UAB Translational Research for Injury Prevention (TRIP) Laboratory

Distracted Driving Translational Research for Injury Prevention (TRIP) Laboratory

Prepared for: Alabama Department of Transportation
Prepared by: Dr. Despina Stavrinos, PI
Project dates: June 3, 2015 - June 30, 2017
September 14, 2018

ALABAMA DOT FINAL REPORT

REPORT SUBMITTED BY: **Dr. Despina Stavrinos & Benjamin McManus**
DATE: **September 13, 2018**

PROJECT TITLE: Distracted Driving Translational Research for Injury Prevention (TRIP) Laboratory

PROJECT START AND END DATES: June 3, 2015 – June 30, 2017

PROJECT BUDGET:

ALDOT	$ 168,236.25
Cost Share UAB/HONDA *facility build out (UAB Psychology)	$ 165,620.00 $ 112,250.00
Total	$ 446,106.25

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Disclaimer

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SUMMARY OF PROJECT OBJECTIVES AND SCOPE

Motor vehicle collisions (MVCs) are one of the leading causes of death for Alabamians across the lifespan. Highway fatalities are a major epidemic in this country. Most car crashes in Alabama take place in urban areas – but most collisions involving fatalities occur on rural roads, according to data compiled by the National Highway Traffic Safety Administration. Younger and older drivers pose the greatest risk in terms of unsafe driving and crashes (Figure 1).

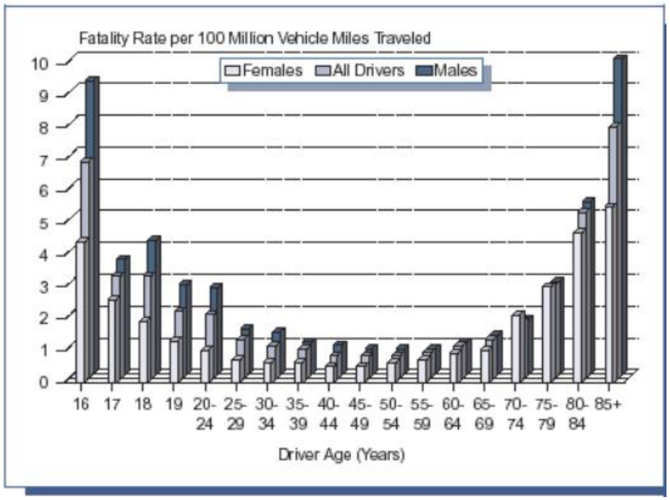

Figure 1: Crash rates by Age Group; Federal Highway Administration (FHWA), 2002

Driving research at UAB through the Translational Research for Injury Prevention (TRIP) Lab has enormous life-saving potential. It will help alleviate a major public health and highway-traffic safety problem. We partner with key community and industry leaders and municipalities around the state. Our aim is to help save lives resulting from traffic crashes. The results of the research undertaken here at UAB provide policymakers and industry leaders alike with sound, immediate, and actionable data that will lead to significant changes in personal responsibility and social norms - changes that will save lives and reduce injury. The UAB TRIP Lab is equipped with the expertise, capacity, and enthusiastic commitment to discover and use research findings that will be used to develop and implement proven interventions that will save lives and reduce injuries, in support of US Department of Transportation's public safety initiatives.

The current study examined the impact of roadway and driver factors on rural road crashes. There were 2 specific aims:

1. Examine at-risk drivers, namely teens and older adults, operating a new high-fidelity driving simulator which provides a hands-on research driving simulation experience for participants in varying roadway conditions (curvatures, weather conditions, light level, road elevation, and intersections)

2. Examine what individual difference factors (age, distractibility) predict risky driving behavior under varying roadway conditions

The following specific tasks were accomplished:

Task 1: Simulator acquisition and build out: driving simulator facility establishment
Task 2: Start-up: preparation of driving simulator scenario/staff training/IRB approval
Task 3: Subject recruitment/data collection: N=100 (50 teens, 50 older adults)
Task 4: Data management and analysis
Task 5: Final report and other deliverables

SUMMARY OF SIGNIFICANT RESULTS AND ACCOMPLISHMENTS

Task 1: Simulator acquisition and build out

Simulated driving environments give the user a sense of being fully immersed in an actual driving scenario. A virtual experience provides key learning opportunities for both researchers and participants in a controlled, safe setting through realistic virtual images, high quality sound, and the feeling of being surrounded by the virtual world rather than just viewing it on the screen; it provides users the ability to truly interact and immerse themselves with the virtual world.

With funds provided by this project, we established a state-of-the-art driving simulator facility in the TRIP Lab at the University of Alabama at Birmingham. It has and will continue to provide avenues for collaborative partnerships with government, industry, academia, and various constituencies. This unique driving simulation platform built by Realtime Technologies, Inc. (RTI), which is the first and only sport utility vehicle (SUV) simulator in the world, is designed to integrate simulators for both training and research purposes, providing a real-time dynamic that represents a variety of vehicle models quickly and accurately. The simulator considers the vehicle in its entirety, calculating the torques at the wheels based on brake pedal, gear, and accelerator pedal inputs, as well as damping rates, bump stops, anti-sway bars, and a myriad of other features providing participants with a more realistic and beneficial learning environment. The simulator provides audio, visual, simulation, and animation software; simulation computer; three flat screens (80” each) with LCD projectors; rear screen and projector; motion-base; equipment setup, training and maintenance; and simulation library. The platform makes use of a variety of cab, control loading, and visual display configurations, and can fully support the data input and output requirements of various cab types.

The driving simulator was officially delivered to our UAB facility on November 12, 2015 (see Figures 1-7). The complete installation occurred from November 12 – November 17, 2015. RTI extensively trained us on the use of the simulator from November 18 – 20, 2015.

Figure 1. Simulator arrival at UAB

Figure 2. Simulator vehicle loaded onto flatbed truck. Entire store front glass façade removed, and simulator vehicle brought into building

Figure 3. Simulator vehicle inside building, awaiting installation into prepared simulator room

Figure 4. TRIP lab personnel with simulator vehicle outside of prepared simulator room

Figure 5. Simulator vehicle moved into prepared simulator room through temporary open wall

Figure 6. Simulator vehicle fully positioned and calibrated in simulator room with sample scenario projected

Figure 7. Fully operational and instrumented interior of the simulator vehicle

Renovations to the simulator facility necessary to meet the requirements of the simulator were completed in February 2016 and totaled over $100,000 (funding provided by UAB Department of Psychology). Renovations included build out of a soundproofed and blacked-out room for full immersion, a separate operator control room, installation of a standalone A/C unit to the car to provide air to participant drivers, and clean-up to return to baseline.

On April 19, 2016, we hosted a grand opening for the driving simulator. Nearly 50 people attended and participated in live demonstrations of the state-of-the-art driving simulator laboratory. UAB Vice President for Research and Economic Development, Dr. Richard Marchase, presided. Speakers included Mr. Waymon Benifield (ALDOT), Mr. Mike Oatridge (VP, Honda Manufacturing of Alabama), Chief Chris Carden (Alabama Attorney General's Office), Dr. Karlene Ball (UAB Psychology Chair), and Dr. Despina Stavrinos (PI and Director of TRIP Lab). Local media covered the event. Figures 8 – 12 depict the event.

Figure 8. Dr. Richard Marchase providing opening remarks at the grand opening of the driving simulator; also pictured (L to R): Mr. Waymon Benifield (ALDOT), Dr. Despina Stavrinos, and Dr. Karlene Ball.

Figure 9. Dr. Stavrinos, Honda Engineer, Mr. Adam Hussemann, and Mr. Waymon Benifield (ALDOT) at the grand opening of the driving simulator

Figure 10. Dr. Stavrinos and Mr. Waymon Benifield (ALDOT)

Figure 11. The Honda Manufacturing of Alabama team with Dr. Stavrinos. (L to R): Mr. Ted Pratt, Mr. Adam Hussemann, Mrs. Stephanie Alexander, and Vice President, Mr. Mike Oatridge.

Figure 12. TRIP Lab student assistants and Dr. Stavrinos

Task 2: Start-Up (Preparation of driving simulator scenario/Staff training/IRB approval)

IRB approval for the current study was obtained in February 2016. A team of students at various levels of training (undergraduate and graduate) were trained and certified to implement the experimental protocol. These students were volunteers (not paid by study funds). Students routinely seek opportunities such as this one to expand the scope of their research skill set. Project team members were assigned project specific tasks to ensure the project was ready to start. These included, but were not limited to, the following: develop recruitment strategies and design flyers to advertise the project; write protocols; employ random order assignment strategies; implement training protocols; create schedules to accommodate appointments for participants 7 days a week and during non-traditional hours (after 5pm).

Scenario development ensued over a period of nearly a year. Pilot testing was conducted by a variety of stakeholders, including teens, older adults, researchers, and ALDOT representatives (see photos in Figures 13 – 17 below). The final scenario was developed to mimic an Alabama, rural, single lane scenario. It consisted of three parts that were equal driving time at the posted speed limit: 1) elevations, 2) curves, and 3) intersections. One-third of the participants began driving the scenario with elevations, 1/3 with curves, and 1/3 with intersections. Within each drive, the scenario components were counterbalanced so that every road section served as the start point, middle section, and ending section equally. For each section there were an equal number of road elements (e.g. elevations, curves, or intersections) to minimize practice effects. All scenarios had traffic in a bi-directional manner with traffic density at “50%” representing Level of Service B. A rainy weather condition scenario was also developed. This scenario was identical to the scenarios described above with the addition of visible rain in the simulated environment and a lowered road surface friction coefficient to match the actual real-world friction coefficient of wet asphalt. Both daytime light conditions and nighttime light conditions versions for all driving scenarios were created.

Three distraction conditions were developed for each age group based on the most common potential real-world distractions within each age group. The distraction conditions for adolescent drivers were 1) handheld cellphone conversation; 2) text messaging interaction; and 3) no distraction. The distraction conditions for older adult drivers were 1) handheld cellphone conversation; 2) hands-free cellphone conversation; and 3) no distraction. For both age groups and all conversation distraction conditions (handheld cellphone and hands-free cellphone), a research assistant called the driver at the beginning of the driving scenario, the driver answered the call, and subsequently engaged in a naturalistic conversation with the research assistant for the duration of the driving scenario. In the text messaging interaction for teens, drivers received a text message at the beginning of the driving scenario and engaged in reading and responding to text messages from a research assistant for the duration of the driving scenario. All conversation and text messaging distractions were semi-structured to imitate a typical conversation between unfamiliar individuals (i.e., research assistants); these research assistants maintained a natural conversation flow. Example conversation questions included "What do you like to do in your free time?" and "What is one of your favorite movies?"

Each driver completed 3 driving scenarios with roadway section orders counterbalanced as described above. The driving scenario in which the text messaging interaction (teens) or hands-free cellphone conversation (older adults) distraction condition occurred was repeated for the 4th drive in the rainy weather condition. The driver completed all 4 drives in the same light condition throughout, with half of the drivers completing their drives in daytime light conditions and half driving in nighttime light conditions.

Figure 13. Mr. Waymon Benifield, Dr. Stavrinos, Mrs. Michelle Owens, and Mr. Ray Pugh participating in the pilot testing of TRIP Lab's state-of-the-art driving simulator

Figure 14. Dr. Stavrinos and Mrs. Michelle Owens at the driving simulator's pilot testing

Figure 15. The TRIP Lab Team and Mrs. Michelle Owens at the simulator's pilot test

Figure 16. Outside view of driving simulator and virtual environment

Figure 17. Inside view of driving simulator and virtual environment

In addition to the simulator drives, the full protocol also included a series of questionnaires examining driving-related constructs (e.g., demographics, personality) to assess how individual difference factors relate to driver responses.

Task 3: Subject recruitment/data collection: Target N = 100 (50 teens, 50 older adults)

We used IRB approved methods for recruitment of older adults and teens for this study. Methods included hanging flyers around UAB campus and the Birmingham area to recruit potential individuals into the study, and postings to social media, websites, and the UAB clinical trials page. In addition, we have mailed nearly 3,000 letters to older adults in the area informing them of this study opportunity.

Recruitment efforts went as expected based on previous studies with similar populations and has concluded. We enrolled and collected data from all 100 participants.

1. A total of 165 individuals were screened for eligibility to participate.
2. 50 teens (M_{age} = 17.58 years, SD = 1.16; 44% male, 68% white) and 50 older adults (M_{age} = 71.7years, SD = 6.16; 52% male, 74% white) were run through the experimental protocol. Data collection was completed as of 3/21/2017.
3. All teen and older adult data were entered and reviewed for accuracy.

The project personnel carefully monitored participants for simulator sickness throughout the experimental protocol. Due to a higher-than-expected level of simulator sickness among older adult participants, a modified scenario was constructed based on feedback from the PAC at the special meeting on September 27, 2016 and the October 7, 2016 visit by PAC members Mr. Ron Johnson and Mrs. Michelle Owens. With the implementation of the new modified scenario, simulator sickness rates in older adults dropped significantly from 70% (in the partial sample/first 10 recruited) to 35% (for the full sample of 50 older adults). The overall simulator sickness rate for all 100 participants (teens and older adults) was 27%, falling within ranges comparable to other driving simulator studies involving older adults (20-30%). Data analyses included complete data (e.g., all 4 driving scenarios completed) from 47 teens and 36 older adults (total N= 83).

Task 4: Data Management and Analysis

Given the need for a modified older adult scenario to compensate for simulator sickness, adolescents and older adult data were managed and analyzed separately for the two age groups. Both groups had the same driving outcomes (average driving speed, speed variability, lane maintenance, and collisions) for all analyses. Linear regressions accounting for repeated measurements within each participant were utilized to analyze and interpret the impact of key predictor variables (e.g., roadway segment, distraction condition) on the driving outcomes speed, speed variation, and lane maintenance. Similarly, general estimating equation (GEE) Poisson regressions were utilized for non-linear count driving outcomes (collisions).

Within each age group, the overall impact of roadway segments, distractions, and light conditions on driving outcomes were examined first. Each driving outcome was regressed on 3 variables: 1) roadway segment; 2) distraction condition; and 3) light level. Elevations were selected as the referent for roadway segment, the no distraction condition was the referent for distraction condition, and daytime was the referent for the light condition variable.

Within each roadway segment (elevations, curves, and intersections), additional regressions were performed with each driving outcome using 1) distraction condition; 2) light level; and 3) weather (rain vs. clear) as predictor variables to determine their impact on driving within these specific roadway elements.

See Figures 18 – 99 for results of Aim 1 data analyses.

ADOLESCENTS

Average Driving Speed

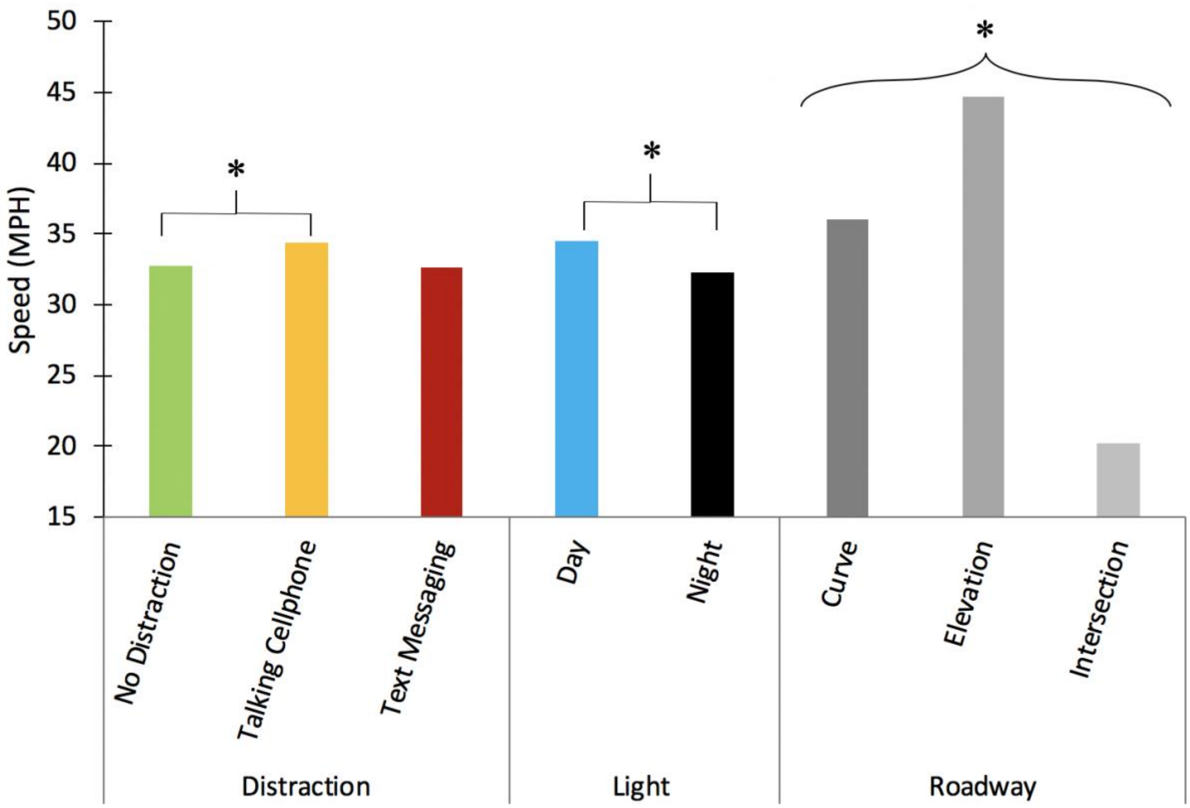

Figure 18. Average speed across all distraction conditions, light conditions and roadways in adolescent drivers.

Average speed was uniquely predicted by the roadway (F = 542.89, p < .0001), distraction condition (F = 9.08, p = .0003) and light condition (F = 6.22, p = .02). Across all light conditions and weather, adolescents drove significantly faster when talking on the cell phone as compared to when in the no distraction task (t = 3.37, p = .001). Adolescents also had a significantly lower average speed when driving in night conditions compared to daytime conditions (t = 2.49, p = .02). Average driving speed of the adolescents during a distraction did not depend on roadway or light condition.

Speed Variability (Standard Deviation of Speed)

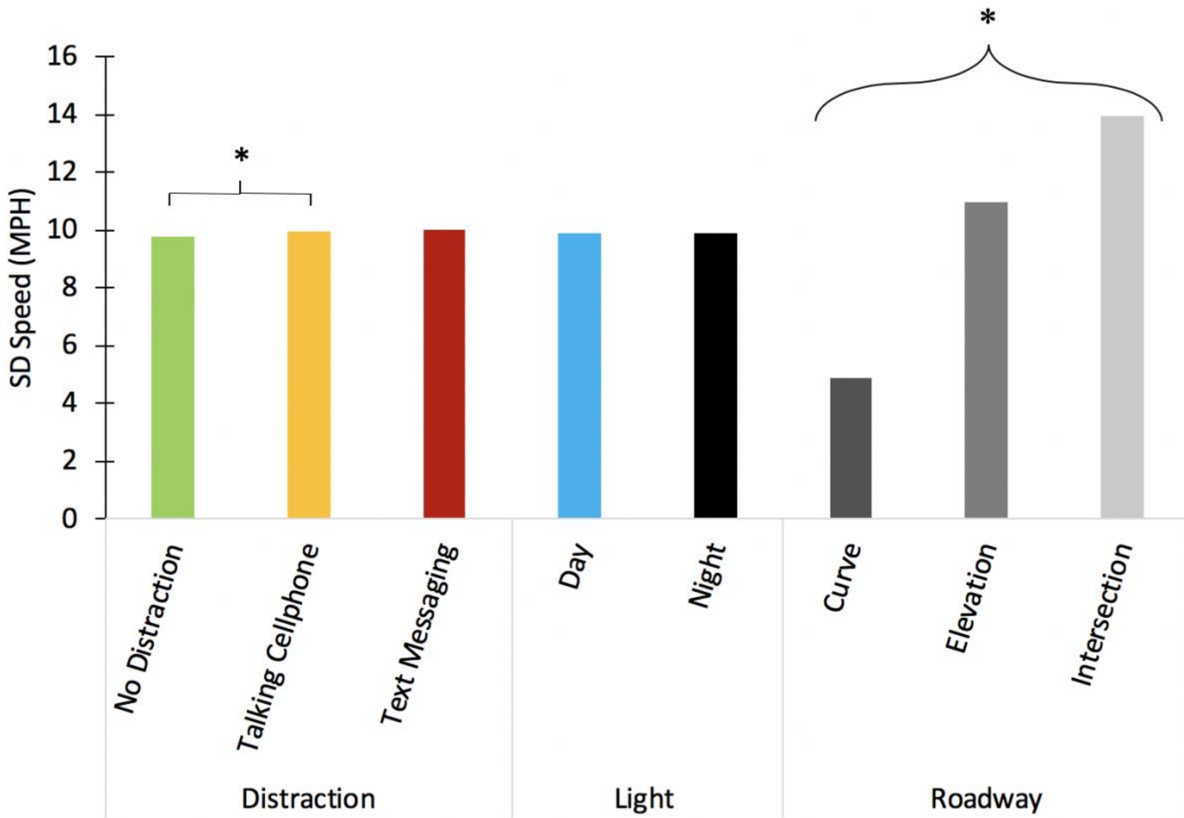

Figure 19. Speed variability (standard deviation of speed) in adolescents across all distraction conditions, light levels, and roadways.

Speed variability was uniquely predicted by roadway ($F = 431.17$, $p < .001$) and distraction ($F = 6.58$, $p = .003$). Speed variability in adolescents was significantly higher when talking on the cellphone compared to when engaged in no secondary task ($t = 3.06$, $p = .004$). There was only marginal evidence to suggest speed variability when distracted significantly depended on the roadway being driven ($F = 2.18$, $p = .07$).

