data for each scenario ranged from 0–5%). Missing data were imputed from available traffic check data in the other scenarios.

Gap selection—Gap selection was defined as the choice of time to enter the left turn stop sign-controlled intersection in reference to the proximity to other vehicles in the intersection (20). Gap selection was determined either by post-encroachment time (PET) or by cross traffic slowing or stopping due to the participant entering the intersection. PET was defined as the time difference between the driver's vehicle and another vehicle passing a common spatial zone. For PET, video coding was used to determine whether a participant waited for cross traffic. Participants who waited for cross traffic did not receive an error. If the participant did not wait for cross traffic, custom MATLAB (Mathworks, Inc., Natick, MA) code was used to reduce raw simulator data for PET. Participants with a PET <1.5 seconds received a *gap selection* error. For some participants, the cross traffic conflict vehicle slowed or stopped short because the participant entered the intersection in close proximity in front of the cross traffic conflict vehicle. If the cross traffic conflict vehicle slowed or stopped, the participant also received a *gap selection* error.

Collisions—Collisions were defined as an overlap of the participant's vehicle with other vehicles programmed in the left turn stop sign-controlled intersection (20). Collisions were derived with custom MATLAB code from simulator data which consisted of the position, orientation, and dimensions of the participant and nearest vehicle and were verified by video review.

Analysis

RAPT-3 Performance Data—The RAPT-3 Baseline Assessment of both the Trained and Untrained groups was analyzed according to the algorithms provided with RAPT-3 in which mouse-click coordinates were used to determine whether hazards were detected. Scoring was on a scale of 0–9 where a nine indicated that correct mouse clicks were given for all nine RAPT-3 scenarios. Similarly, for the Trained Group, the RAPT-3 Post-Assessment was scored on a scale of 0–9 for similar scenarios.

For the RAPT-3 Baseline and RAPT-3 Post Assessment, medians, interquartile ranges [IQR], and ranges were computed. To gauge central tendency of non-normally distributed data, a Wilcoxon Rank Sum Test was used to compare the distribution of RAPT-3 scores: Baseline Assessment between Trained and Untrained; and Baseline of the Untrained to the Post Assessment for the Trained group. A Wilcoxon Signed Rank Sum test was used to compare the distribution of RAPT-3 scores between the Baseline and Post Assessment for the Trained group.

Driving Performance Metrics—Frequency and percentages of errors and collisions for each scenario were computed. For each stop sign-controlled left turn, a Fisher's exact test was computed to compare proportional differences of traffic check and gap selection errors, as well as collisions, between the Trained and Untrained groups.

All aggregated analyses were conducted using R v3.1.1 (<http://www.r-project.org>).

RESULTS

Our analytic sample included $n=37$ teens (see Figure 1). The Untrained group included 19 teens: 42% female, 63.2% White, 15.8% African American, 21.3% more than one race reported, 100% non-Hispanic, median age=17 years (IQR, 17–17; range, 16–18), with provisional license for a median of 66 days (IQR, 38–108; range, 12–180). The Trained group included 18 teens: 50% female 55.6% White, 38.9% African American, 5.6% more than one race reported, 100% non-Hispanic, median age=17 (IQR 16–17, range 16–18), with provisional license for median of 74 days (IQR, 43–118, range, 20–178).

RAPT-3 Training Results

There was no significant difference in RAPT-3 Baseline scores for the Trained (median=5; IQR: 4–5) and Untrained (median=5; IQR: 4–6) groups ($z=0.35$, $p=0.73$). The Trained group scored significantly higher in their RAPT-3 Post Assessment than in the RAPT-3 Baseline Assessment (Median=8; IQR: 8–8 vs. Median=5; IQR: 5–6, $s=76.50$, $p<0.0001$). In addition, the Trained group's median score was 3 points higher on the RAPT-3 Post Assessment than the Untrained group's RAPT-3 Baseline Assessment ($z=4.52$, $p<0.0001$), indicating a measured training effect.

Driving Performance Metrics

Table 2 outlines the results in the Trained and Untrained groups. The frequency and percentage indicate the number and percentage of participants with an error in a metric in a given scenario.

Almost half of the Trained and Untrained teens made *traffic check* errors in Scenarios #1 (obstruction) and #3–#5 (no obstruction). Trained and Untrained teens made the most *gap selection* errors in Scenarios #5 and #6 (no obstruction). There were few *collisions* in the six stop sign controlled left turn intersections.

