EXPLORING SIMULATED DRIVING PERFORMANCE AMONG VARSITY MALE SOCCER PLAYERS

Mathieu Tremblay[1,2], Martin Lavallière[3,4,5], Wayne J. Albert[1], Simon R. Boudreau[2], Michel J. Johnson[2]

[1] Occupational Performance Lab, Faculty of Kinesiology, University of New Brunswick, Fredericton (NB), Canada.
[2] École de kinésiologie et de loisir, Université de Moncton, Moncton (NB), Canada.
[3] Module de Kinésiologie, Département des Sciences de la Santé, Université du Québec à Chicoutimi (UQAC), Saguenay (QC), Canada.
[4] Laboratoire de recherche biomécanique & neurophysiologique en réadaptation neuro-musculo-squelettique (Lab BioNR), UQAC, Saguenay (QC), Canada.
[5] Centre de recherche – Charles-Le Moyne – Saguenay–Lac-Saint-Jean sur les innovations en santé (CRCSIS) (QC), Canada.

Mathieu Tremblay mathieu.tremblay@unb.ca
Martin Lavalliere martin_lavalliere@uqac.ca
Wayne J. Albert walbert@unb.ca
Simon R. Boudreau simon.boudreau005@gmail.com
*Michel J. Johnson michel.johnson@umoncton.ca

*Corresponding author:
Michel J. Johnson
École de kinésiologie et de loisir
CEPS Louis-J. Robichaud
Université de Moncton
40, avenue Antonine-Maillet,
Moncton, NB, Canada, E1A 3E9
Phone: +1.506.858.4811 Fax: +1.506.858.4308

ABSTRACT

Background: It is documented that male athletes display riskier behaviours while driving (as well as in their life in general) than female athletes and non-athletes. However, literature reported that athletes show better driving ability than non-athletes. This paradox between behaviours and abilities motivated the present study to further understand the collision risk of varsity athletes.

Objective: The current study estimates the performance differences between varsity male soccer players and male undergraduate non-athlete students on: i) a driving task and, ii) three perceptual-cognitive tasks (associated to collision risk prediction; i.e. Useful Field of View (UFOV) test).

Methods: Thirty-five male undergraduate students (15 varsity soccer players, 20 undergraduate non-athlete students) took part in this study. Driving performances were assessed during 14 minutes of urban commuting using a driving simulator. While completing the simulated driving task and UFOV test, the physiological responses were monitored using an electrocardiograph (ECG) to document heart rate variability (HRV).

Results: Varsity soccer players shown more at-risk behaviours at the wheel compared to their non-athlete student peers. Varsity soccer players spent more time over the speed limits, did more driving errors and, they also adopted less safe and legal behaviours. However, no difference was observed between both groups on driving skills variables (i.e. vehicle control, vehicle mobility, ecodriving). For subtest 1 and 2 of UFOV (i.e. processing speed, divided attention), both groups perform identically (i.e. 17 milliseconds; ms). The non-athlete group tends to outperform on the selective attention task (i.e. subtest 3 of UFOV test), (63.2 ± 6.2 ms vs. 87.2 ± 10.7 ms, respectively, but this difference was non-significant ($p = 0.76$).

Conclusion: Preventive driving measures should be enforced in this high-risk population to develop strategies for risk reduction in male team athletes.

KEYWORDS

Undergraduate students, Behaviour, Driving skills, Perceptual-cognitive task.

INTRODUCTION

Vehicular collisions remain one of the leading causes of death for individuals under 24 years of age in North America (Heron 2015; Public Health Agency of Canada (PHAC) 2012). The main contributors to these deaths and serious injuries are risky driving behaviours such as speeding, driving under the influences of alcohol, distractions and neglecting to wear a seatbelt (Lambert-Bélanger et al. 2012; Transport Canada 2012.). However, a gender difference within this age group is also noted, with men having a 3.3 times higher incidence rate of collisions resulting in death than females (16.8 per 100,000 vs 5.1 per 100,000, respectively) (Statistics Canada 2014). Furthermore, as reported by the National Collegiate Athletic Association (NCAA), the principal cause of male mortality was vehicle collisions, representing a yearly rate of 9.5 deaths per 100,000 American student-athletes (Asif et al. 2013). When comparing male athletes to their female counterparts and non-athletic peers, it has been observed that male athletes engaged in riskier behaviours such as alcohol consumption, unsafe sex, speeding, seatbelt omission, and cellphone usage while driving (Asif et al. 2013; Nattiv et al. 1997). Nonetheless, in Canada very little research has been done to compare driving performance in athletes and non-athletes among the student population, in part because athletic status is typically not a factor taken into consideration while looking at road safety statistics.