Lane Maintenance (Standard Deviation of Lane Position)

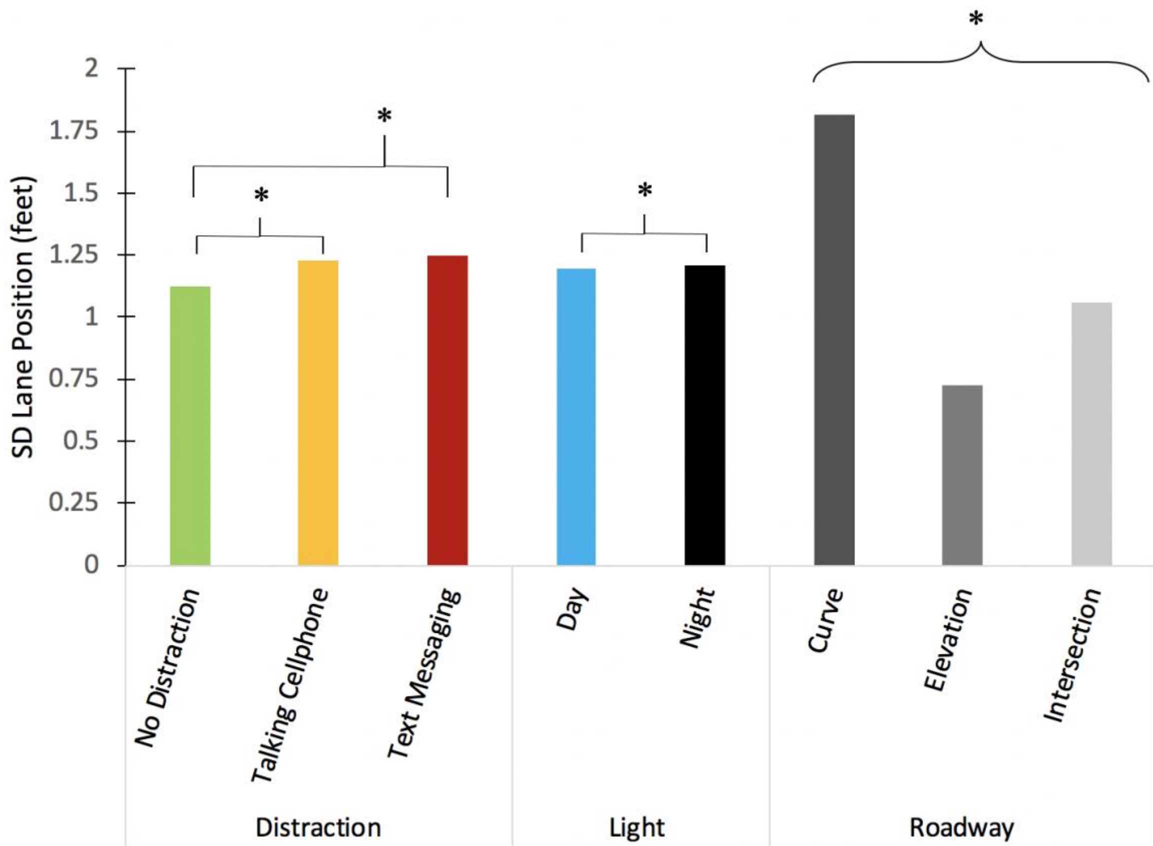

Figure 20. Lane maintainence as measured by standard deviation of lane position across all distraction conditions, light conditions, and roadways in adolescents.

Lane maintainence was uniquely predicted by roadway (F = 308.84, p < .001), distraction condition (F = 8.62, p = .0004), and weather (F = 5.61, p = .02). Compared to intersections, lane maintaince was significantly poorer in curves (t = 16.61, p < .0001) and signiciantly better in elevations (t = 5.02, p < .0001). Lane maintaince was significantly poorer both when talking on the cell phone (t = 3.49, p = .001) and when text messaging (t = 3.86, p = .0002). Lane maintaince when distracted significantly depended on the roadway (F = 4.45, p = .002), such that lane maintaince when talking on the cellphone was significantly poorer specifically when in curves (t = 3.46, p = .001) and in intersections (t = 2.81, p = .006).

Motor Vehicle Collisions

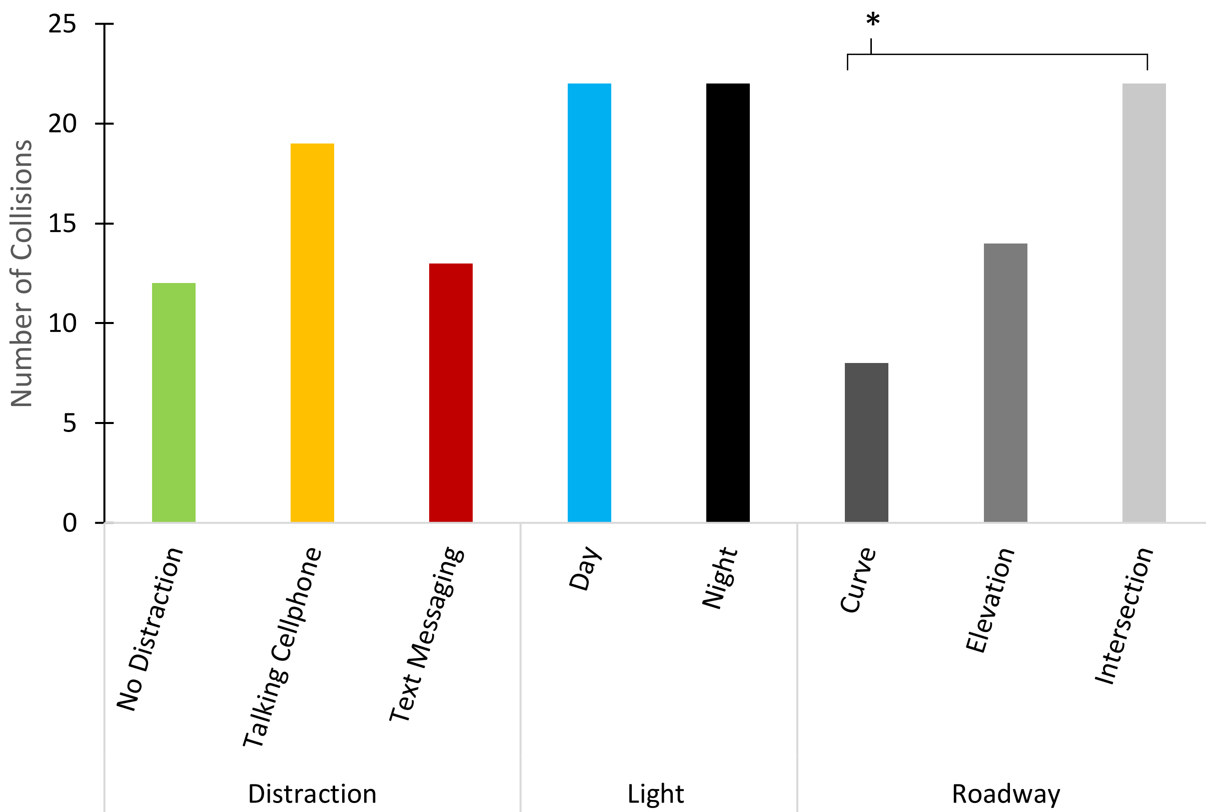

Figure 21. Total motor vehicle collisions across all distraction conditions, light conditions, and roadways in adolescents.

Roadway significantly predicted the likelihood of a collision in the simulated drive (χ^2 = 6.05, *p* = .049). Specifically, there was a 137% increase in the likelihood of a collision in interesctions when compared to curves (Rate Ratio (RR) = 2.37, 95% CI: 1.18 - 4.74). The likelihood of a collision for adolescents during distraction conditions did not significantly depend on the roadway.

Elevations

Average Speed

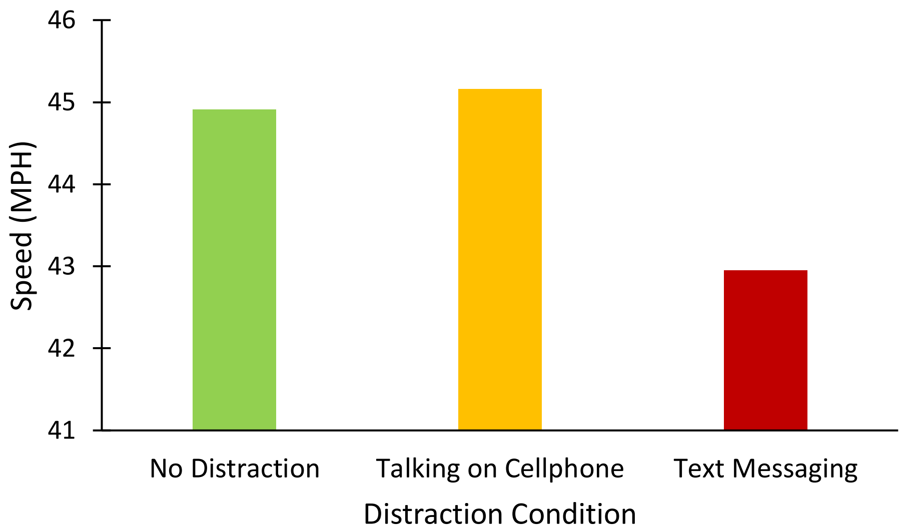

Figure 22. Average speed of adolescents in elevations sections by distraction task.

Across all light conditions and weather, there was only marginal evidence for a statistically significant difference among distraction conditions on average driving speed in elevations. (F = 2.76, p = .07).

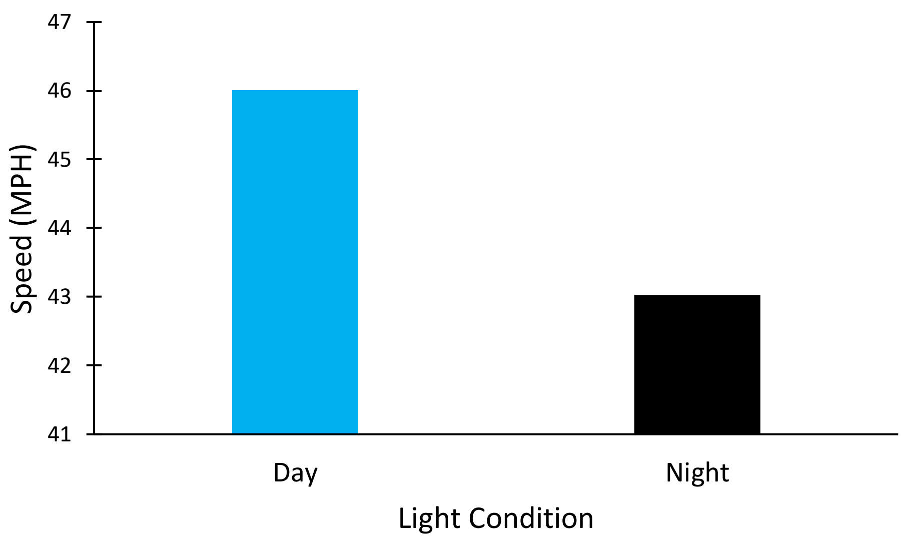

Figure 23. Adolescents' average speed in elevation sections by light condition (daytime and nighttime).

There was no statistically significant difference between daytime and nighttime light conditions on average speed in elevations (F = 2.78, p = .10).

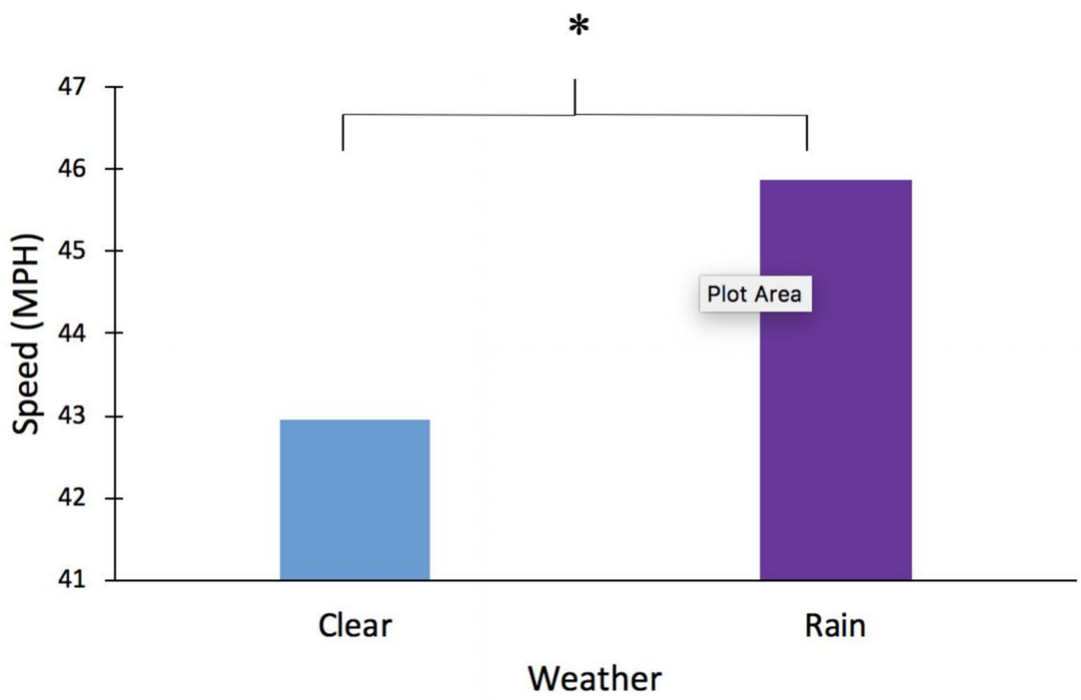

Figure 24. Average Speed in elevations when text messaging by weather condition.

In elevation sections, drivers drove significantly faster when texting in rain compared to when texting in clear weather (t = 2.27, p = .03).

Speed Variability

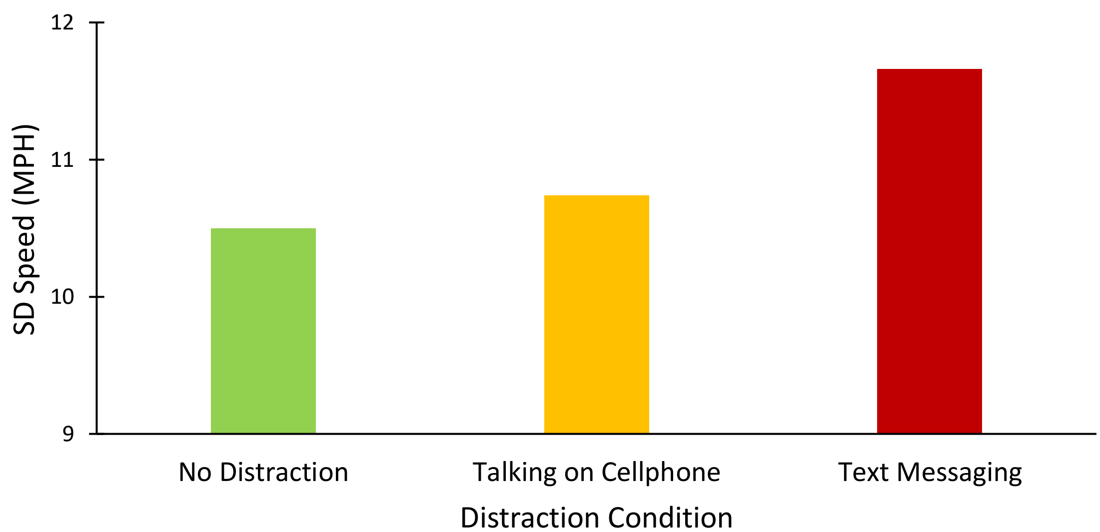

Figure 25. Speed variability in elevations by distraction condition.

There was only marginal evidence to suggest a statistical difference in speed variability in among the distraction conditions in elevations (F = 2.76, p = .07).

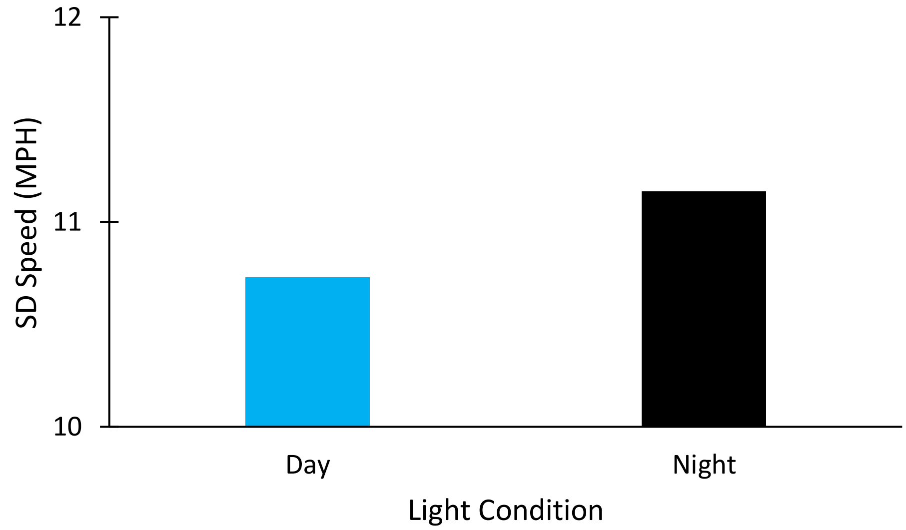

Figure 26. Adolescents' speed variability in elevations.

Speed variability did not significantly differ between day and night light conditions for adolescents in elevations (F = 2.79, p = .10).

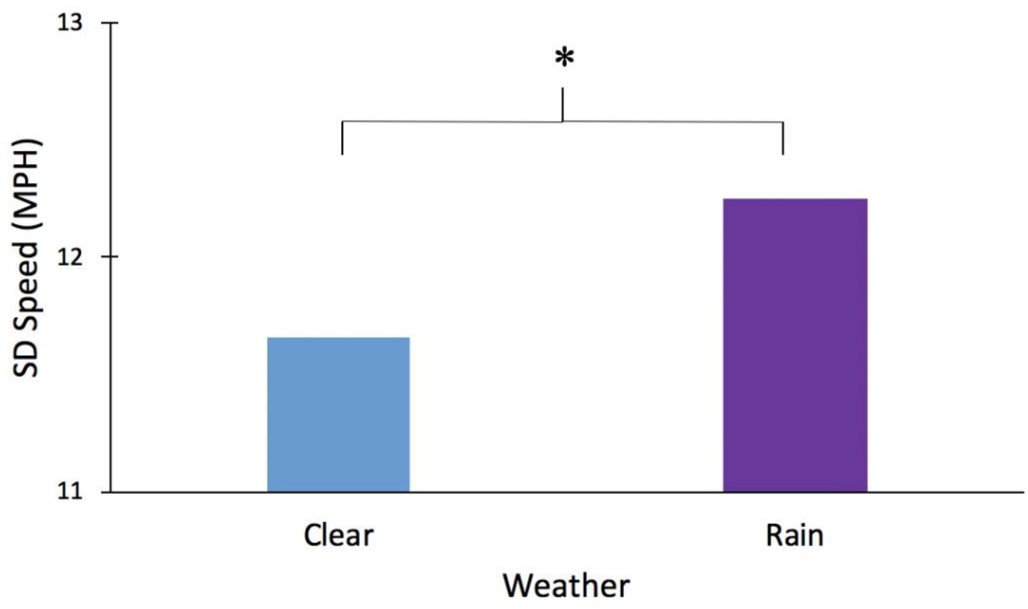

Figure 27. Speed variability in elevations when text messaging.

Adolescents displayed greater speed variability when text messaging in the rain compared to in clear weather (t = 2.78, p = .01).

<u>*Lane Maintenance (Standard Deviation of Lane Position)*</u>

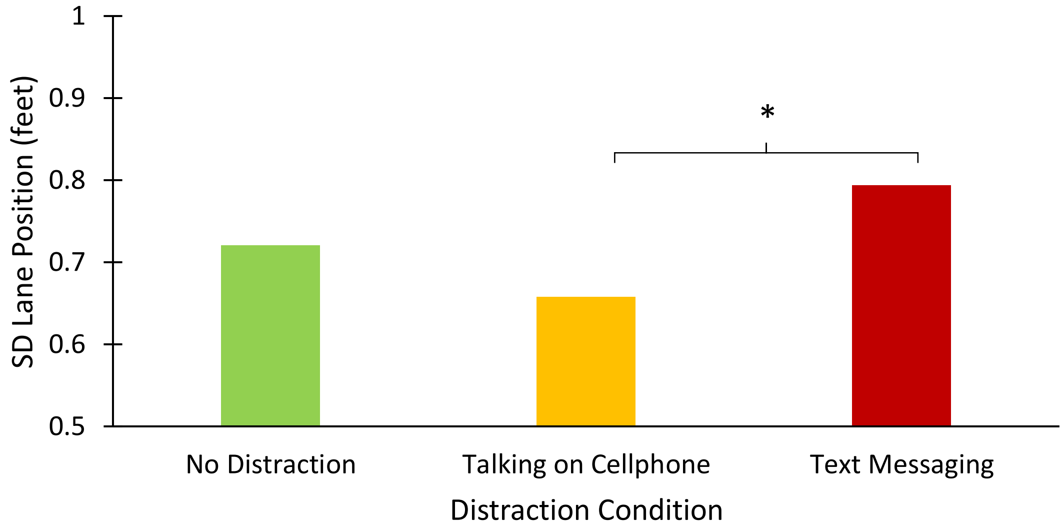

Figure 28. Lane maintenance in elevations by distraction in adolescents.

Lane maintenance was significantly poorer in elevations when adolescents were text messaging compared to when talking on the cellphone (t = 2.70, p = .01). There was no significant difference compared to no distraction for either talking on the cell phone or text messaging.

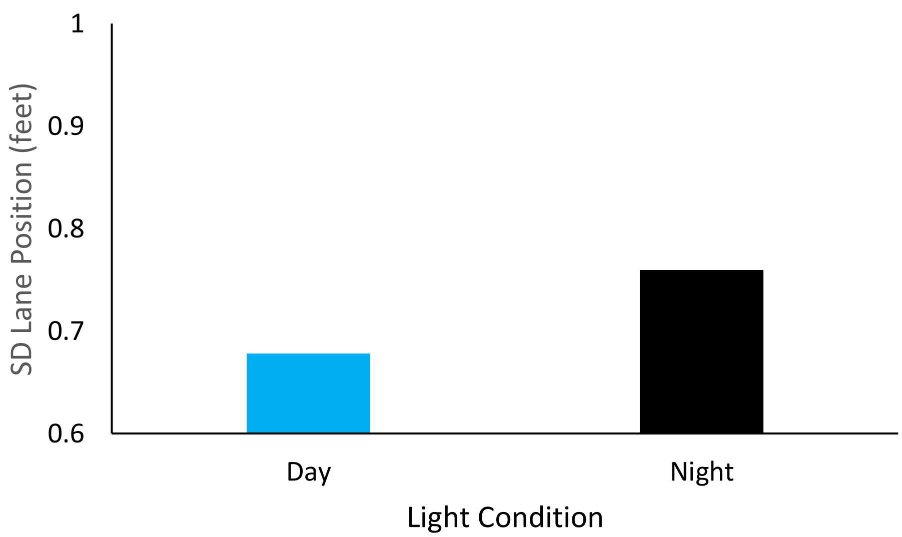

Figure 29. Lane maintenance in elevations by light condition in adolescents.

There was no statistically significant difference between daytime and nighttime light conditions in adolescents in elevations (F = 2.01, p = .16).

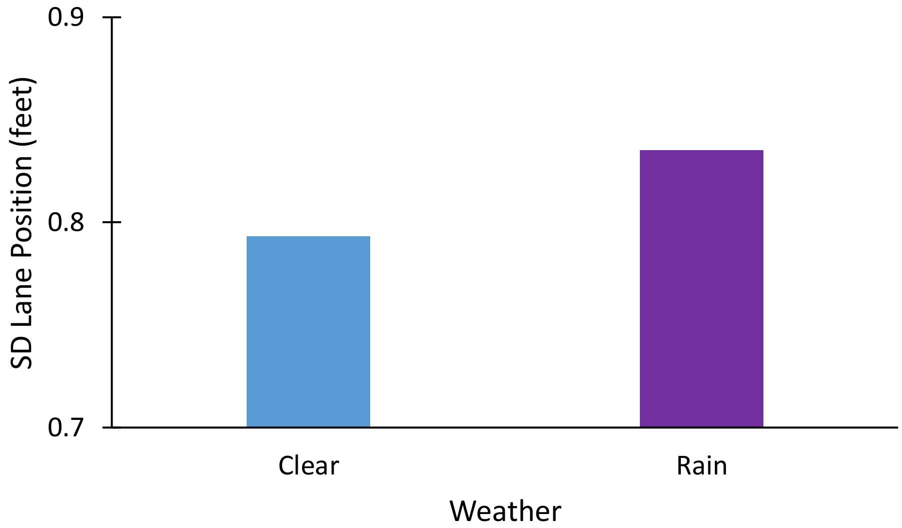

Figure 30. Lane maintenance in elevations when text messaging by weather condition.