Across all the scenarios and driving performance metrics, there were no significant differences between the Trained and Untrained groups. Scenario #2, with a construction site acting as an obstruction for the hazard, had a trend in the expected direction of Trained doing better, but it was not significant.

DISCUSSION

The Trained teens had improvements in their RAPT-3 assessment scores, and had higher final RAPT-3 Assessment Scores than the Untrained group. However, there were no significant differences in traffic check and gap selection errors or collisions in the left turn stop sign controlled intersections for the Trained and Untrained teens. In our sample, even though Trained teens learned about hazard anticipation related to latent hazards, this learning did not translate to performance differences in the SDA left turn intersections. In previous studies, different versions of RAPT have been shown to have training effects in near transfer scenarios, though not always as effective in far transfer scenarios (22). Based on our results, it is possible that RAPT training does not generalize to scenarios where the threats can be seen but constant monitoring is still needed in order to detect the threats.

Two scenarios in the SDA (Scenario #1 and #2) could be considered far transfer in the RAPT-3 risk category of Complete Obstruction of a Threat. Neither SDA scenario had significant differences between the groups. In Scenario #1, as the truck turns (the obstruction), it no longer obscured the cross traffic conflict vehicle (hazard). Scenario #2, which showed a trend for fewer traffic check errors by the Trained group had a single, static object was hiding the view of a dynamic, latent threat: in the case of the SDA, it was a construction site which hid a possible vehicle in cross traffic. Even though there were some similarities to RAPT-3, the different types of obstructions (static and dynamic) may make teens feel confident that they looked at the obstruction and did not see any potential hazard at first glance, not realizing that some obstructions move in the environment. Therefore, the teens do not make multiple glances at the intersection to ensure the environment has not changed with additional traffic. Intersections present multiple, dynamic hazards that require frequent glances at a number of locations (23). Cross traffic may not be present from a distance as the driver approaches the intersection, but may be present as the driver is at the intersection. Dynamic hazards at intersections require multiple glances to the left and the right on approach and while stopped for the driver to select an appropriate gap to turn (24). Like other complex driving environments, intersections which require multiple glances also point to the issue of the need to consider classes of threats, both latent and overt (25; 26).

In RAPT-3 training, teens are trained to glance at one critical area of interest for each of the specific scenarios. RAPT-3 training does not include direction on multiple glances to potentially hazardous areas of interest. With left turn intersections, multiple glances are needed in order to acquire information about potential hazards. In addition to multiple glances at critical regions, intersections require the complex cognitive task of processing the glances made towards potential hazards, dividing attention among potential hazards, and making decisions based on the acquired visual information and cognitive processing (27; 28). Our results indicate that the training of RAPT in regards to latent hazards needs to be augmented to include training for teens to develop a cadre of skills that includes identification of latent hazards, use of multiple glances to areas of interest, and choice of safe entrance into an intersection in order to avoid collisions.

Our findings point to the need for better understanding of the timing of training programs. Although crashes involving left turns declined relatively rapidly over the course of the first 36 months of licensure (29), our participants were newly licensed (within 180 days of licensure) and might not yet have accumulated enough practical understanding of how to properly handle left turns. Receiving training on tactical scanning skills and hazard recognition during the first few months of licensure might not have transferred the significance and relevance for applying such knowledge on left turn scenarios.

Further research is also needed to better understand the challenges novice teens have with intersections as they progress and transition to more experienced drivers. Many studies examine driving behavior of elderly drivers at intersections (30; 31). However, fewer studies address teen or young driver behavior at intersections (27; 32). Further research is needed to better understand not only where teens need to be looking at areas of interest, but also how they must divide attention among the competing critical areas, how much time should be

spent glancing at critical areas, how traffic patterns affect performance, and the role that intersection design can play in safety.

Limitations

Our study was not without limitations. Our SDA did not include any RAPT-3 simulator scenarios that would allow for assessment of near transfer. Thus, we cannot be confident that the training worked (or did not work). However, our scenarios in the SDA were created to reflect the most frequent types of teen driver serious crashes and not evaluate the effects of any one training program. There was little variability in the collisions in these scenarios. Given the prevalence of left turn crashes for teens in crash data sources, we would have expected more collisions in our SDA. There may have been an underrepresentation of crashes in some of our scenarios because cross traffic conflict vehicle sometimes slowed or stopped to avoid a collision with the participant vehicle. We aimed to have teens come in at about one to two weeks after RAPT-3 training. However, given scheduling conflicts with teens, three teens were outside the two weeks. Given that RAPT had shown long-term effects up to a year (19), we included these teens in our sample. In addition, our sample was not large enough to do sub-analyses on the teens that came in more than two weeks after receiving RAPT training.