Despite the fact that the research field in "*athlete and driving*" is limited, the literature tends to show that male athletes have greater risk-taking behaviours than non-athletes as well as female athletes (Asif et al. 2013; Nattiv et al. 1997). Nevertheless, the literature reported that athletes possess better driving ability than non-athlete (without a gender influence). A research team has observed driving maneuvers in a driving simulator with a cohort of young participants with less than 5 years of driving experience (Hancock et al. 2002). They observed that athletes outperformed non-athletes for an imposed task within the driving simulation. Wayne and Miller (2018) evaluated the driving skills of young driving students with less than five hours of driving experience. The participants were evaluated on-road by their driving instructor. They reported that athletes or individual with serious athlete-background have greater driving skills. Another study observes among a cohort of young and novice drivers, that team-sports athletes had a better field of view. More specifically, they had a more effective ability to detect peripheral stimulus while driving than non team-sports athletes (Matos and Godinho 2009). Therefore, the literature suggests the existence of ability transfer from the athletic background to the driving skills (Matos and Godinho 2009; Wayne and Miller 2018).

This phenomenon observed among athletes of ability transfer might be explained by the fact that, driving is well known in the literature to be a combination of perceptual and cognitive abilities, and it was also documented that athletes have better perceptual-cognitive abilities than non-athletes (Faubert 2013). Several factors are studied in the literature in order to provide a better understanding of the transfer of sports background to perceptual-cognitive abilities. However, regarding the studies who had assess perceptual-cognitive abilities among athletes, it can be noticed that the groups of athletes came mostly from sports with an important aerobic fitness component (Faubert 2013; Mann et al. 2007; Vestberg et al. 2017; Voss et al.

2010). Based on this observation, and the fact that an increasing aerobic capacity was associated with an enhanced of cognitive skills of individuals (Colcombe and Kramer 2003; Hillman et al. 2008), it seems reasonable to assume that cardiovascular fitness appears to be an important factor. A second factor that might help to explain the phenomenon is the level of expertise (or experience) of the athletes (e.g. elite vs. recreational athletes), because it was associated positively with higher perceptual-cognitive skills (Mann et al. 2007; Vestberg et al. 2017; Voss et al. 2010). Suggesting that experience allows the athlete to develop, monitor, regulate and perform better perceptual-cognitive skills for their sports, and for other non related-sport tasks (like driving perhaps) (Voss et al. 2010). The third factor represents the influence of sport specificity, where the specificity tends to enhance certain skills more than others. For example, athletes from interceptive sports have quicker reaction time and faster processing speed than strategic or self-paced sports athletes (Mann et al. 2007; Voss et al. 2010). Overall, athletes outperform non-athletes during sport-specific tasks and also non-specific perceptual-cognitive tasks (Voss et al. 2010). In general, findings indicate that perceptual-cognitive skills transfer is a fundamental aspect of many sports that could be relevant to driving skills.

This paradox between the behaviours and abilities motivated the present investigation to understand the involvement in collision risk of varsity athletes. The aims of this study are to estimate the performance difference between male varsity soccer players and undergraduate non-athlete students: i) in a driving simulator and, ii) in perceptual-cognitive tasks associated to collision risk prediction (i.e. Useful Field of View (UFOV) test)). It was hypothesized that the group of male athletes would outperform the non-athlete group for driving skills and the perceptual-cognitive tasks, but would demonstrate riskier behaviours at the wheel. Furthermore, while completing the driving and perceptual-cognitive tasks, the physiological responses are monitored in order to evaluate the potential differences between both groups. It was expected that the group undergraduate non-athlete students would present higher physiological responses during all tasks. A better understanding of behaviours displayed by young men while driving may aid in understanding increased involvement in collision risk for this specific population and might guide future prevention strategies.