Adolescents’ lane maintenance did not significantly differ between clear weather and rain (F = 0.96, p = .33).

Motor Vehicle Collisions

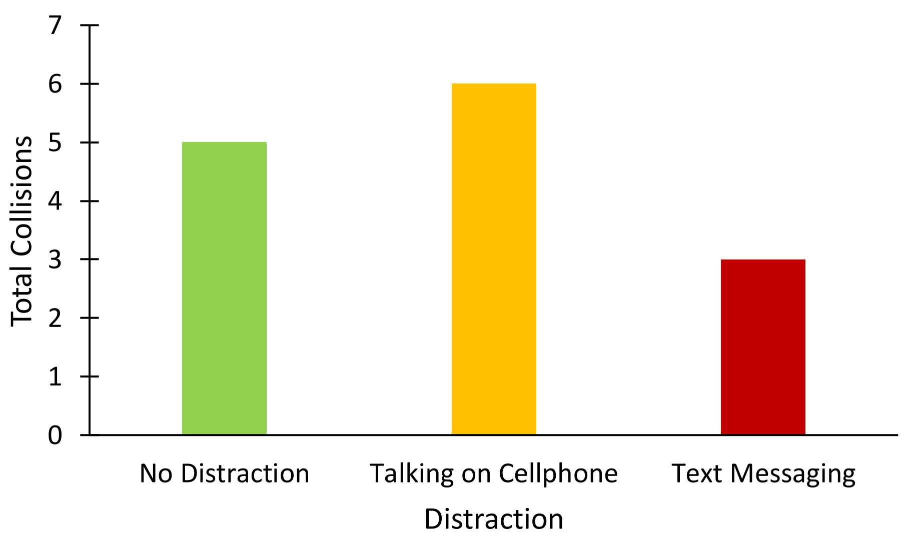

Figure 31. Total collisions by distraction condition in elevations.

There were no significant differences among distraction conditions on the likelihood of a collision in elevations among adolescents (χ^2 = 1.10, p = .58).

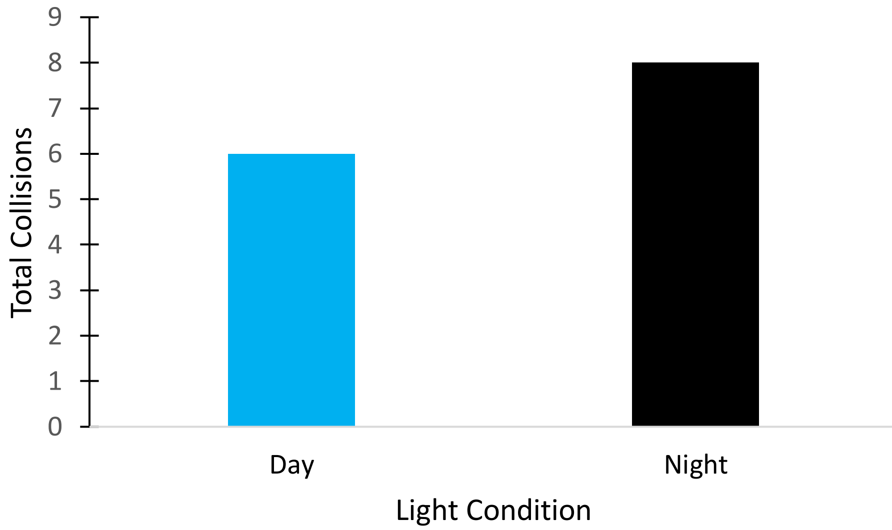

Figure 32. Total collisions in elevation sections by light condition.

There was no difference between daytime and nighttime light conditions on the likelihood of a collision in elevation sections among adolescents (χ^2 = 1.26, p = .26)

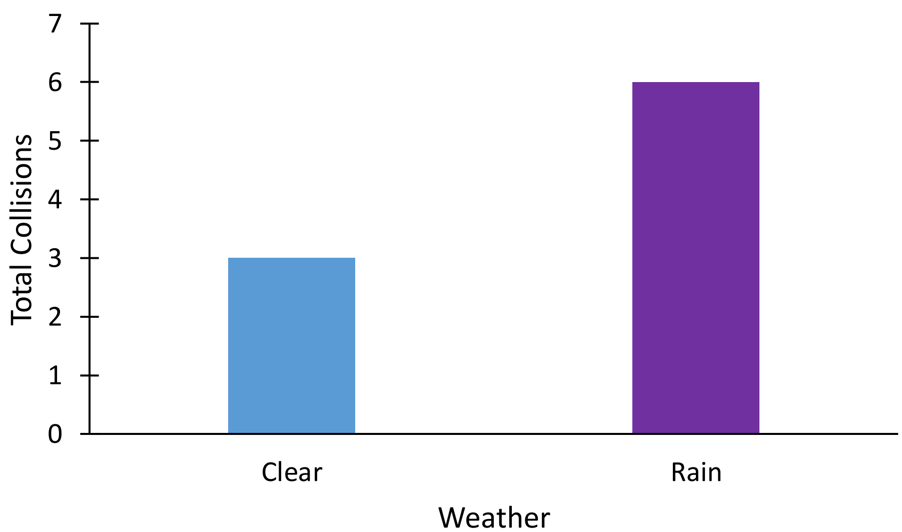

Figure 33. Total collisions by weather condition in elevations.

There was no significant difference between clear weather and rain in elevation sections among adolescent on the likelihood of a collision (χ^2 = 0.81, p = .37).

Curves

Average Speed

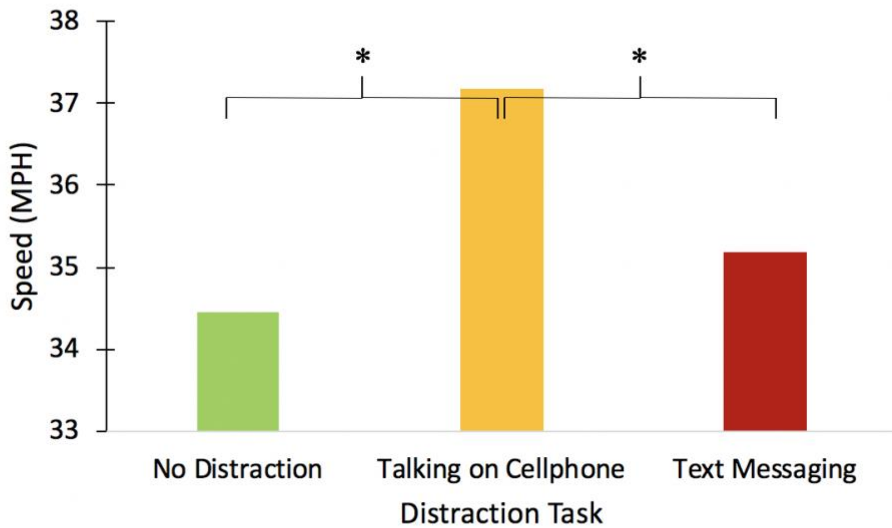

Figure 34. Average speed of adolescents in curve sections by distraction task.

Across all light conditions and weather, there was a statistically significant difference among distraction conditions on average driving speed in curves. (F = 6.79, p = .002). Compared to when talking on the cellphone, adolescents drove at significantly lower speed in curves when in the no distraction condition (t = 3.60, p = .001) and text messaging condition (t = 2.47, p = .02).

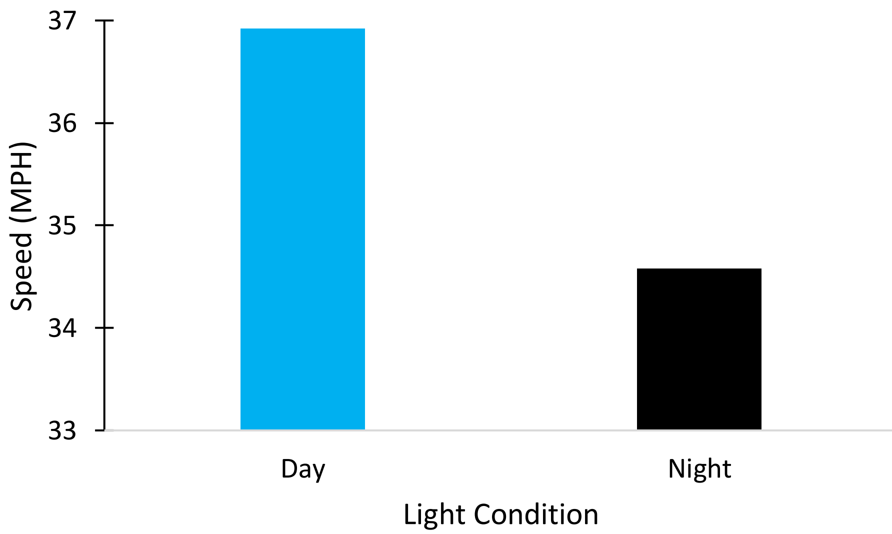

Figure 35. Adolescents' average speed in curve sections by light condition (daytime and nighttime).

There was only marginal evidence to suggest a statistical difference between daytime and nighttime light conditions on average speed in curves (F = 3.31, p = .08).

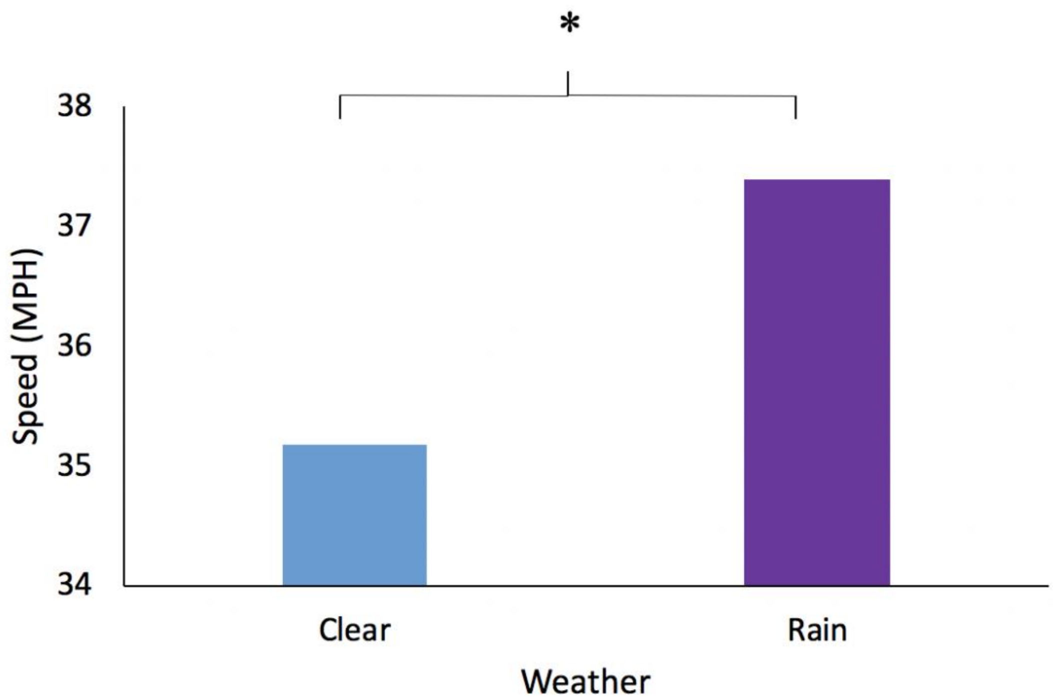

Figure 36. Average speed in curves when text messaging by weather conditions.

In curves sections, drivers drove significantly faster when texting in rain compared to when texting in clear weather (*t* = 2.61, *p* = .01).

Speed Variability

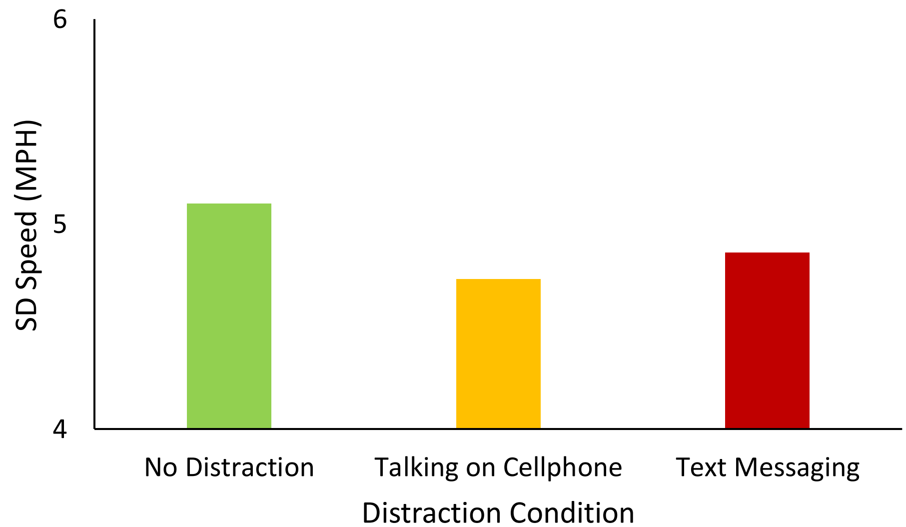

Figure 37. Speed variability in curves by distraction condition.

There was no statistical difference in speed variability in among the distraction conditions in curves (*F* = 0.26, *p* = .77)

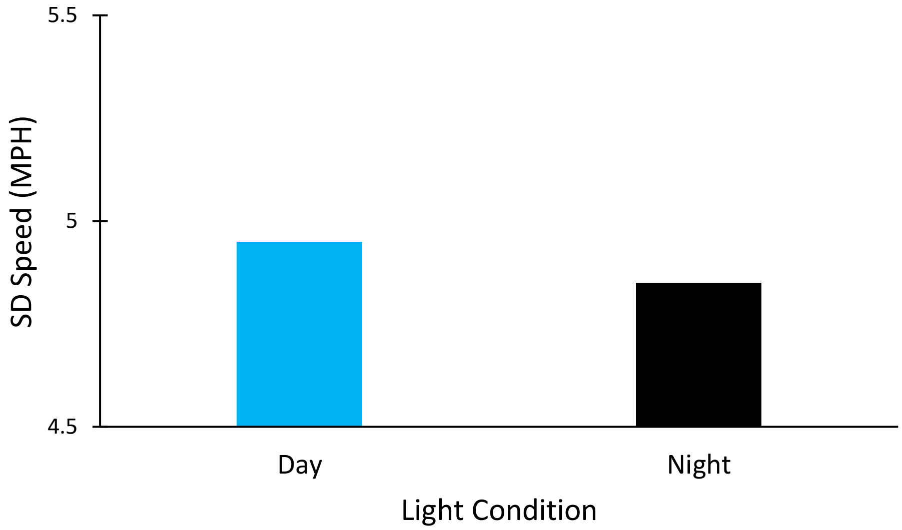

Figure 38. Adolescents' speed variability in curves.

Speed variability did not significantly differ between day and night light conditions for adolescents in curves ($F = 0.06$, $p = .81$).

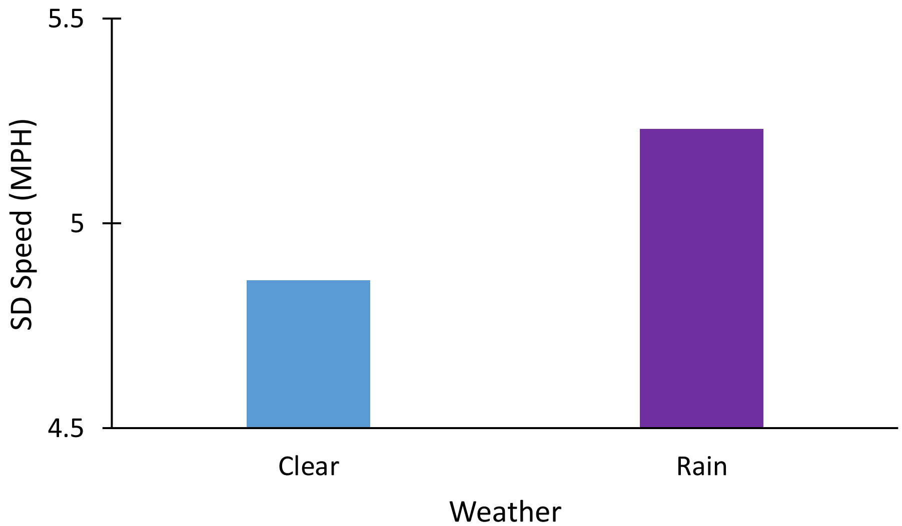

Figure 39. Speed variability in curves when text messaging by weather.

There was no difference in speed variability when text messaging between clear weather and rain in adolescents ($F = .50$, $p = .49$).

Lane Maintenance (Standard Deviation of Lane Position)

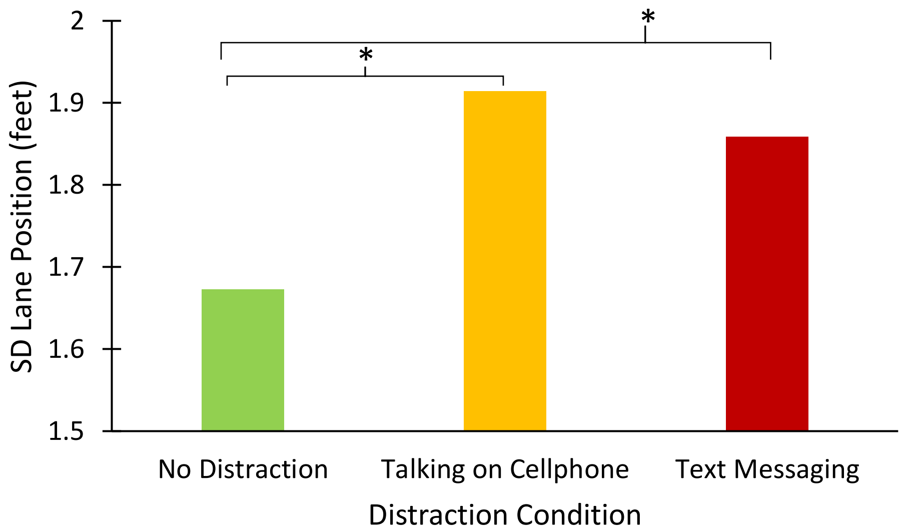

Figure 40. Lane maintenance in curves by distraction in adolescents.

Lane maintenance was significantly poorer in curves both when adolescents were talking on the cellphone (t = 3.79, p = .0003) and text messaging (t = 2.56, p = .01) compared to when in the no distraction condition.

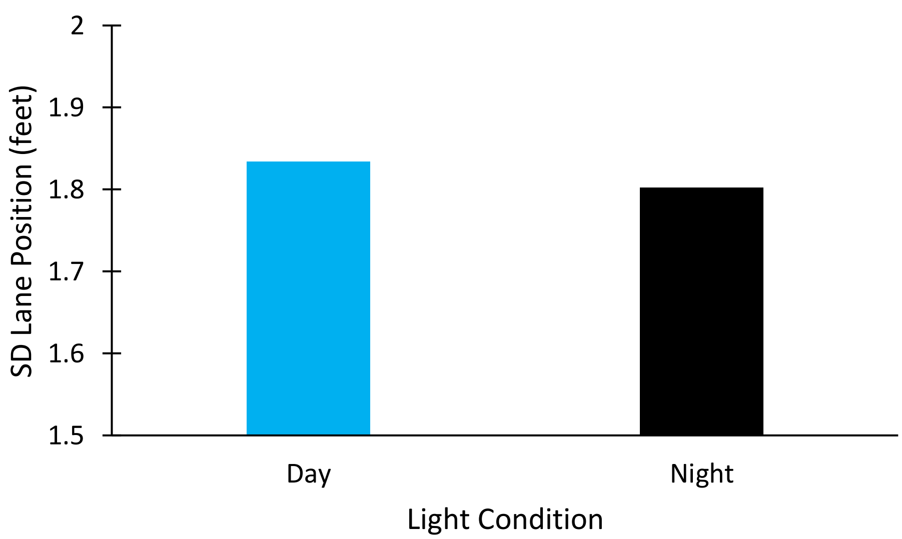

Figure 41. Lane maintenance in curves by light condition in adolescents.

There was no statistically significant difference between daytime and nighttime light conditions in adolescents in curves (F = 0.19, p = .67).

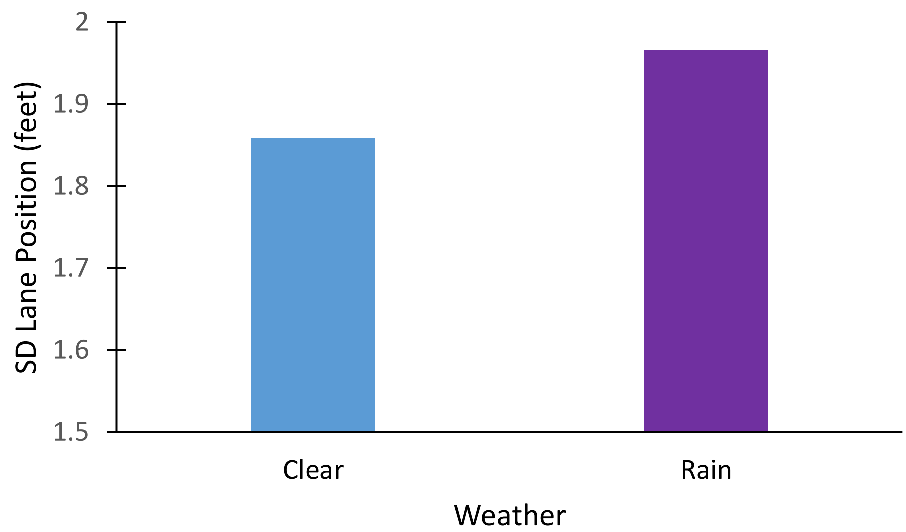

Figure 42. Lane maintenance in curves when text messaging by weather condition.

There was only marginal evidence to suggest adolescents' lane maintenance significantly differed between clear weather and rain when text messaging in curves (t = 1.83, p = .07).

Motor Vehicle Collisions

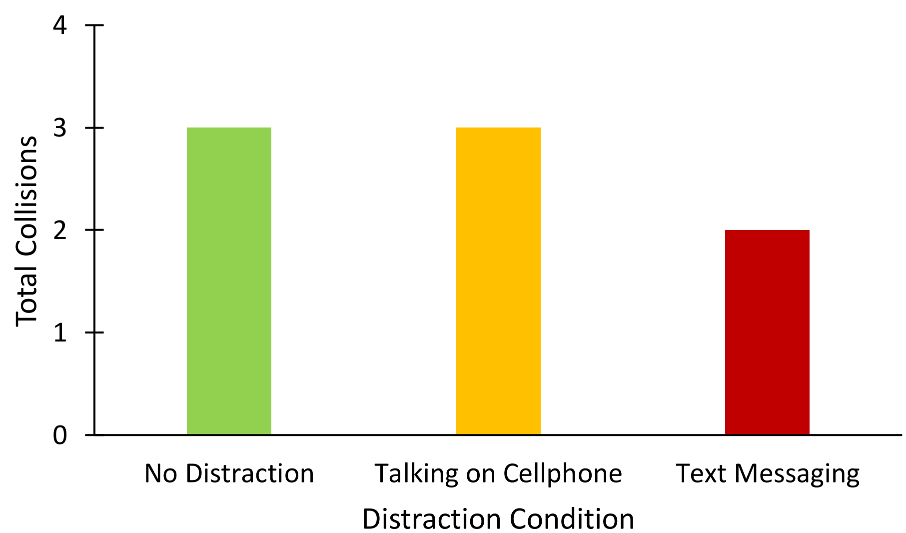

Figure 43. Total collisions by distraction condition in curves.