CONCLUSION

Left turn intersections present difficulties for teen drivers and can lead to serious crashes. Addressing inadequate surveillance associated with crashes at intersections is important to prevent teen driver crashes. It is possible that enhanced development of hazard recognitions training programs like RAPT could target skill deficits at intersections. Targeted training addressing hidden hazards or those that do not materialize could be coupled with training for hazards that can be identified with multiple glances may address crash risk.

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FIGURE 1.
Sample derivation.

TABLE 1

Description of Stop Sign Controlled Left Turn Scenarios

Scenario #	Description
Complete Obstruction of a Threat	
Scenario #1	The participant approaches a T-intersection for which the participant but not the cross-traffic has a stop sign. All traffic has two travel lanes in each direction. A blue truck approaches from the left and makes a right hand turn from the right lane. A white sedan (which was <i>obstructed</i> by the blue truck) approaches from the left as cross traffic (in left lane) heading in a straight path.
Scenario #2:	The participant approaches a T-intersection for which the participant but not the cross-traffic has a stop sign. All traffic has two travel lanes in each direction. A green sedan approaches from the left as cross traffic heading in a straight path (in left lane) and the view is <i>obstructed</i> by a construction zone in the right lane.
No Obstruction of Threat But Multiple Glances Required Due to Multiple Areas of Interest	
Scenario #3	The participant approaches a T-intersection for which the participant but not the cross-traffic has a stop sign. All traffic has two travel lanes in each direction. A grey truck approaches from the left (in right lane) as cross traffic and continues straight. A red sedan approach from the right (in right lane) as cross traffic heading straight. A yellow sedan approaches from the left as cross traffic (in left lane) heading in a straight path.
Scenario #4	The participant approaches a stop sign at a 4-way intersection. The participant and opposing traffic ahead have a stop sign but cross traffic does not. All traffic has two travel lanes in each direction. A blue sedan is heading in a straight path across the intersection on the opposite side of the road (in right lane). A red truck approaches from the right (in right lane) and turns right. A green sedan approaches from the left as cross traffic (in right lane) heading in a straight path.
Scenario #5	The participant approaches a 4-way intersection. The participant and opposing traffic ahead have a stop sign but cross traffic does not. All traffic has two travel lanes in each direction. A blue sedan with its left turn signal flashing is facing the participant across the intersection (in left lane). A red sedan approaches from the left as cross traffic (in left lane) heading in a straight path.
Scenario #6	The participant approaches a T-intersection for which the participant but not the cross-traffic has a stop sign. All traffic has two travel lanes in each direction. A green truck approaches from the right (in right lane) as cross traffic heading in a straight path. A gray sedan approaches from the left as cross traffic (in left lane) heading in a straight path.

TABLE 2

Comparison of Trained and Untrained Errors in Each Scenario

Scenario and Error	Trained (n=18) N (%)	Untrained (n=19) N (%)	p-value*
Scenario #1			
Traffic check	10 (55.6%)	6 (31.6%)	0.19
Gap Selection	0 (0%)	0 (0%)	-
Collision	0 (0%)	0 (0%)	-
Scenario #2			
Traffic check	3 (16.7%)	7 (36.8%)	0.27
Gap Selection	1 (5.6%)	3 (15.8%)	0.60
Collision	1 (5.6%)	1 (5.3%)	1.00
Scenario #3			
Traffic check	9 (50%)	8 (42.1%)	0.75
Gap Selection	0 (0%)	0 (0%)	-
Collision	0 (0%)	0 (0%)	-
Scenario #4			
Traffic check	9 (50%)	8 (42.1%)	0.75
Gap Selection	2 (11.1%)	1 (5.3%)	0.60
Collision	1 (5.6%)	0 (0%)	0.49
Scenario #5			
Traffic check	10 (55.6%)	12 (63.2%)	0.74
Gap Selection	6 (33.3%)	5 (26.3%)	0.73
Collision	0 (0%)	0 (0%)	-
Scenario #6			
Traffic check	7 (38.9%)	7 (36.8%)	1.00
Gap Selection	3 (16.7%)	5 (26.3%)	0.69
Collision	0 (0%)	0 (0%)	-

* Fisher's exact tests were used to compare the proportional differences of each error between Trained and Untrained groups within each scenario.