METHODS

Procedures

Thirty-five undergraduate students took part in this study. A total of 15 male varsity soccer players (22.1±1.6 years old; 5.1±1.41 years of driving experience) and 20 male undergraduate non-athlete students (21.2±1.5 years old; 5.0±1.50 years of driving experience) volunteered. All drivers were recruited from the undergraduate community of the university. Before starting the experiment, all participants were briefed on the procedures of the study. In addition, participants were asked to refrain from caffeine and alcohol consumption 24 hours before the experiment. Once in the lab, participants read a study information form, then were informed of their rights and signed a consent form approved by the university research ethics board. A three lead ECG (electrocardiogram) using a Lead II electrode placement according to Einthoven's triangle configuration was used to collect physiological response (Becker 2006). A 5-minute rest period was provided to collect a baseline period of physiological data. Next, the perceptual-cognitive assessment was performed using the three subtests (i.e. processing speed, divided attention, selective attention) of UFOV (Edwards et al. 2005). Afterward, the participants were guided through a 10-minute practice driving scenario to get familiarized with the controls of the driving simulator. Five out of thirty-five participants were unable to complete the driving simulator familiarization period due to simulator sickness while they were driving (i.e. 3 varsity soccer players and 2 undergraduate non-athlete students). The simulated drive was similar to a daily commute driving in clear day through a city while encountering different levels of traffic density with other road users (approximately 14 minutes for 7.5 kilometres route).

Apparatus

Driving simulator: The simulated drives were completed on a driving simulator (VS500M, Virage Simulation, Montréal, Canada) (Figure 1). The open car simulator resembles a General Motors (GM) compact cab interior. The simulator consists of a driver's seat, steering column, pedals, automatic transmission and a dashboard, which are mounted on a three-axis motion/vibration platform that provides force feedback and vibration. Figure 1 shows two side screens located behind the driver that provides additional visual feedback for the left and right blind spots.

Useful field of view (UFOV) test: UFOV test is an assessment of three perceptual-cognitive tasks: processing speed, divided attention and selective attention. These three tasks represent higher-order cognitive functioning required for safe vehicle driving (Edwards et al. 2005). UFOV test was performed on a 17" touch screen (Elo Touchsystems 2700 Intellitouch USB) with UFOV software (version 6.1.4; Visual Awareness Research Group inc., USA).

Electrocardiogram (ECG): A 3-lead ECG (MLA2340), was used to collect, condition (i.e. amplification, filtering, converting) and record heart signals with the help of the Bio Amp unit (FE132) and an eight-channel PowerLab unit (PL3508) (AdInstruments, USA). LabChart software (version 7, AdInstruments, USA) was used for data collection, data analysis and calculation of heart rate variability (HRV). HRV was used to assess physiological responses to the simulated driving evaluation and to the UFOV test, by comparing physiological measures to the corresponding baseline values.

Dependent Variables

Driving performance: The simulator measures the driver's ability to control the vehicle and to anticipate and manage collision avoidance during the scenario. Measures are processed internally by the simulator to calculate driving scores:

i) Specific performance scores are calculated based on 100 points:
   - *Control*: Steering and pedals stability, lane position, intersection approaches and turns.
   - *Mobility*: Travel time, flow-density of traffic, speed homogenization.
   - *Ecodriving*: Fuel consumption related to brake and acceleration management.

- *Safety*: Safety margin and anticipation between with other road users and objects.
- *Legality*: Respect of signs and lights, legal maneuvers.
- *Sharing*: Courtesy (sharing, priority, anticipation) with other road users, distance between vehicles.

ii) A global performance score (*Global*) based on 100 points resulting from the cumulative weight of the six driving elements mentioned above: *Control*(15%), *Mobility*(5%), *Ecodriving*(10%), *Safety*(30%), *Legality*(30%) and *Sharing*(10%).

iii) Percentage of time spent over the speed limit (*Speeding*);

iv) Amount of driving errors (*Mistakes*) including collisions, disrespect of signalization, sudden stops and inappropriate handling of the vehicle in turns, lane changes.

Perceptual-cognitive tasks performance: Three perceptual-cognitive tasks were obtained from the three UFOV subtests in milliseconds (ms): P*rocessing speed*, *Divided attention* and *Selective attention*.

Physiological response: Each HRV variables were calculated by comparing the values between baseline and UFOV subtests and the driving task, respectively (differences of means by subtracting conditions from baseline measures).

i) Mean heart rate (MeanHR) in beats per minute (bpm);

ii) Mean time intervals between normal-to-normal beats (MeanNN) in milliseconds (ms);

iii) Standard deviation of time intervals between normal-to-normal beats (SDNN) in ms;

iv) Square root of the mean squared differences of successive normal-to-normal beats (RMSSD) in ms.