There was no significant difference among distraction conditions on the likelihood of a collision in curves among adolescents when accounting for light levels and weather (χ^2 = 0.17, p = .92).

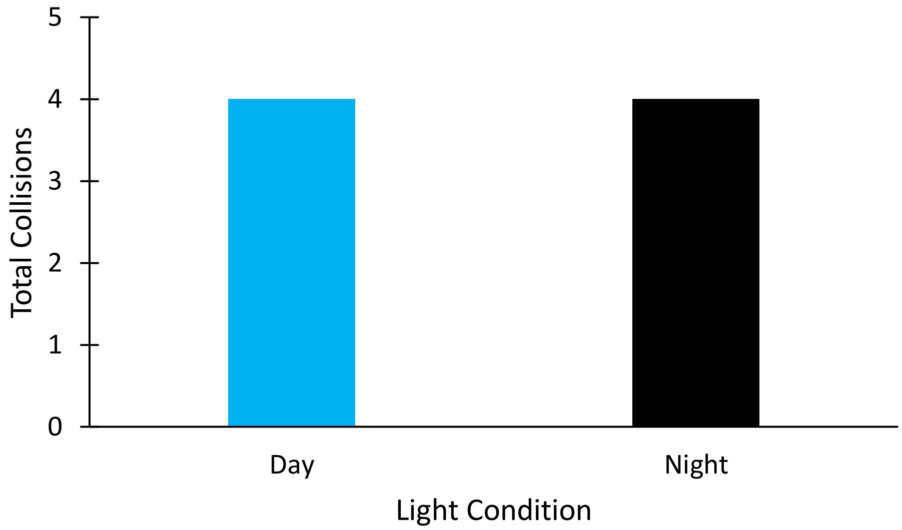

Figure 44. Total collisions in curve sections by light condition.

There was no difference between daytime and nighttime light conditions on the likelihood of a collision in curve sections among adolescents when accounting for distraction and weather (χ^2 = 0.06, p = .81).

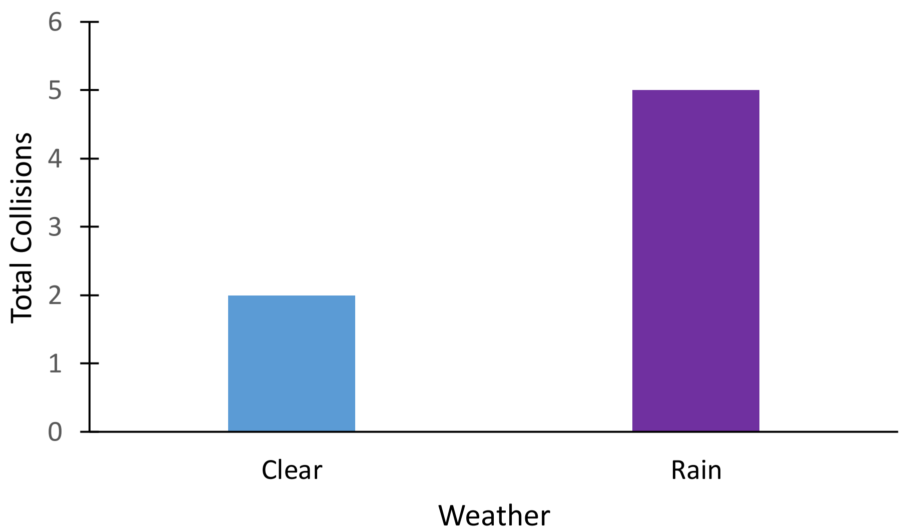

Figure 45. Total collisions by weather condition in curves.

There was no significant difference between clear weather and rain in curve sections among adolescents on the likelihood of a collision when accounting for distraction and light condition (χ^2 = 1.29, p = .26).

Intersections

Average Speed

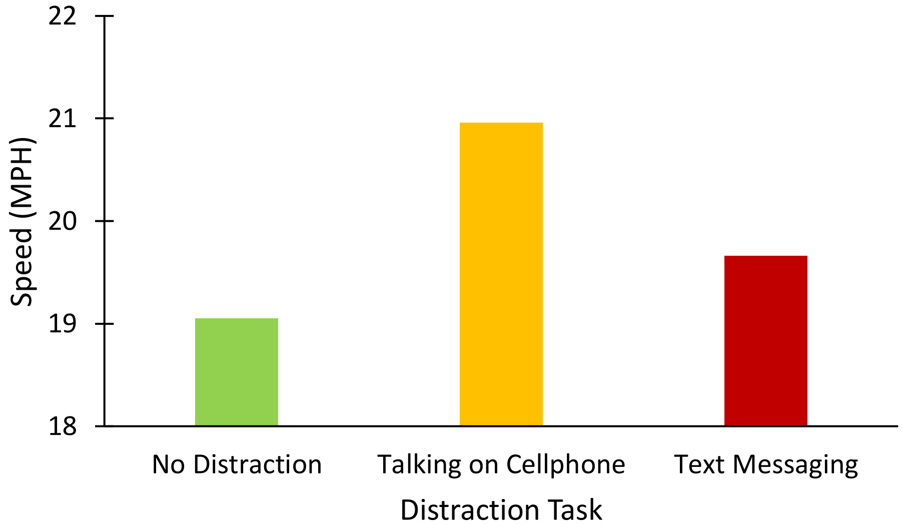

Figure 46. Average speed of adolescents in intersections by distraction task.

Across all light conditions and weather, there was no statistically significant difference among distraction conditions on average driving speed in intersections. (F = 1.51, p = .23).

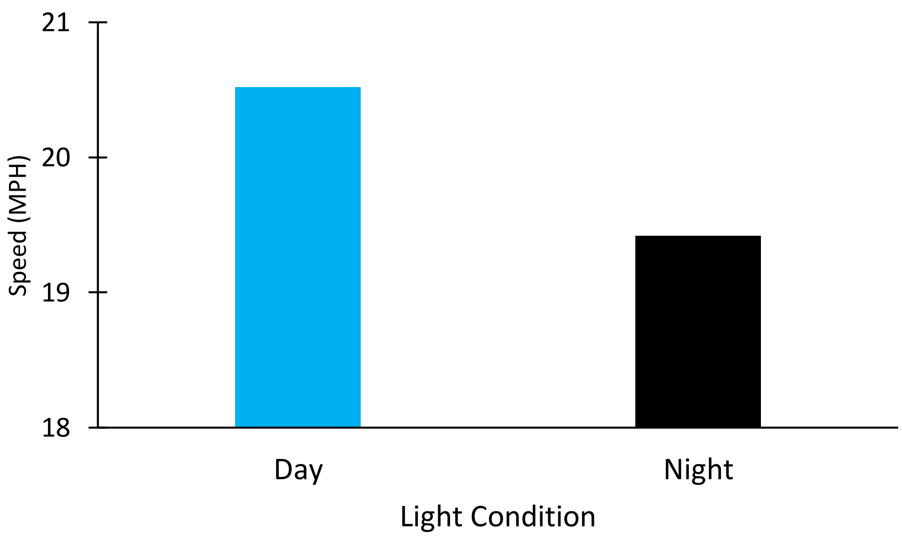

Figure 47. Adolescents' average speed in intersections by light condition (daytime and nighttime).

When accounting for distraction and weather conditions, there was no statistical difference between daytime and nighttime light conditions on average speed in curves (F = 1.84, p = .18).

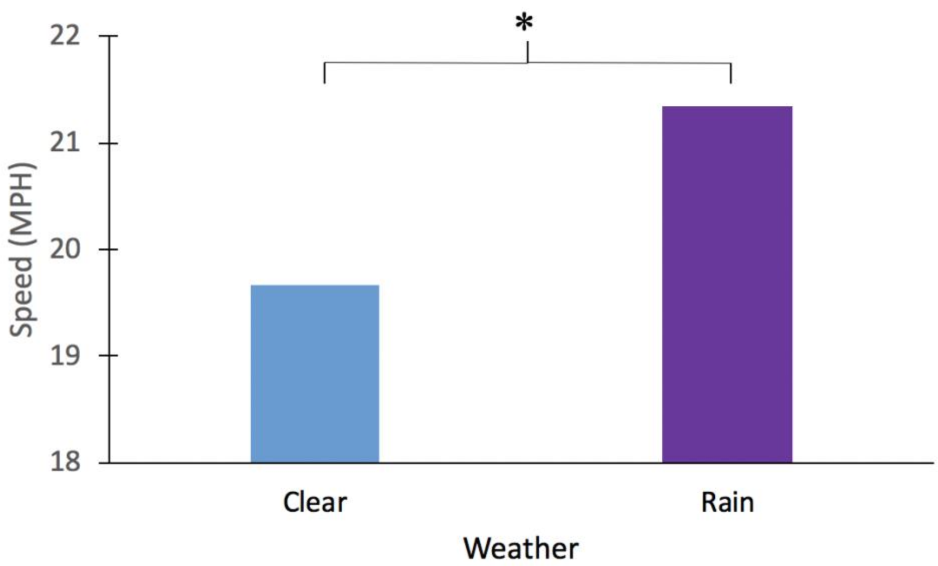

Figure 48. Average speed in intersections when text messaging by weather conditions.

In intersections, adolescents drove significantly faster when texting in rain compared to when texting in clear weather (t = 3.03, p = .004).

<u>*Speed Variability*</u>

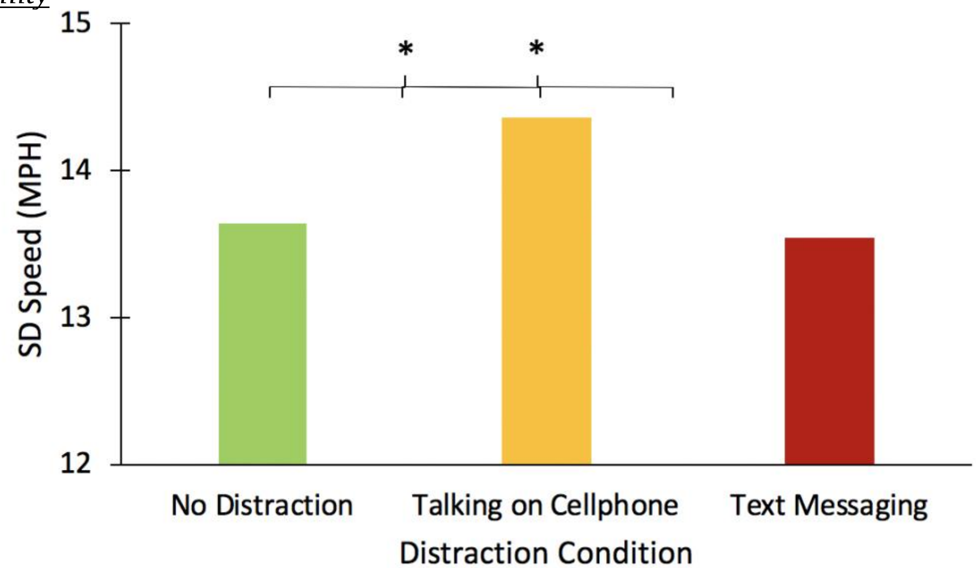

Figure 49. Speed variability in intersections by distraction condition.

When accounting for light conditions and weather, distraction condition significantly predicted speed variability in intersections among adolescents (F = 4.94, p = .01). Specifically, compared to when talking on the cellphone, adolescents exhibited significantly lower variation in speed when text messaging (t = 2.85, p =.01) and when in the no distraction condition (t = 2.55, p = .01).

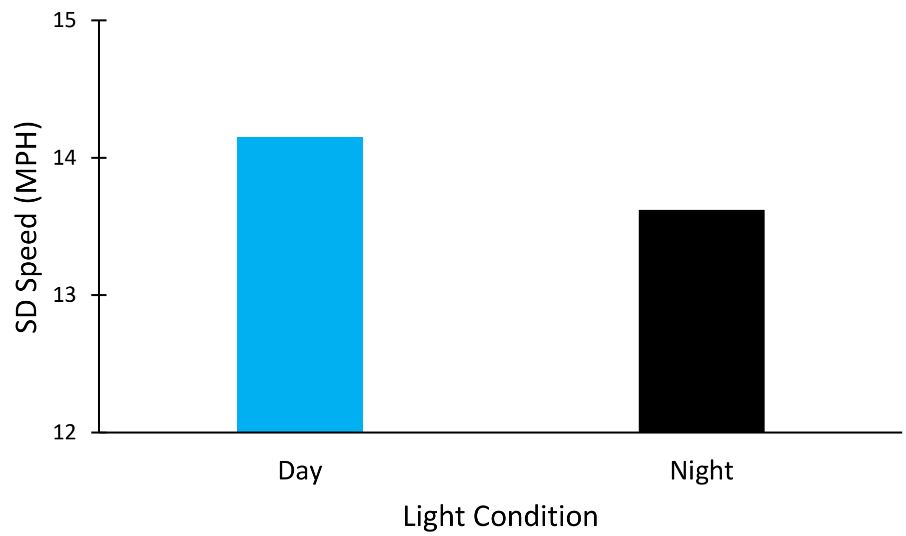

Figure 50. Adolescents' speed variability in intersections by light levels.

Accounting for distraction condition and weather, speed variability did not significantly differ between day and night light conditions for adolescents in intersections (*F* = 1.27, *p* = .27).

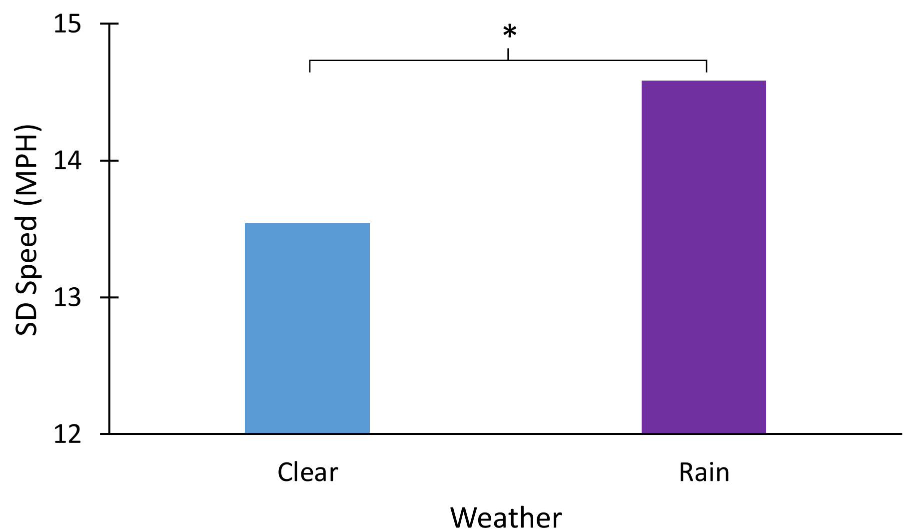

Figure 51. Speed variability in intersections when text messaging by weather.

Adolescents exhibited significantly greater speed variability when text messaging in rain compared to clear weather (*F* = 10.64, *p* = .002).

<u>*Lane Maintenance (Standard Deviation of Lane Position)*</u>

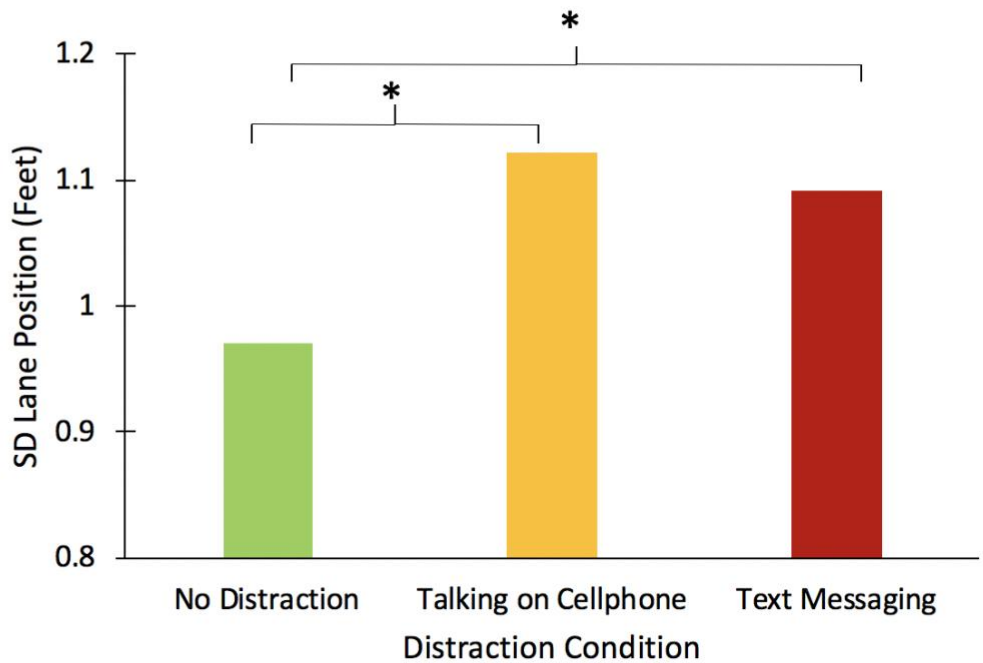

Figure 52. Lane maintenance in intersections by distraction in adolescents.

Lane maintenance was significantly poorer in intersections both when adolescents were talking on the cellphone (t = 2.82, p = .007) and text messaging (t = 4.58, p < .001) compared to when in the no distraction condition.

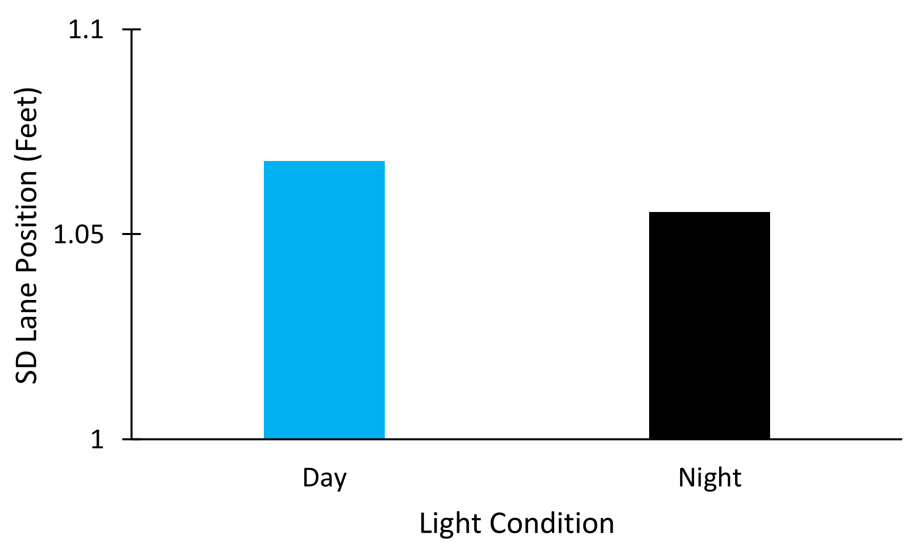

Figure 53. Lane maintenance in intersections by light condition in adolescents.

There was no statistically significant difference between daytime and nighttime light conditions in adolescents in intersections (F = 2.17, p = .15).

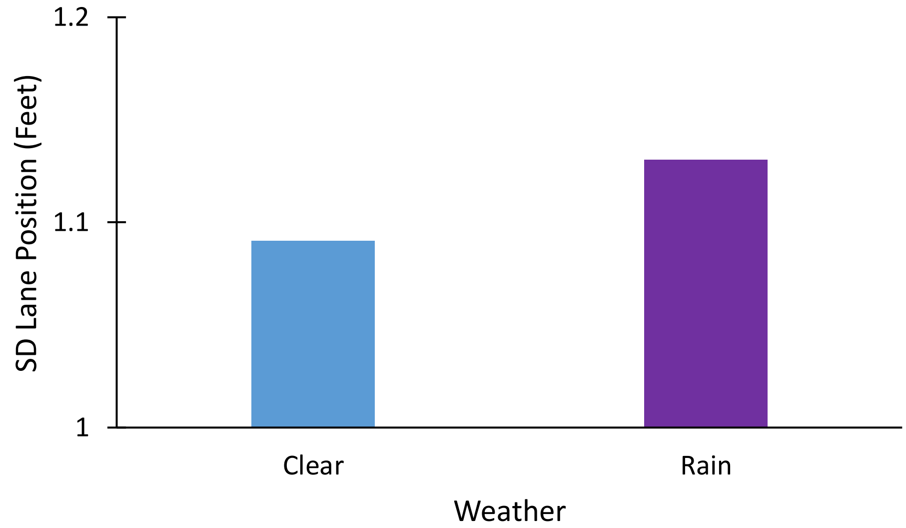

Figure 54. Lane maintenance in intersections when text messaging by weather condition.

There no significant difference between clear weather and rain when text messaging in intersections for adolescents (F = 1.76, p = .19).

Motor Vehicle Collisions

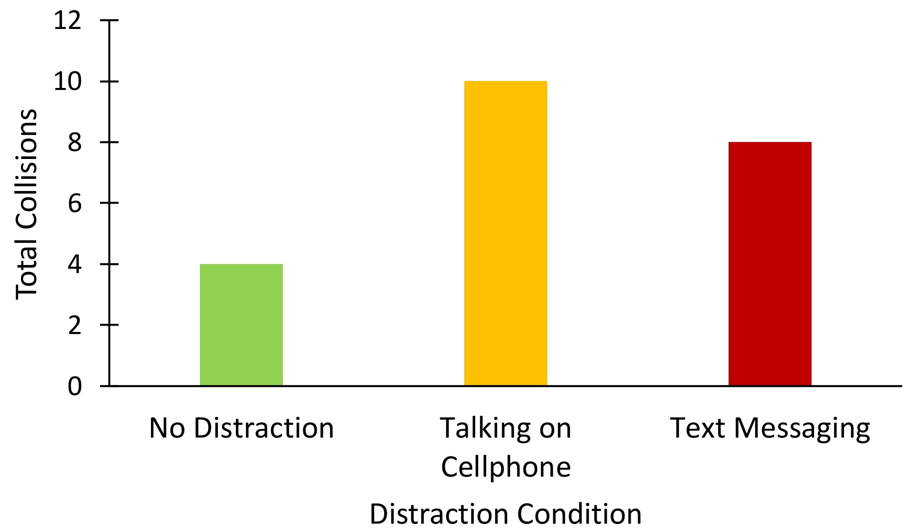

Figure 55. Total collisions by distraction condition in intersections.

There were no significant differences among distraction conditions on the likelihood of a collision in intersections among adolescents when accounting for light levels and weather (χ^2 = 2.69, p = .26).

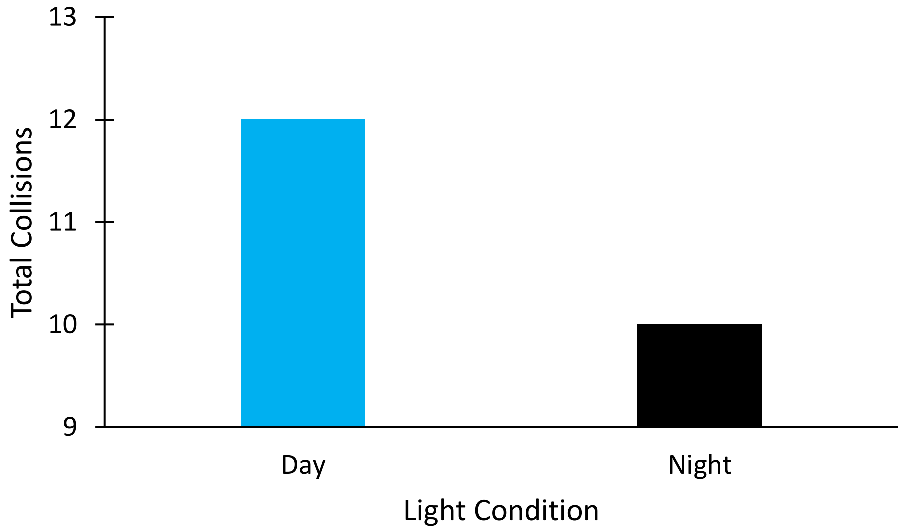

Figure 56. Total collisions in intersections by light condition.

There was no difference between daytime and nighttime light conditions on the likelihood of a collision in intersections among adolescents when accounting for distraction and weather (χ^2 = 1.09, p = .30).

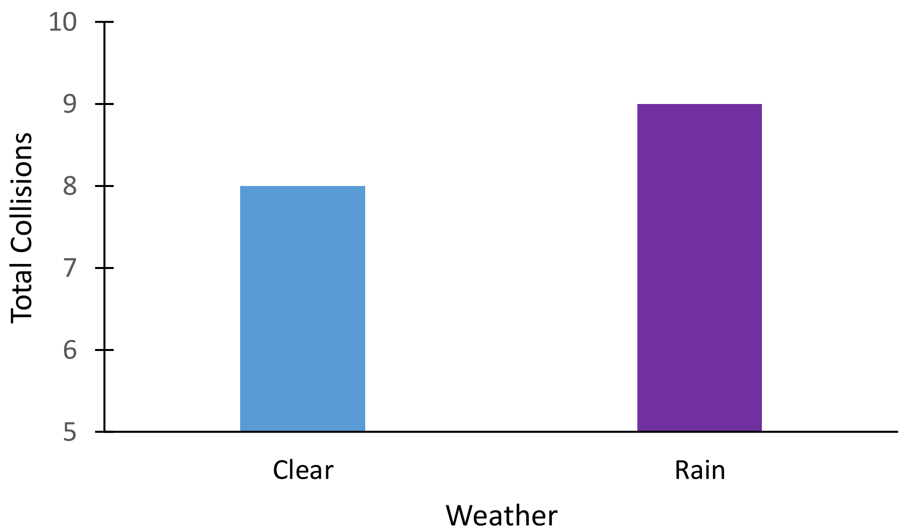

Figure 57. Total collisions by weather condition in intersections.

There was no significant difference between clear weather and rain in intersections among adolescents on the likelihood of a collision when accounting for distraction and light condition (χ^2 = 0.05, p = .82).

OLDER ADULTS

Average Driving Speed

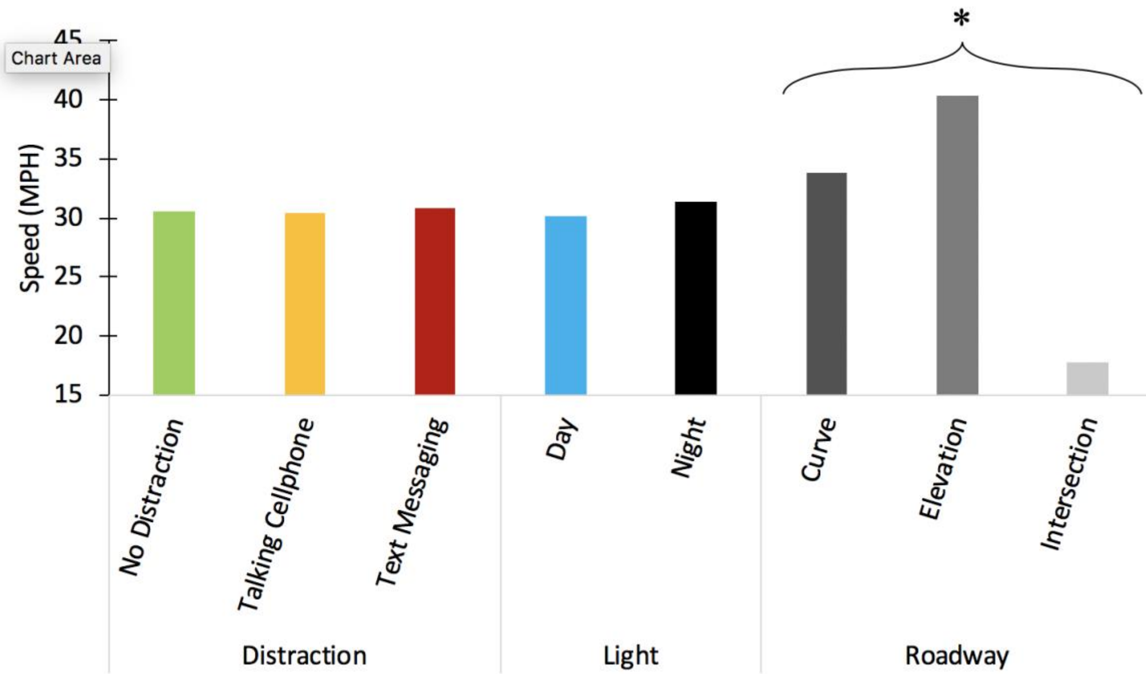

Figure 58. Average speed across all distraction conditions, light conditons and roadways in older adult drivers.

Average speed significantly differed among all roadway sections ($F = 596.04$, $p < .0001$). Average driving speed of the older adults during a distraction did not depend on roadway or light condition.

Speed Variability (Standard Deviation of Speed)

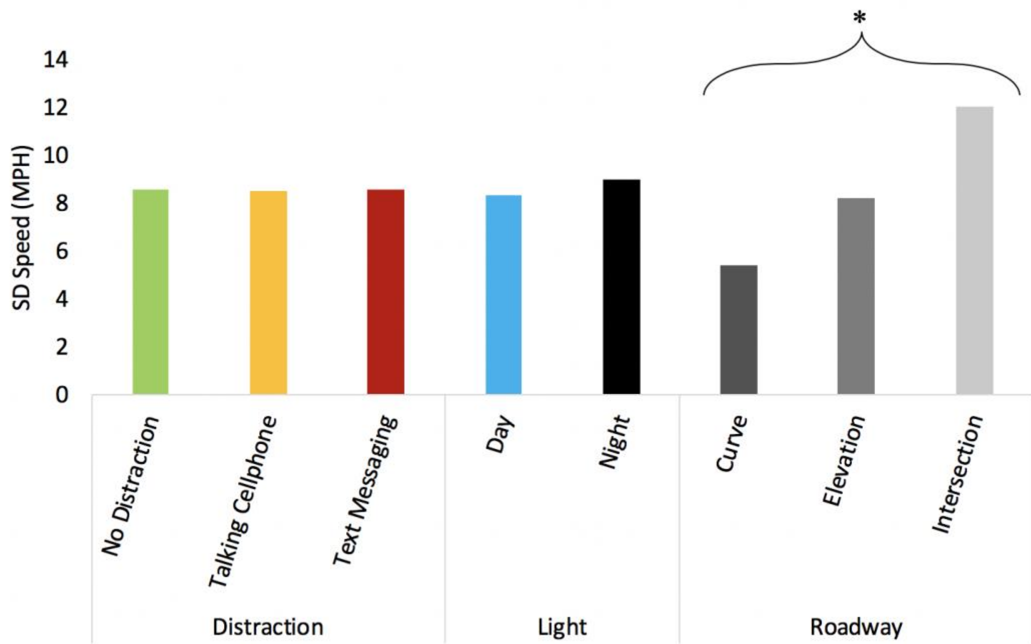

Figure 59. Speed variability (standard deviation of speed) in older adults across all distraction conditions, light levels, and roadways.

Speed variability significantly differed among all roadways (F = 431.17, p < .001). Speed variability when distracted did not significantly depend on the roadway being driven in older adults.

Lane Maintenance (Standard Deviation of Lane Position)

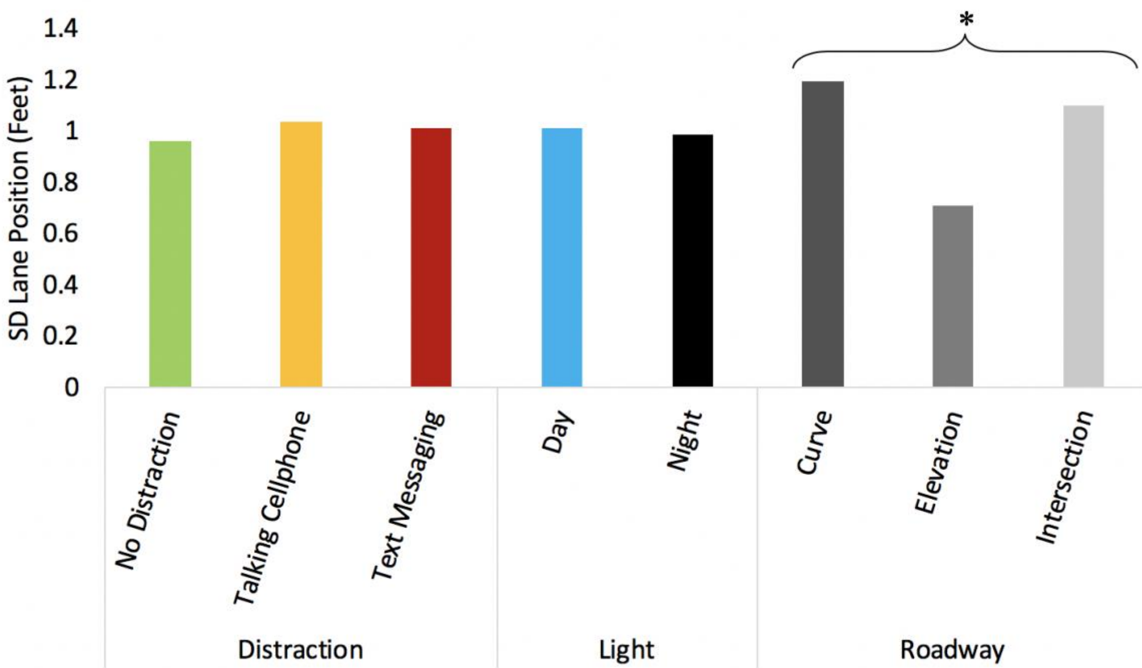

Figure 60. Lane maintainence as measured by standard deviation of lane position across all distraction conditions, light conditions, and roadways in older adults.

Lane maintainence significantly differed among all roadways ($F = 41.88$, $p < .001$). Older adults' lane maintainence when distracted did not significantly depend on the roadway.

Motor Vehicle Collisions

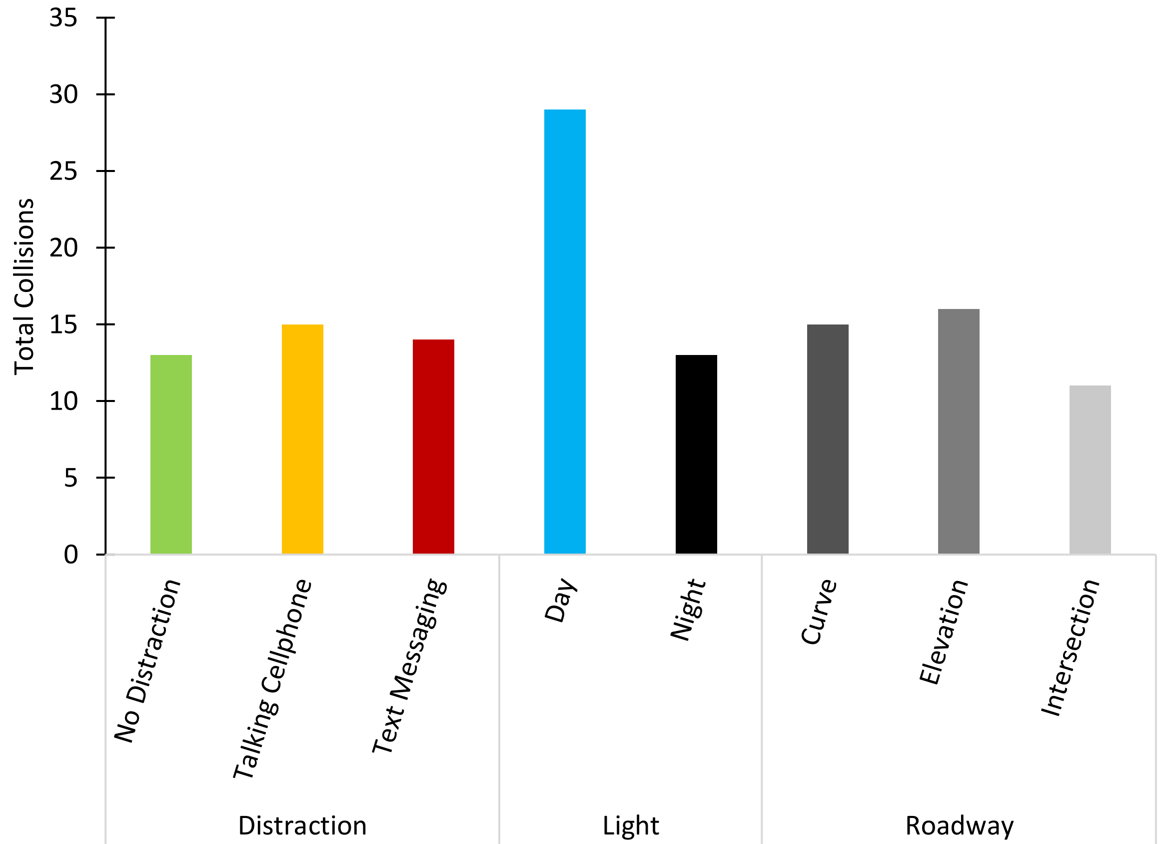

Figure 61. Total motor vehicle collisions across all distraction conditions, light conditions, and roadways in older adults.

Distraction, light, and roadway did not uniquely predict the likelihood of a collision for older adults. The likelihood of a collisions when distracted did significantly depend upon the roadway (F = 10.34, p = .04). Specifically, compared to elevation road sections the likelihood of a collision was significantly less when in curves only when in the no distraction condition (z = 2.09, p = .04). Older adults were 80% less likely to have a collisions in curves (compared to elevation sections) when not distracted (RR = 0.10, 95% CI: 0.01 – 0.86).

Elevations

Average Speed

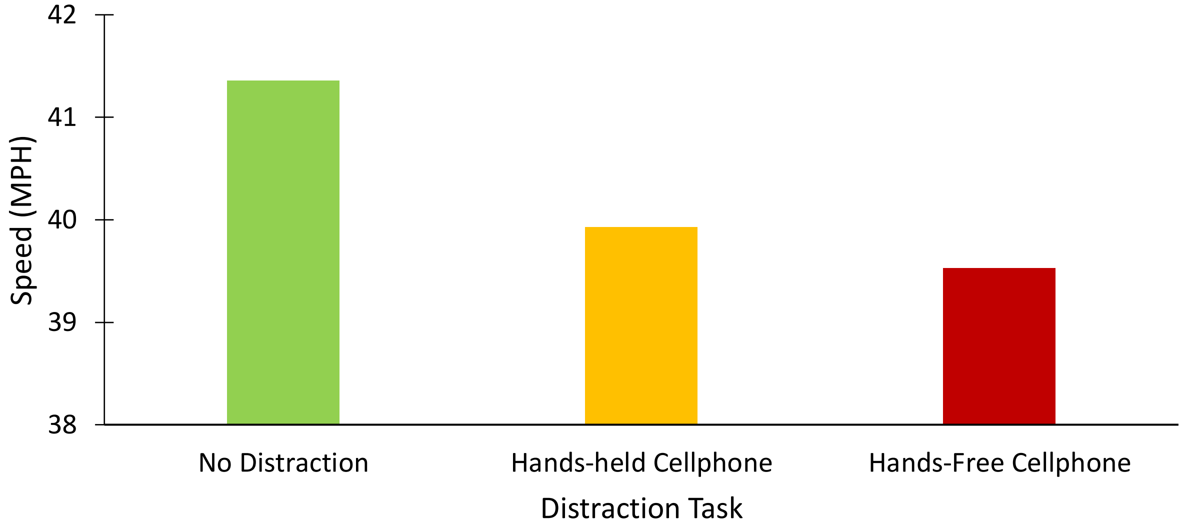

Figure 62. Average speed of older adults in elevations sections by distraction task.

Across all light conditions and weather, there was no evidence for a statistically significant difference among distraction conditions on average driving speed in elevations (F = 0.45, p = .64).

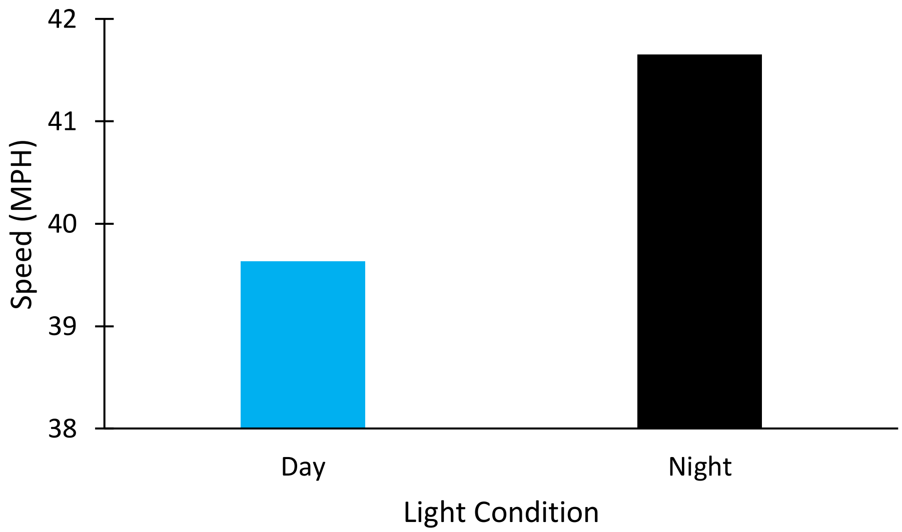

Figure 63. Older adults' average speed in elevation sections by light condition (daytime and nighttime).

There was no statistically significant difference between daytime and nighttime light conditions on average speed in elevations (F = 0.44, p = .51).

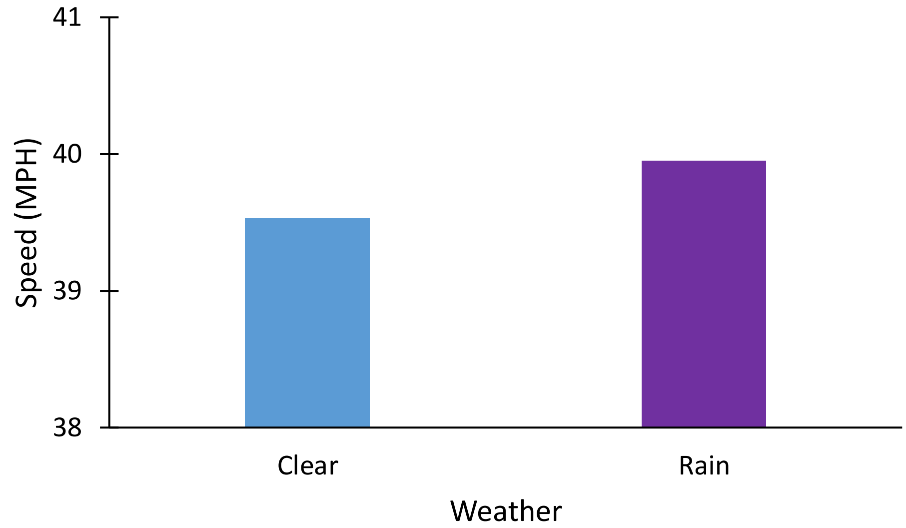

Figure 64. Average Speed in elevations when text messaging by weather conditions.

In elevation sections, older adults exhibited no significant difference in driving speed between clear weather and rain (F = 0.01, p = .93).

Speed Variability

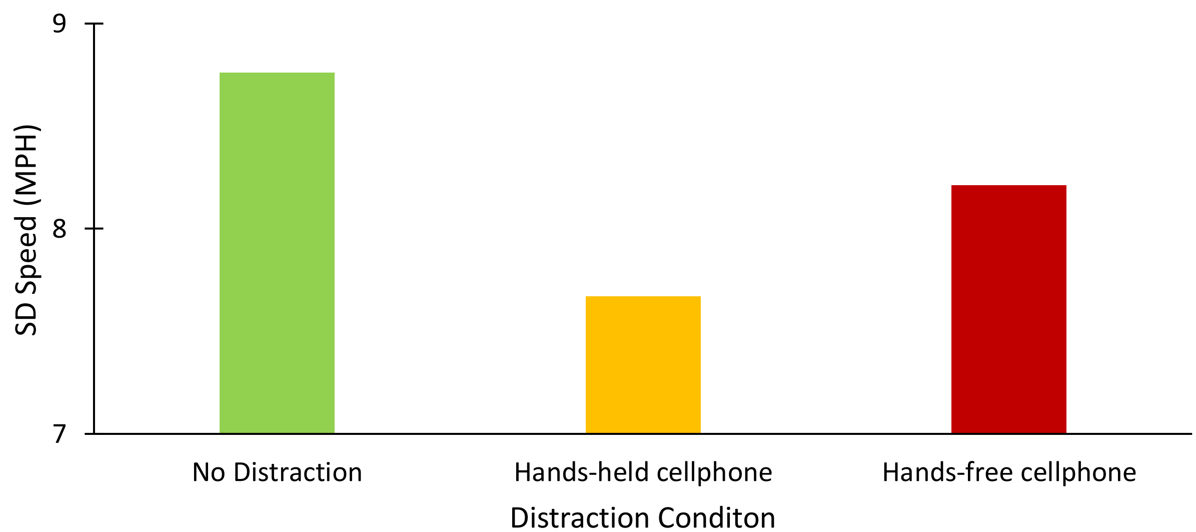

Figure 65. Speed variability in elevations by distractions in older adults.

There was no evidence to suggest a statistical difference in speed variability among the distraction conditions in elevations (F = 1.99, p = .15).

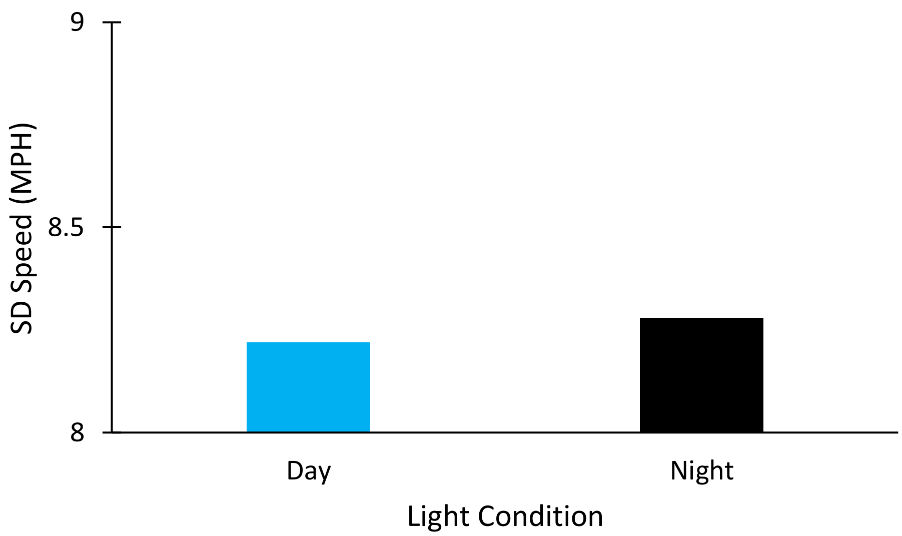

Figure 66. Older adults' speed variability in elevations.

Speed variability did not significantly differ between day and night light conditions for older adults in elevations (F = 0.04, p = .83).

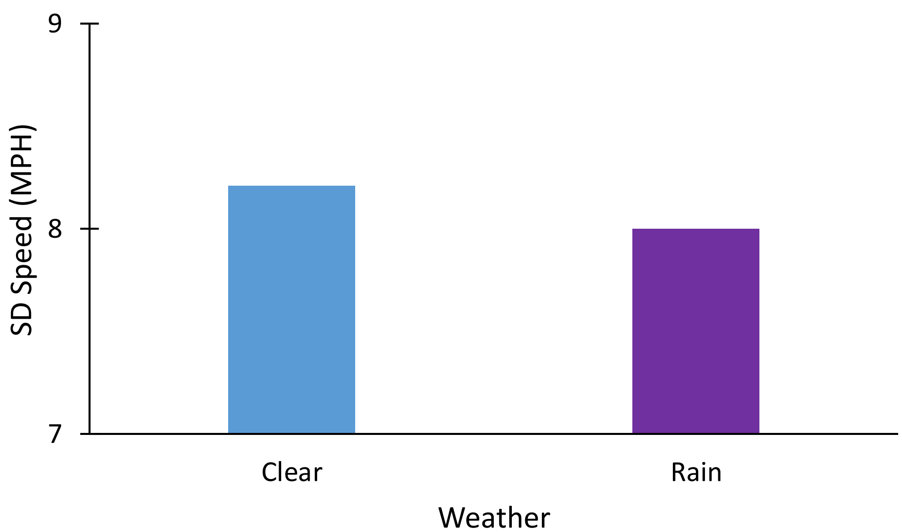

Figure 67. Speed variability in elevations when talking hands-free.

Older adults displayed no significant difference in speed variability when talking hands-free in the rain compared to in clear weather (F = 0.14, p = .71).

Lane Maintenance (Standard Deviation of Lane Position)

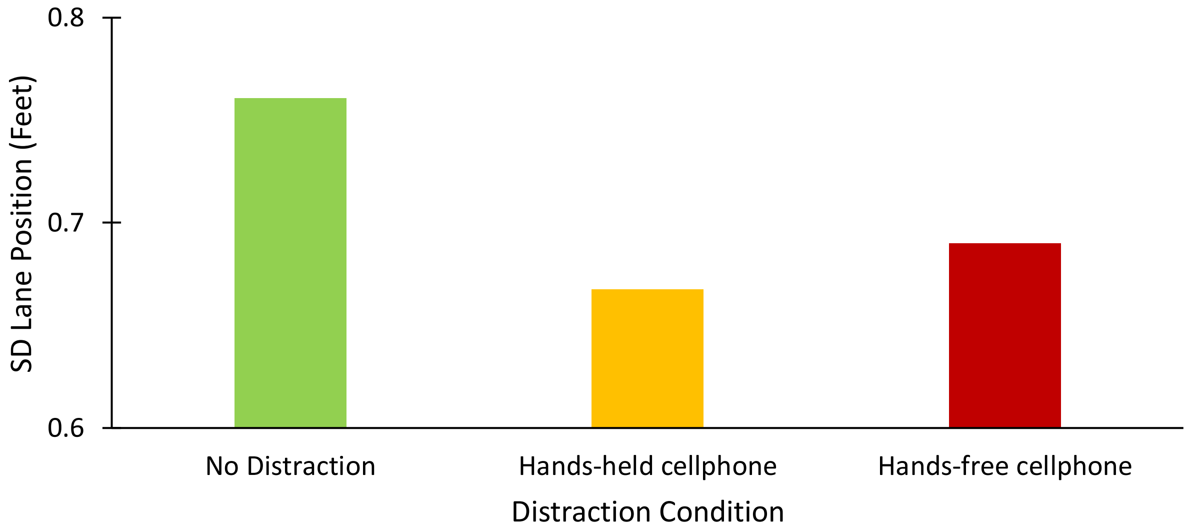

Figure 68. Lane maintenance in elevations by distraction in older adults.

Accounting for light levels and weather, there was no difference in lane maintenance among the distraction conditions in elevations (F = 1.07, p = .35).

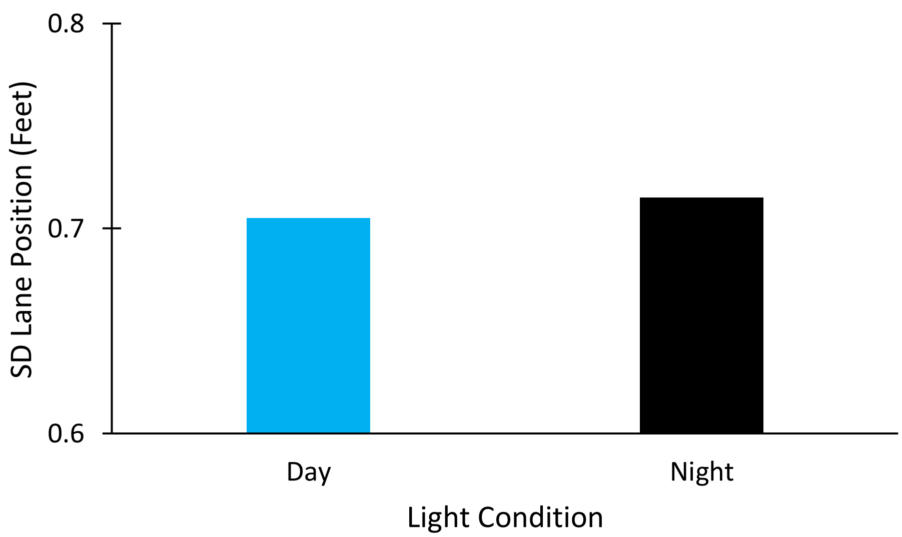

Figure 69. Lane maintenance in elevations by light condition in older adults.

There was no statistically significant difference between daytime and nighttime light conditions in older adults when driving in elevations (F = 0.29, p = .59).

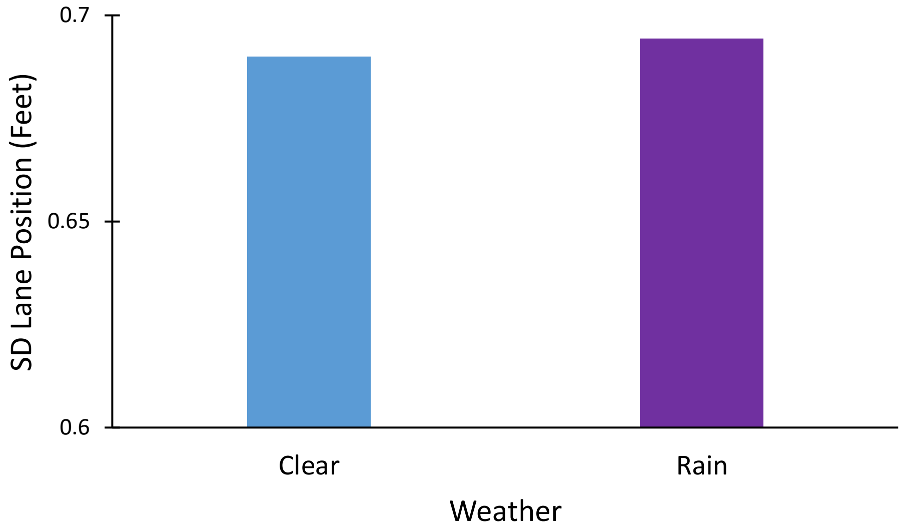

Figure 70. Lane maintenance in elevations when talking hands-free by weather condition.

Older adults' lane maintenance did not significantly differ between clear weather and rain (F = 0.00, p = .99).

Motor Vehicle Collisions

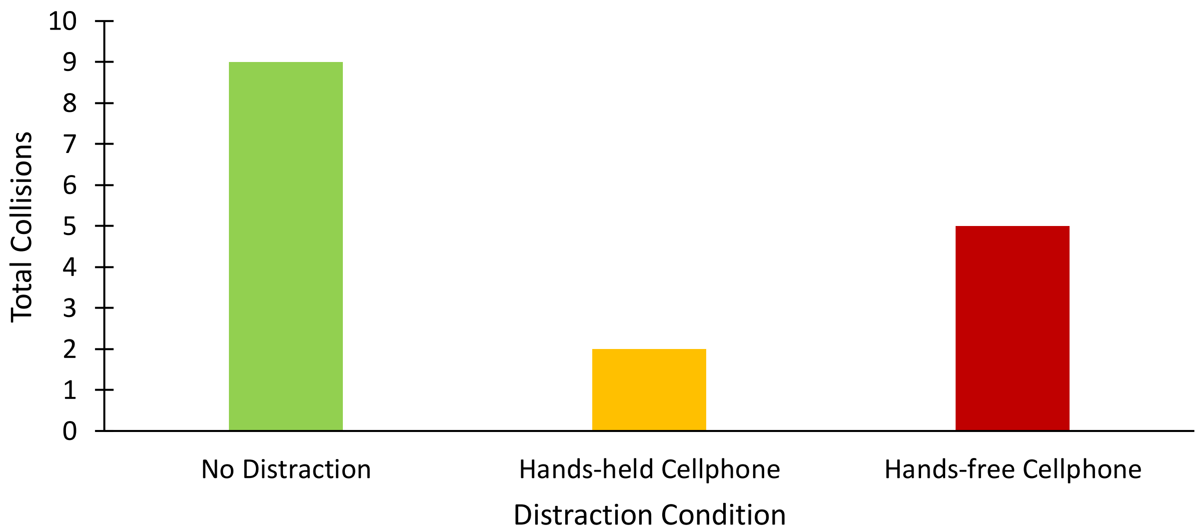

Figure 71. Total collisions by distraction condition in elevations.

When accounting for light conditions and weather, there was no significant difference among distraction conditions on the likelihood of a collision in elevations among older adults (χ^2 = 3.42, p = .18).

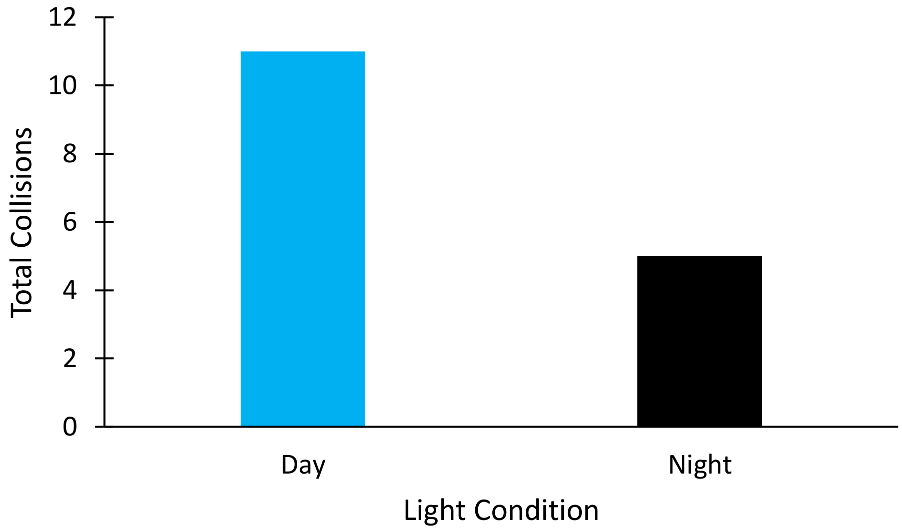

Figure 72. Total collisions in elevation sections by light condition.

There was no difference between daytime and nighttime light conditions on the likelihood of a collision in elevation sections among older adults when accounting for distraction condition and weather (χ^2 = 0.41, p = .52).

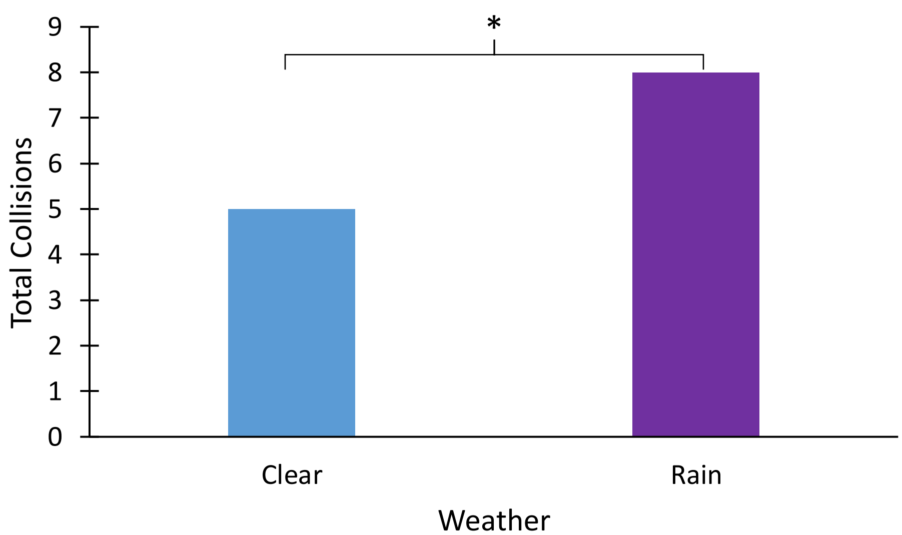

Figure 73. Total collisions by weather condition when talking hands-free in elevations.

When accounting for light level, weather significantly predicted the likelihood of a collision in elevation sections in older adults ($\chi 2$ = 5.77, p = .02). Older adults were 115% more likely to have a collision in rain compared to clear weather (RR = 2.15, 95% CI: 1.20 – 3.87).

Curves

Average Speed

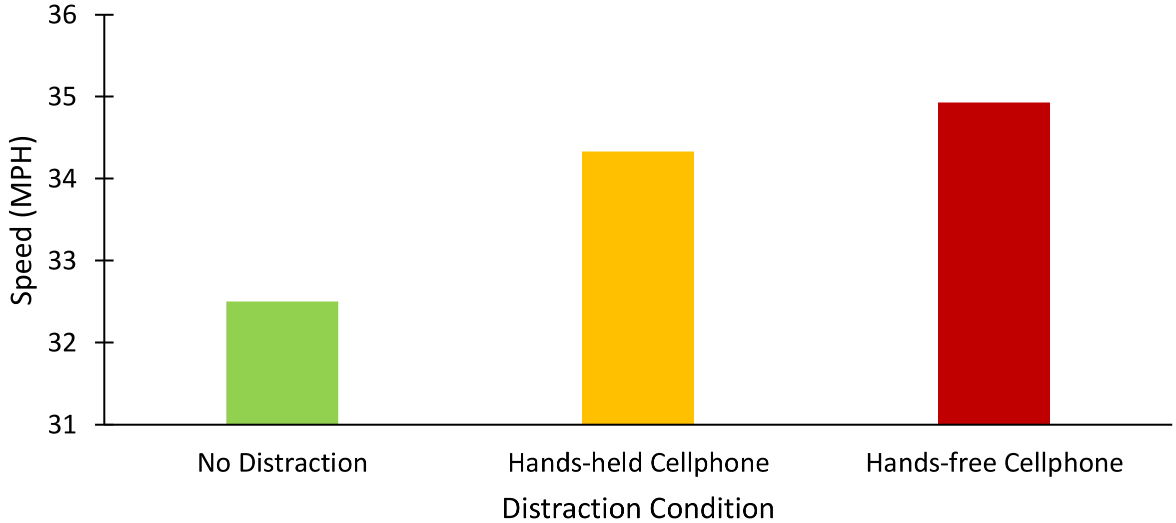

Figure 74. Average speed of older adults in curve sections by distraction task.

Across all light conditions and weather, there was only marginal evidence for a statistically significant difference among distraction conditions on average driving speed in curves. (F = 2.70, p = .08).

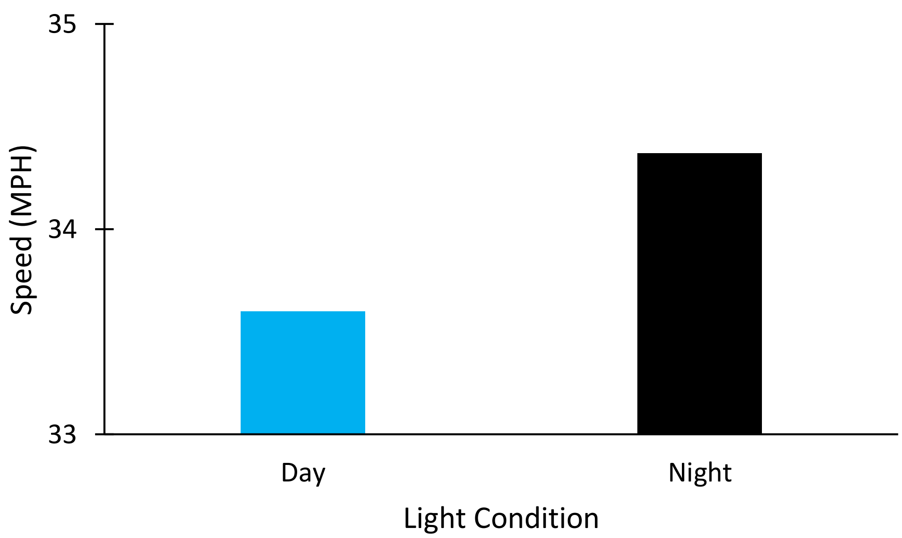

Figure 75. Older adults' average speed in curve sections by light condition (daytime and nighttime).

There was no statistical difference between daytime and nighttime light conditions on average speed in curves (F = 0.50, p = .48).

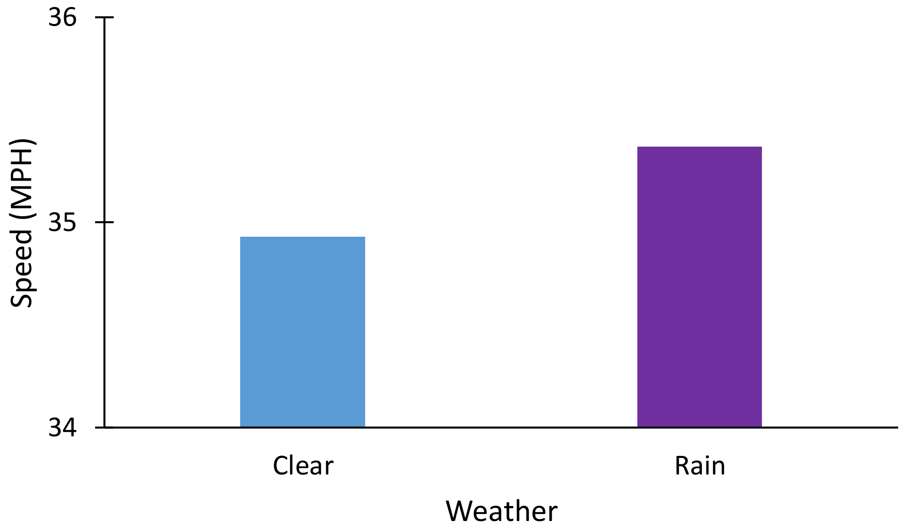

Figure 76. Average speed in curves when talking on the hands-free phone by weather conditions.

In curves sections, there was no difference in average speed between clear weather and rain in older adults (F = 0.03, p = .86).

Speed Variability

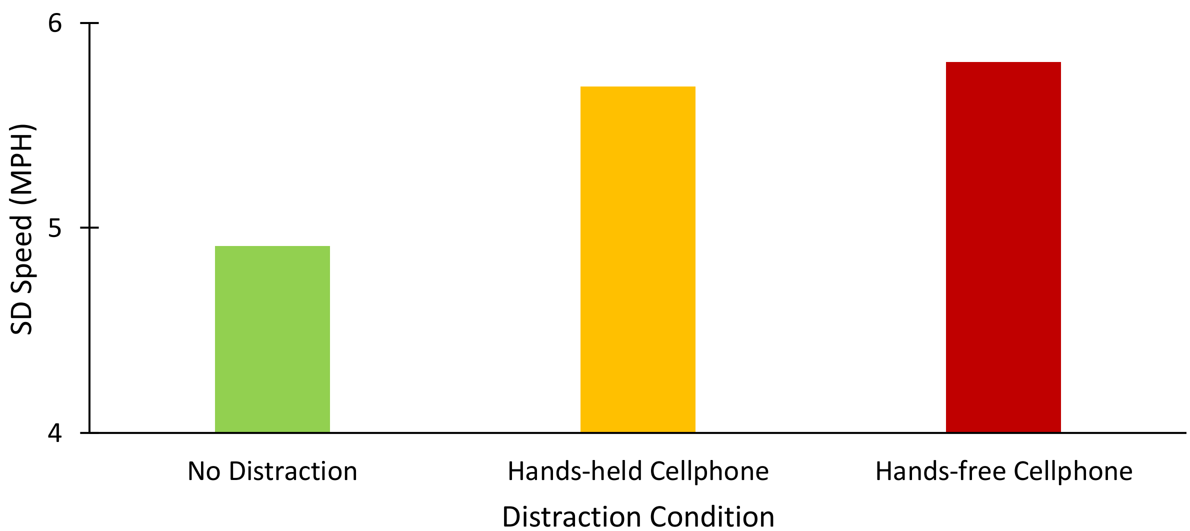

Figure 77. Speed variability in curves by distractions in older adults.

In older adults, there was no statistical difference in speed variability among the distraction conditions in curves (F = 1.03, p = .36)

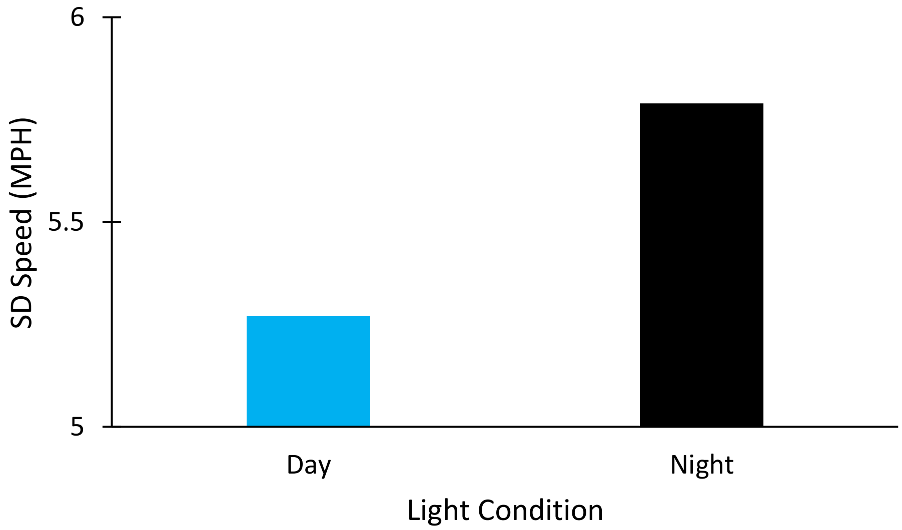

Figure 78. Older adults' speed variability in curves.

Across all distraction conditions and weather, Speed variability did not significantly differ between day and night light conditions for older adults in curves (F = 0.53, p = .47).

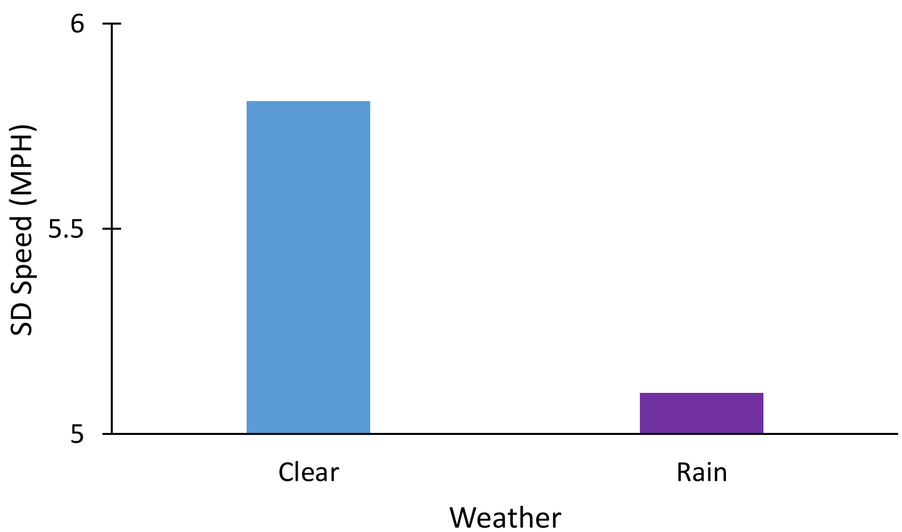

Figure 79. Speed variability in curves when talking on the hands-free cellphone by weather.

There was no difference in speed variability when talking on the hands-free cellphone between clear weather and rain in older adults (F = .92, p = .35).

Lane Maintenance (Standard Deviation of Lane Position)

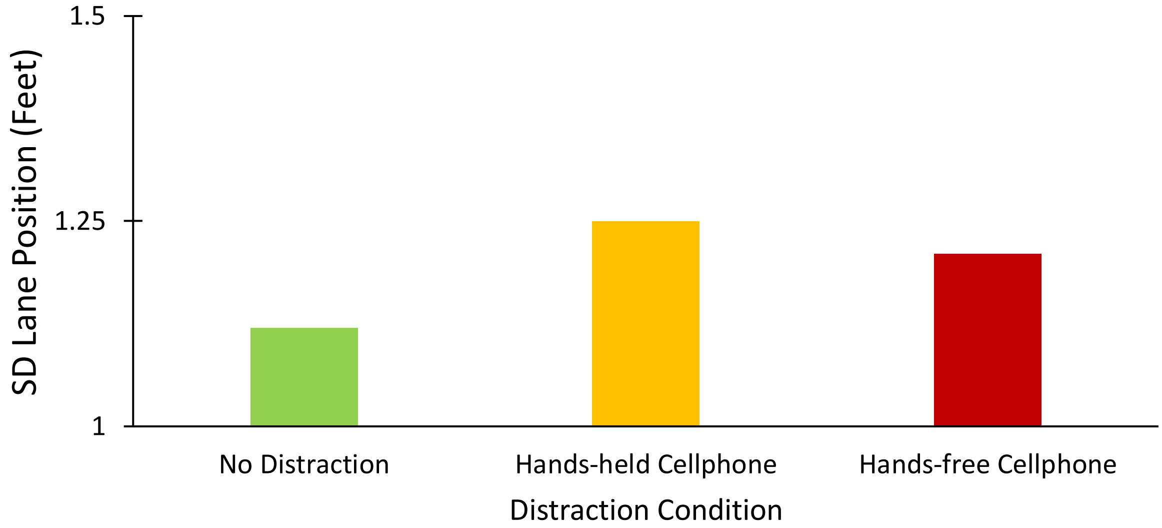

Figure 80. Lane maintenance in curves by distraction in older adults.

Across all light levels and weather conditions, there was no significant difference among the distraction conditions on lane maintenance in older adults (*F* = 1.19, *p* = .31).

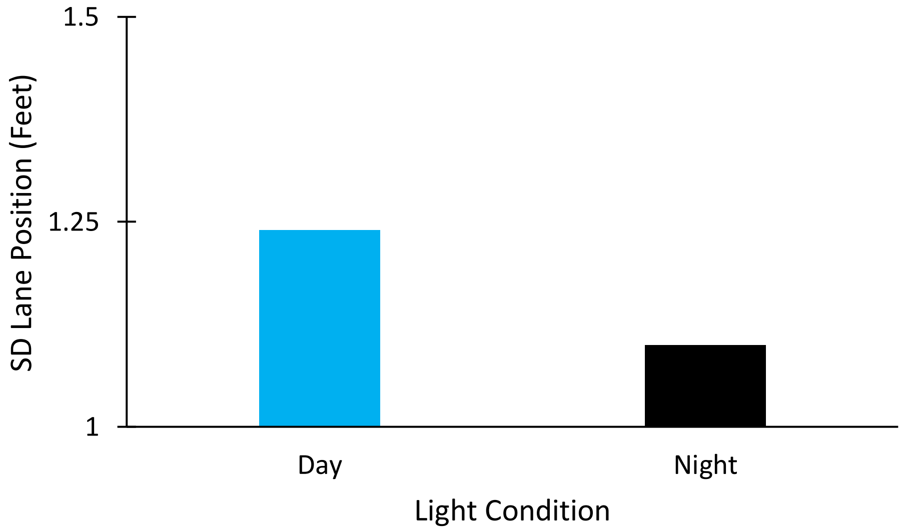

Figure 81. Lane maintenance in curves by light condition in older adults.

There was no statistically significant difference between daytime and nighttime light conditions in older adults in curves (*F* = 2.19, *p* = .15).

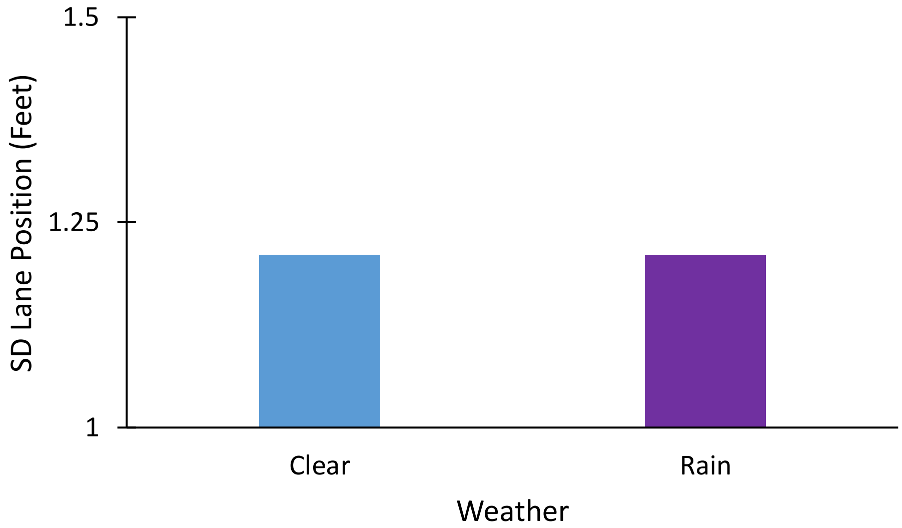

Figure 82. Lane maintenance in curves when talking on the hands-free phone by weather condition.

There was no significant difference between clear weather and rain on lane maintenance in older adults when talking on the hands-free phone (F = 0.21, p = .65).

Motor Vehicle Collisions

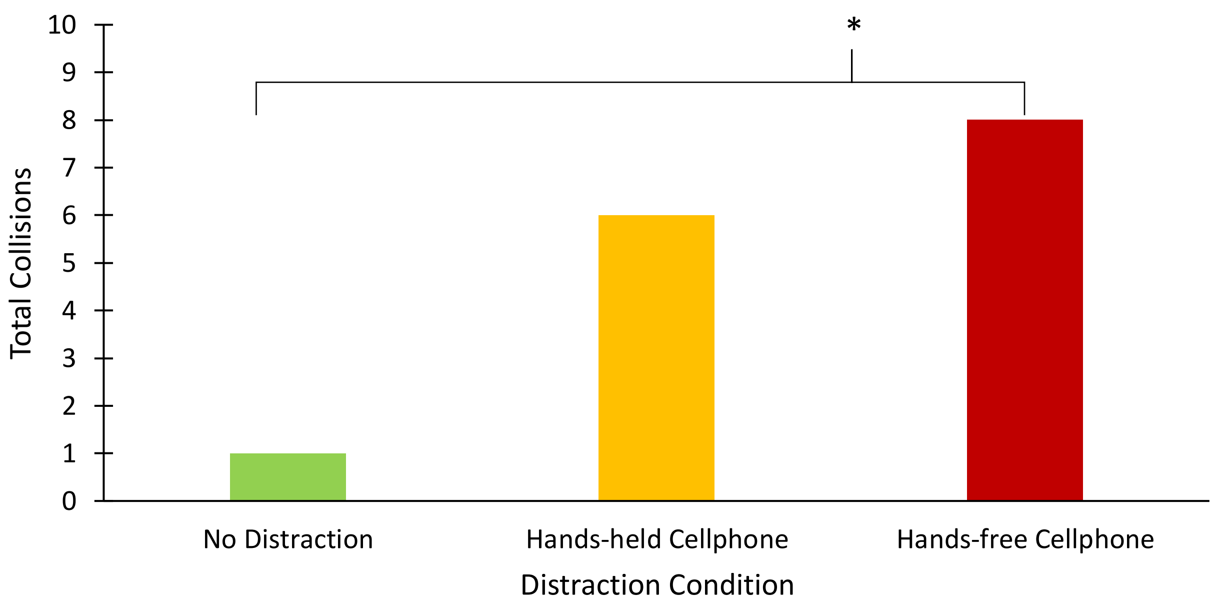

Figure 83. Total collisions by distraction condition in curves.

There was a significant difference among distraction conditions on the likelihood of a collision in curves among older adults when accounting for light levels and weather (χ^2 = 8.43, p = .01). Compared to when in the no distraction condition, older adults were 9.03 times more likely to have a collision in curves when talking hands-free on the phone (RR = 9.03, 95% CI: 1.18 - 68.87)

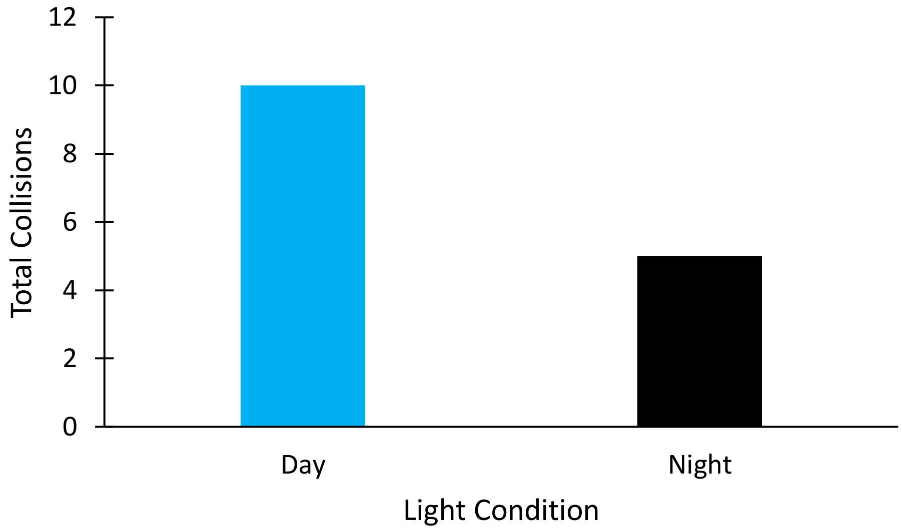

Figure 84. Total collisions in curve sections by light condition.

There was no difference between daytime and nighttime light conditions on the likelihood of a collision in curve sections among older adults when accounting for distraction and weather (χ^2 = 0.11, p = .74).

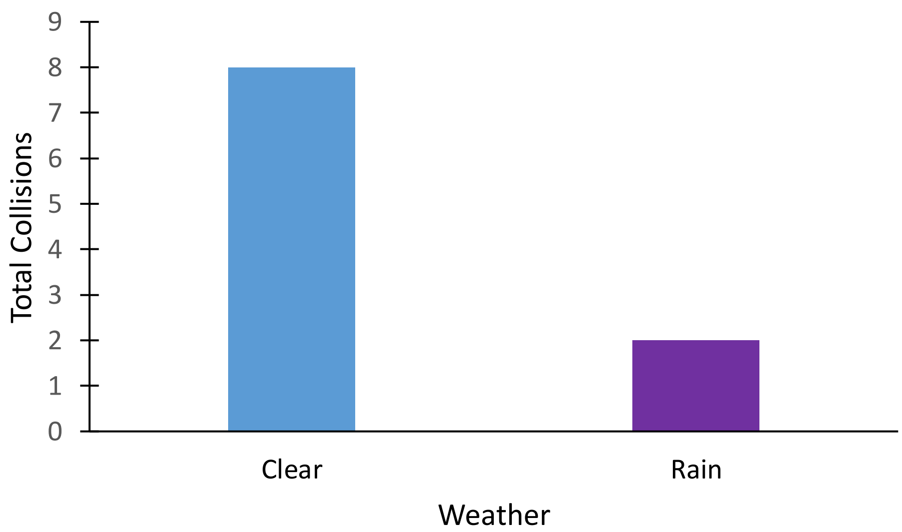

Figure 85. Total collisions by weather condition in curves.

There was marginal evidence to suggest a significant difference between clear weather and rain in curve sections among older adults on the likelihood of a collision when accounting for distraction and light condition (χ^2 = 3.59, p = .06).

Intersections

Average Speed

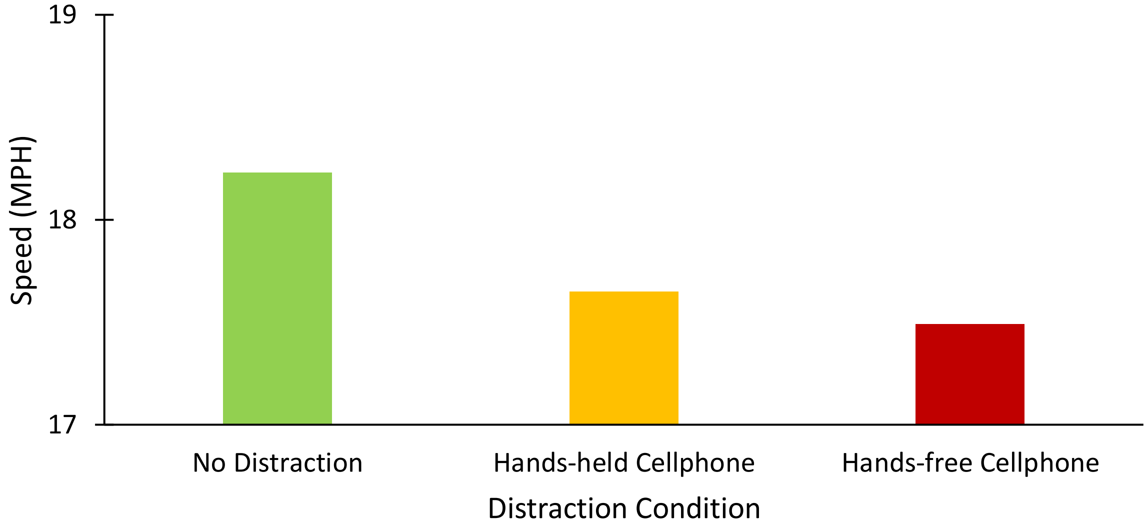

Figure 86. Average speed of older adults in intersections by distraction task.

Across all light conditions and weather, there was no statistically significant difference among distraction conditions on average driving speed in intersections. (F = 1.35, p = .27).

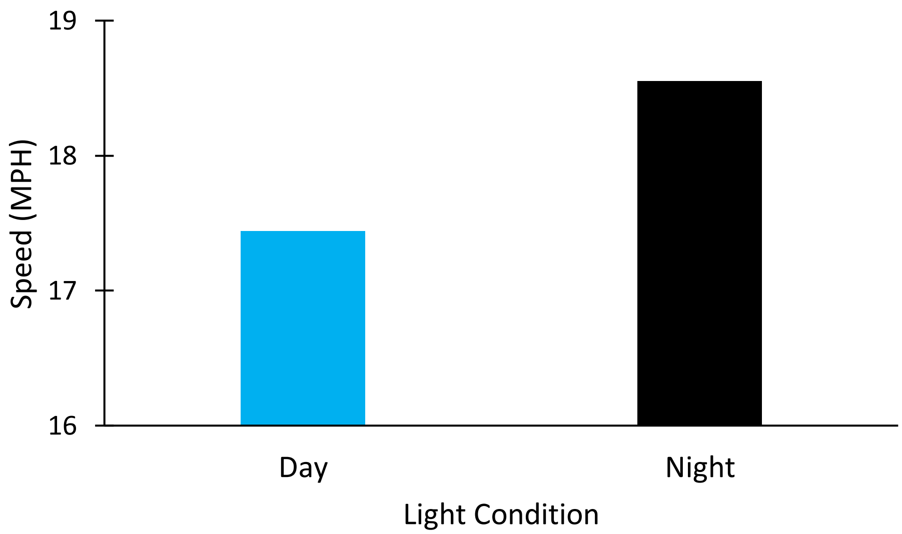

Figure 87. Older adults' average speed in intersections by light condition (daytime and nighttime).

When accounting for distraction and weather conditions, there was no statistical difference between daytime and nighttime light conditions on average speed in curves (F = 0.43, p = .52).

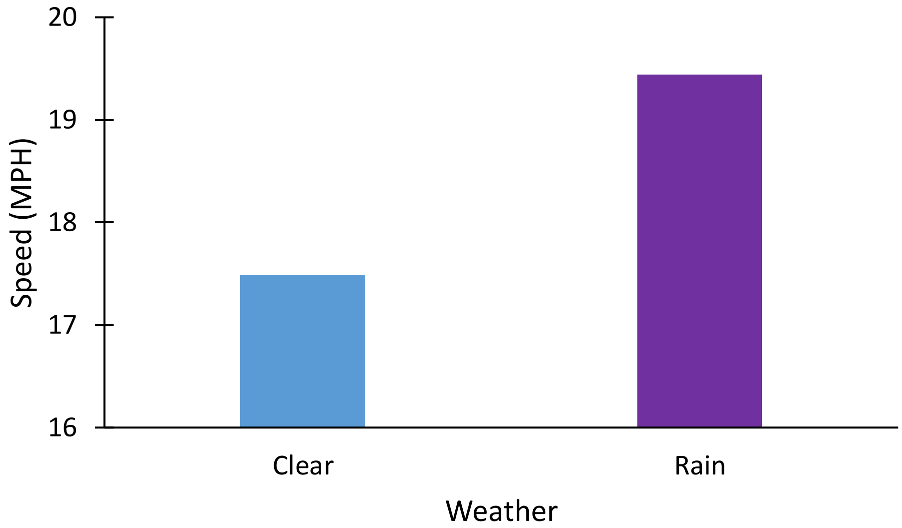

Figure 88. Average speed in intersections when talking on the hands-free cellphone by weather conditions.

For older adults, there was no significant difference between average driving speed in clear weather and rain within intersections (F = 2.26, p = .15).

Speed Variability

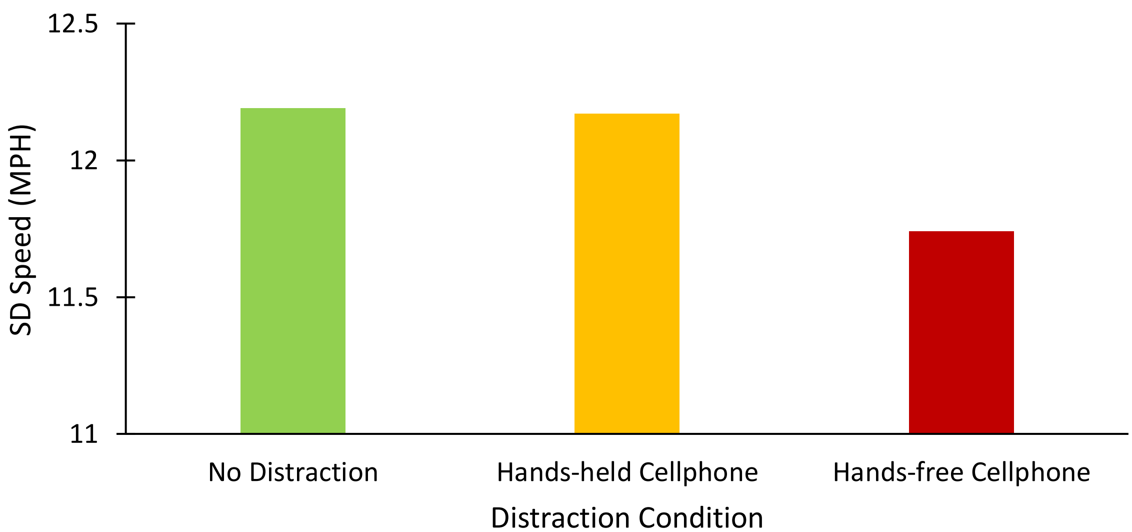

Figure 89. Speed variability in intersections by distraction conditions.

When accounting for light conditions and weather, there was no significant difference among distraction conditions in speed variability for older adults (F = .70, p = .50).

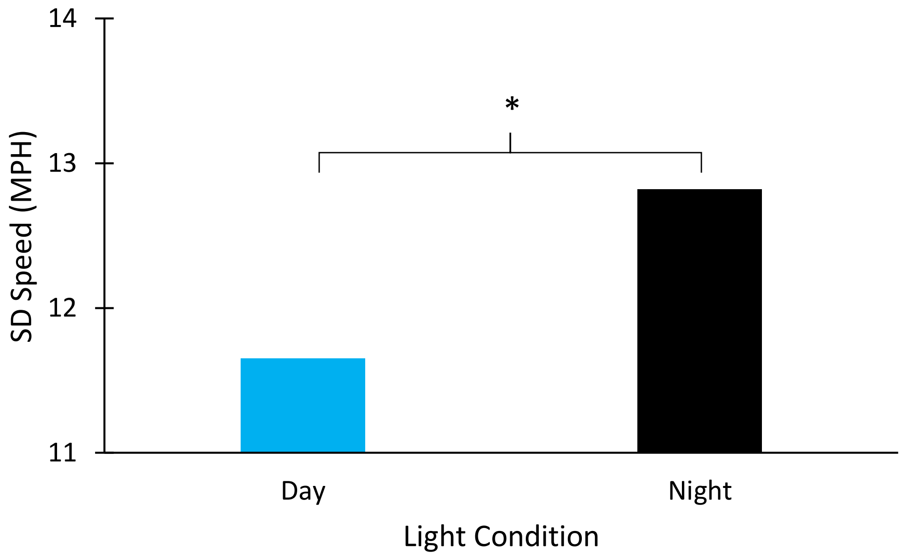

Figure 90. Older adults' speed variability in intersections by light levels.

Accounting for distraction condition and weather, speed variability was significantly greater during night for older adults (t = 2.04, p = .0495). Compared to driving in daytime light levels, speed varied by 1.7 mph greater in older adults.

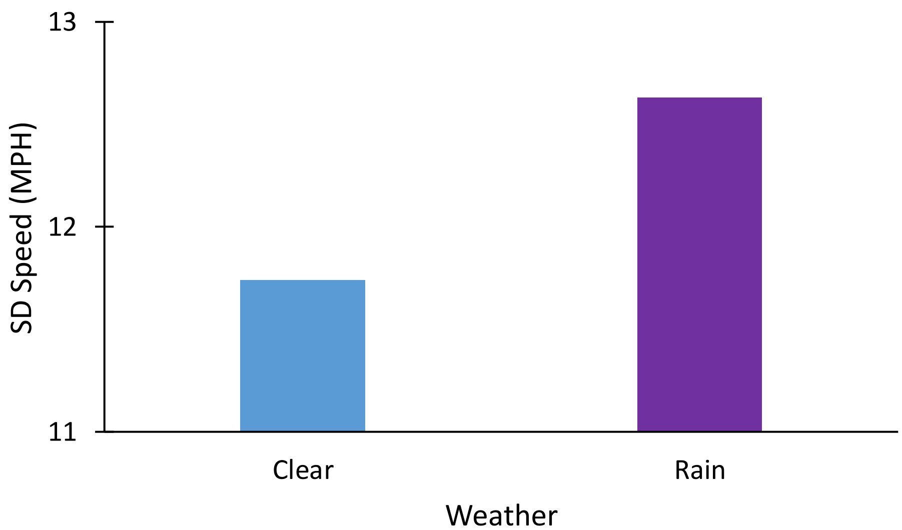

Figure 91. Speed variability in intersections when talking on the hands-free cellphone by weather.

There was no significant difference in speed variability in older adults between clear weather and rain (F = 1.37, p = .25).

<u>Lane Maintenance (Standard Deviation of Lane Position)</u>

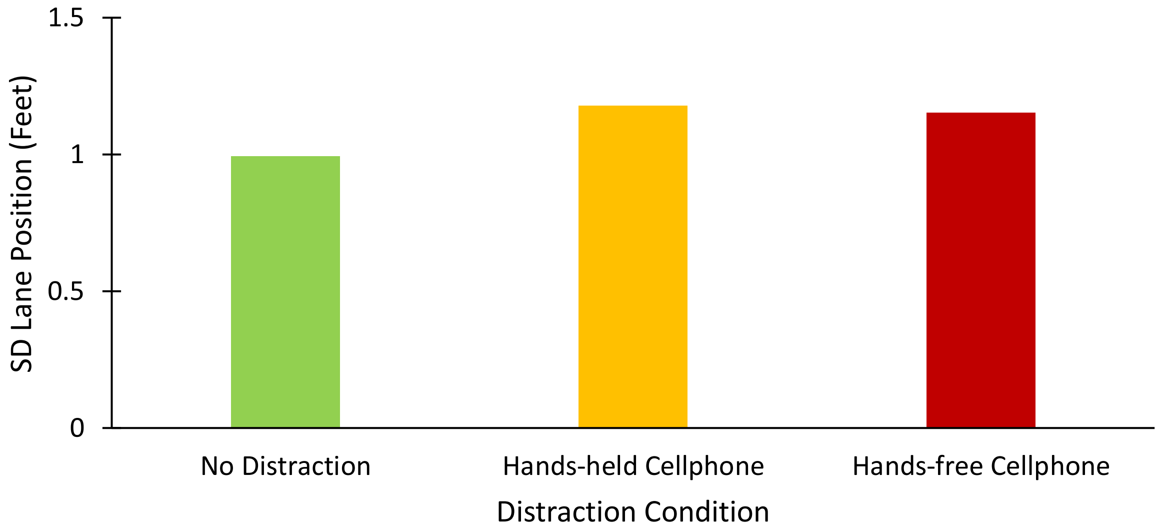

Figure 92. Lane maintenance in intersections by distraction in older adults.

Across all light levels and weather, there was no significant difference in lane maintenance among the distraction conditions in older adults (F = 0.58, p = .057).

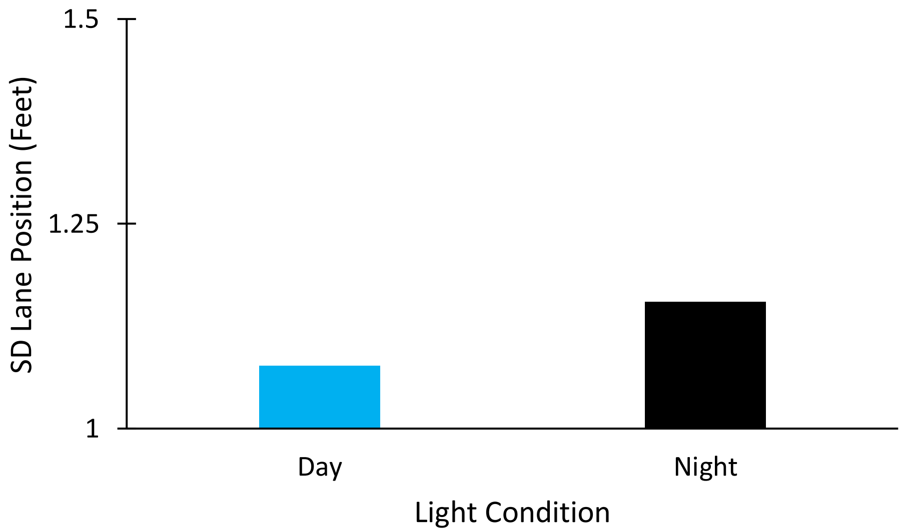

Figure 93. Lane maintenance in intersections by light condition in older adults.

There was no statistically significant difference in lane maintenance between daytime and nighttime light conditions in older drivers in intersections (F = 0.18, p = .68).

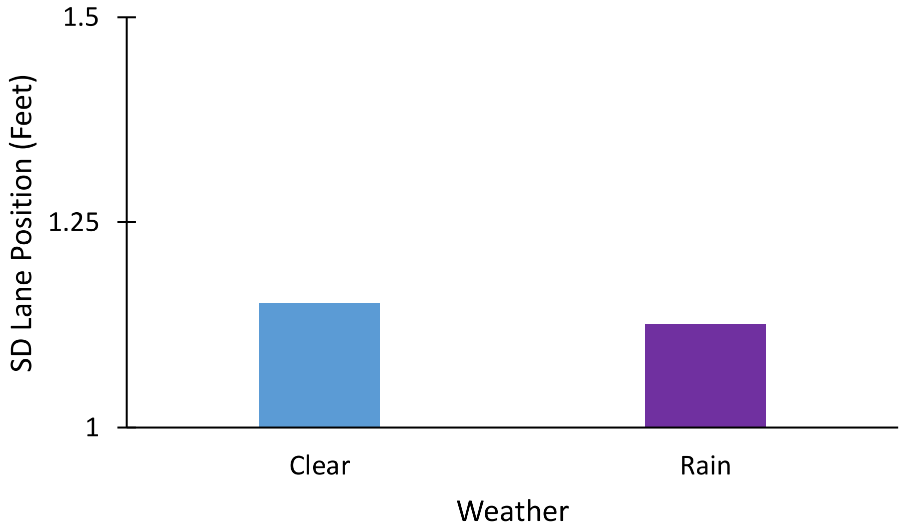

Figure 94. Lane maintenance in intersections when talking hands-free by weather condition.

There no significant difference in lane maintenance between clear weather and rain when talking hands-free in intersections for older adults (F = .01, p = .91).

Motor Vehicle Collisions

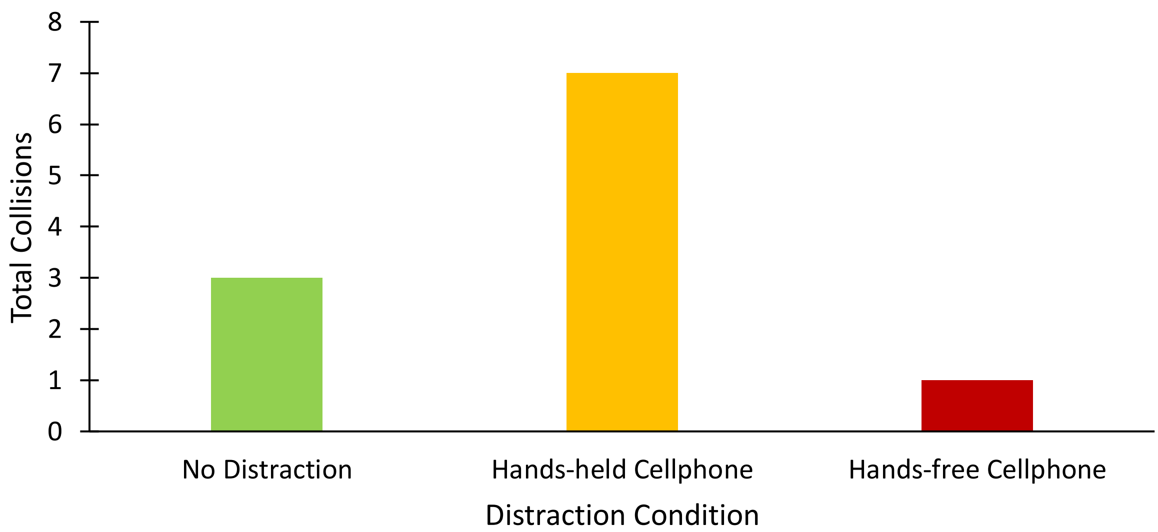

Figure 95. Total collisions by distraction condition in intersections.

There was no significant difference among distraction conditions on the likelihood of a collision in intersections among older adults when accounting for light levels and weather (χ^2 = 3.90, p = .14).

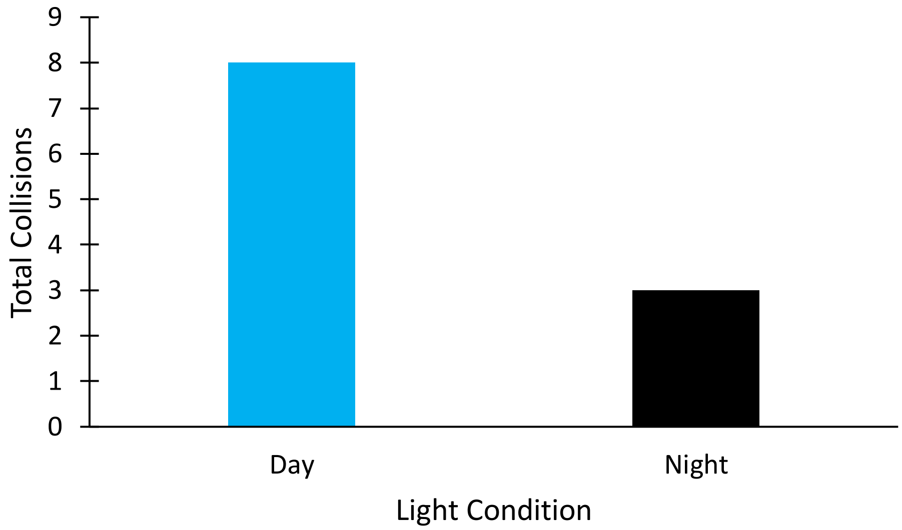

Figure 96. Total collisions in intersections by light condition.

There was no difference between daytime and nighttime light conditions on the likelihood of a collision in intersections among older adults when accounting for distraction and weather (χ^2 = 0.24, *p* = .62).

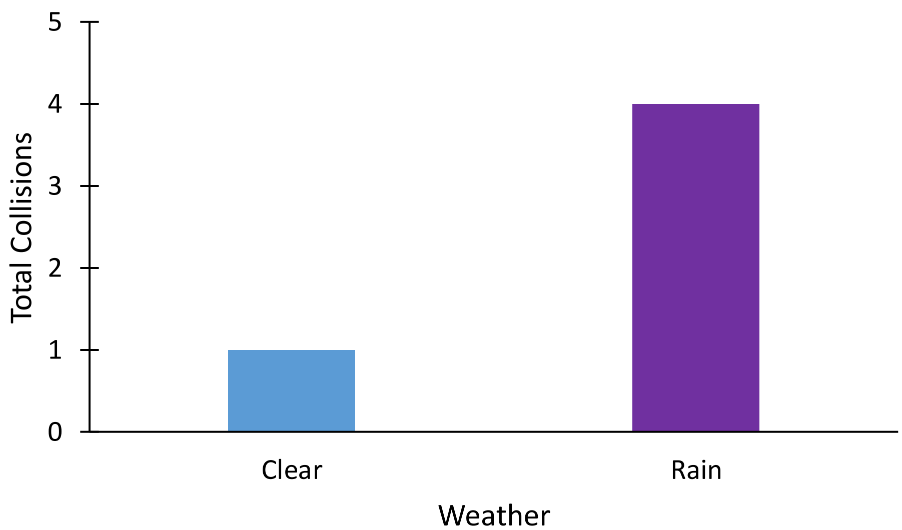

Figure 97. Total collisions by weather condition when talking hands-free in intersections.

There was only marginal evidence to suggest a statistical difference between clear weather and rain in intersections among older adults on the likelihood of a collision when talking hands-free (χ^2 = 3.10, *p* = .08).

Through Aim 2, we examined what individual difference factors (age, distractibility) predict risky driving behavior under varying roadway conditions. In adolescents, associations of individual difference factors with driving variables indicated that older age (older adolescents) was significantly correlated with lower speed variability ($r = 0.30$, $p = .040$) when under no distraction.

Males adolescents displayed poorer lane maintenance compared to their female peers when under the no distraction condition ($t = 2.15$, $p = .04$). Examining interactions of personality factors with distraction conditions suggested that adolescents with higher openness displayed significantly poorer lane maintenance specifically when engaged in a hands-held cellphone conversation ($t = 2.53$, $p = .01$)

For older adults, poorer divided attention and selective attention were both correlated with slower average driving speed ($r = -.35$ and $-.37$ respectively, $p < .05$ for both) under no distraction. This association was not shown when talking on a hands-held cellphone. However, when engaged in the hands-free cellphone conversation, both poorer divided attention and selective attention were significantly associated with slower average driving speed ($r = -.44$ and $-.37$ respectively, $p < .04$ for both).

Older adult gender differences were suggested, with males driving significantly faster average speeds during the no distraction condition ($t = 2.94$, $p = .01$) and during the hands-free cellphone conversation ($t = 2.39$, $p = .02$). Similarly, males displayed significantly greater speed variability during the hands-free cellphone conversation ($t = 2.41$, $p = .02$).

Task 5: Final Report and Other Deliverables

Preliminary research results (largely led by students) have been disseminated through several mechanisms as described below. We have provided attribution to ALDOT for partial funding of these efforts. We will continue to keep ALDOT aware of additional products resulting from this large, rich database.

Presentations at local, regional, and national scientific meetings:

1. *Bell, T.R., *Pope, C.N., & **Stavrinos, D.** (2018, March). *Executive function mediates the relation between emotional regulation and pain catastrophizing in older adults.* Poster presented at the 2018 American Pain Society Scientific Summit. Anaheim, CA.

2. *Albright, G., ***McManus, B., Fernandez, C., Mirman, J.H., & **Stavrinos, D.** (2018, January). *Comparison of younger and older drivers on driving habits: The role of perceived experience and executive function.* Poster presented at the 2018 Transportation Research Board Annual Meeting. Washington, DC.

3. Fernandez, C., *McManus, B., *Albright, G., Mirman, J.H., & **Stavrinos, D.** (2018, January). *Associations among executive function, gender, and driving experience on driving avoidance in young drivers.* Poster presented at the 2018 Transportation Research Board Annual Meeting. Washington, DC.

4. Fernandez, C., Mirman, J.H., & **Stavrinos, D.** (2018, January). *Comparing the factor structure of the driving habits questionnaire between different age groups.* Poster presented at the 2018 Transportation Research Board Annual Meeting. Washington, DC.

5. *Bridges, M.K., *Bell, T., & **Stavrinos, D.** (2017, July). *Effect of adolescent inattention and impulsivity on visual attention during simulated driving.* Poster presented at the 2017 University of Alabama at Birmingham Summer Expo. Birmingham, AL.

6. *Washington, L., *Bell, T., & **Stavrinos, D.** (2017, July). *The impact of weather on visual inattention during driving among adolescents*. Poster presented at the 2017 University of Alabama at Birmingham Summer Expo. Birmingham, AL.

7. *Parr, M.N., *McManus, B., & **Stavrinos, D.** (2017, April). *Personality traits predict simulated distracted driving performance among adolescents*. Poster presented at the 2017 University of Alabama at Birmingham Ost Research Competition. Birmingham, AL.

Publication to peer-reviewed scientific journals:

1. *Bell, T.R., Mirman, J.H., & **Stavrinos, D.** (in press, 2018). Pain, pain catastrophizing, and individual differences in executive function in adolescence. *Children's Health Care*.
2. *Pope, C.N., Bell, T.R., & **Stavrinos, D.** (2017). Mechanisms behind distracted driving behavior: The role of age and executive function in the engagement of distracted driving. *Accident Analysis and Prevention*, *98*, 123-129.
3. *Parr, M.N., *McManus, B., & **Stavrinos, D.** Personality traits predict simulated distracted driving performance among adolescents. Manuscript under review.

Presentation of results to community organizations and other external agencies:

1. **Stavrinos, D.** (2018, July). *Teen driving: A developmental psychologist's perspective*. Driver's Education In-Service Meeting. Homewood, AL.

2. **Stavrinos, D.** (2018, June). *Teen driving: A developmental psychologist's perspective*. Presented at the 2018 Traffic and Driver Safety Conference. Gulf Shores, AL.

3. **Stavrinos, D.** (2018, March). *University partnerships: UAB Translational Research for Injury Prevention Laboratory*. Presented at the 2018 meeting of the Alabama Transportation Planners Association. Birmingham, AL.

4. *McManus, B., Eubank, M.S., & **Stavrinos, D.** (2017, December). *At-risk drivers & driver training.* Presented at the 2017 Alabama Strategic Highway Safety Plan Summit. Tuscaloosa, AL.

5. McManus, B., & **Stavrinos, D.** (2017, October). *Collaborative partnerships.* Presented at the 2017 Gulf Region ITS Annual Meeting. Florence, AL.

6. **Stavrinos, D.** & Peters, R.W. (2017, June). *Role of infrastructure for reducing and preventing distracted driving-related motor vehicle crashes.* Presented at the Southeastern Transportation Research Innovation, Development, and Education Center. Gainesville, FL.

7. **Stavrinos, D.** (2017, February). *Understanding and preventing distracted driving behavior*. Presented at the 2017 Annual Transportation Conference of the Highway Research Center. Auburn, AL.

8. **Stavrinos, D.**, *Parr, M.N. (2016, October). *Psychology on the road*. Keynote presentation at Atlanta UAB Night (UAB recruitment event). Atlanta, GA.

9. **Stavrinos, D.** (2016, October). *Translational research for injury prevention*. 2016 Comprehensive Neuroscience Center Retreat. Birmingham, AL.

10. **Stavrinos, D.** (2016, October). *Distracted driving: What the research suggests.* EPI 603 – Injury Epidemiologic Principles and Prevention Strategies, University of Alabama at Birmingham. Birmingham, AL.

11. **Stavrinos, D.** (2016, March). *Top deadly distractions.* State Farm UrKeys2Drv Teen Driving Event. Bessemer, AL.

12. **Stavrinos, D.** (2016, September). *Understanding driver behavior using a driving simulator*. Keynote speaker for the 2016 Gulf Region Intelligent Transportation Society. Birmingham, AL.

13. **Stavrinos, D.** (2016, July). *Driver distractions: Catch 'em all!* Keynote address for the 2016 UAB Summer Undergraduate Research Expo. Birmingham, AL.

14. **Stavrinos, D.** (2016, April). *Technological innovations to understand and prevent motor vehicle crashes*. UAB Department of Computer and Information Sciences Seminar Series. Birmingham, AL.

Press releases in a variety of media outlets:

We have worked with UAB's media division to launch a high visibility campaign to increase exposure to the driving simulator and the work conducted by TRIP Laboratory. As a result, the driving simulator has received extensive local and national exposure. In all cases, attribution is provided to Alabama Department of Transportation for providing funds to make the state-of-the-art driving simulator laboratory possible. Links to selected news coverage is found below:

- The grand opening for the driving simulator was featured on WIAT CBS 42 and WVTM NBC 13 http://wiat.com/2016/04/19/uab-launches-state-of-the-art-driving-simulator-lab/

- Newswise also featured a press release of the driving simulator http://www.newswise.com/articles/first-of-its-kind-driving-simulator-lab-at-uab-powered-by-donation-from-honda-manufacturing-of-alabama-and-aldot

- Claims Journal featured the driving simulator http://www.claimsjournal.com/news/southeast/2016/04/25/270327.htm

- The TODAY Show segment "Rossen Reports" featured the driving simulator in a segment on April 29, 2016. Filming took place on the 28th and aired live from the driving simulator on April 29th. http://www.today.com/video/watch-how-fast-your-selfie-can-cause-a-crash-676179523610

- UAB News featured a story about the national debut of the driving simulator on the TODAY Show https://www.uab.edu/news/innovation/item/7271-uab-driving-simulator-lab-has-national-debut-live-on-today

- The TODAY Show featuring the driving simulator was highlighted in the UAB Reporter's Top News on May 3rd as well: Top News **Driving simulator debuts live on TODAY** . *NBC's TODAY show correspondent Jeff Rossen reported live from UAB's Translational Research for Injury Prevention Lab — the world's first SUV simulator — about the dangers of using social media and texting while driving. See it here: https://www.youtube.com/watch?v=_x6lAiAIPC4&t=1s*

- CNN visited the driving simulator and filmed on May 23, 2016 to include the driving simulator to be featured in a documentary on distracted driving planning to air on CNN in late summer 2016.

- The UAB student-run Kaleidoscope interviewed Dr. Stavrinos and highlighted the driving simulator and the lab's work: https://www.uab.edu/studentmedia/kaleidoscope/news/687-first-of-its-kind-simulator-developed-in-part-by-uab-faculty

- WBRC Fox 6 featured the driving simulator in a segment aired on Memorial Day:

http://www.wbrc.com/story/32102879/road-warrior-new-state-of-the-art-driving-simulator-finds-home-at-uab.

- WDJC 93.7's "The Way Home with Mark and Stephanie" toured the lab and aired a radio interview with Dr. Stavrinos on June 21, 2016
- A promotional video regarding the grand opening of the simulator can be found here: https://www.youtube.com/watch?v=qmTpnCQ5l0E