Statistical Analysis

Comparison tests were used to evaluate the difference between both groups (varsity male soccer players vs. undergraduate male non-athlete students) on nine driving performance variables and subtest 3 of UFOV test (i.e. selective attention; perceptual-cognitive task). Normality distribution was assessed by Shapiro-Wilk tests. If significant ($p<0.05$), Mann-Whitney U tests were used to test for significant differences. Otherwise, independent Student t-tests were used. The variables with significant differences ($p<0.05$) were selected to perform multiple linear regression models. The regressions used were stepwise backward selection approach in order to identify the best-fit models to predict driving performance variables ($p<0.05$). The stepwise backward selection approach starts with all covariates in the model, and then removes the covariate with the least statistical significance until all remaining variables have a significant p-value. The covariates were: *Groups*, *Selective attention* task, *Age* and *Driving experience*. Considering that all participants obtained the same value for *Processing speed* and *Divided attention* tasks, they were excluded in the statistical analysis (i.e. comparison and regression).

The physiological responses during driving and perceptual-cognitive tasks were compared between both groups. To compare HRV variables between groups, values during the tasks were subtracted from baseline values. Based on Shapiro-Wilk tests the HRV variables were tested, when the tests were significant non-parametric approach was used, whilst non-significant test led to parametric tests: i) inter-group comparisons were tested with a Mann-Whitney U test or independent Student t-test; ii) intra-group comparisons were assessed with a Friedman test or repeated measures ANOVA test. When the p-value was inferior to 0.05 (p<0.05), Conover or Bonferroni post-hoc tests were conducted as non-parametric and parametric tests, respectively. For all analyses, a significant threshold was determined lower than 0.05. JASP (version 0.9.0.1; University of Amsterdam) were used to conduct all analyses.

RESULTS

Driving Task

The evaluated driving scenario was a simulated urban drive. The time to completion was 13.8±2.7 minutes for soccer players and 14.7±1.2 minutes for non-athletes (p>0.05). Overall, the non-athletes showed better general driving performance, as they scored 13.8 higher than the soccer players on the *Global* score (61.8±3.2 vs. 48.0±3.5, respectively) (p<0.05). Compared to soccer players, non-athletes displayed higher *Safety* (55.0±5.7 vs. 30.3±8.3; p<0.05) and *Legality* (61.2±3.5 vs. 46.7±6.3; p<0.05) scores. The soccer players spent more time over the speed limit (*Speeding*; 10.0±1.7 vs. 3.9±0.7; p<0.05) and were more often involved in driving errors (*Mistakes;* 6.1±0.7 vs. 3.8±0.3; p<0.05) when compared to the non-athlete drivers. However, *Control* (56.4±6.1 vs. 61.8±4.2), *Mobility* (74.5±4.2 vs. 75.2±7.7), *Ecodriving* (57.6±7.6 vs. 59.6±2.8) and *Sharing* (68.5±6.7 vs. 79.8±4.1) were not significantly different (p>0.05) between groups (athletes vs. non-athletes). Figure 2 through 4 illustrate the differences between both groups for all driving variables.

Five driving variables (i.e. *Global*, *Safety*, *Legality*, *Speeding*, *Mistakes*) presented significant difference (p<0.05) between both groups. These variables were selected to perform multiple linear regression models based on a stepwise backward selection approach. Results from the regressions on these driving performance variables while controlling for *Groups*, *Selective attention*, *Age* and *Driving experience* are presented in tables 1 to 3. Models 3 shows that *Groups* and *Driving experience* influence *Global* and *Safety* significantly (r^2=0.236, p=0.026; r^2=0.218, p=0.036) as well as *Groups* and *Age* seem to affect *Speeding* and *Mistakes* (r^2=0.352, p=0.003; r^2=0.292, p=0.009) (Appendix 1, tables A1.1, A1.2). However, *Driving experience* and *Age* did not have a significant effect in Model-3 (p>0.05), only the impact of *Groups* was significant on those four driving variables (p=0.010; p=0.020; p=0.004; p=0.025). Model-4 confirmed that only *Groups* were significant (*Global* r^2=0.225, p=0.008; *Safety* r^2=0.187, p=0.017; *Speeding* r^2=0.338, p<0.001; *Mistakes* r^2=0.289, p=0.002). Using the *Selective attention* in the models to predict driving variables only had an influence on the *Legality*. Despite of lack of significant influence of *Groups*, *Age* and *Driving experience*, Table A.1.3 (Appendix 1) presents the significant impact of *Selective attention* on the *Legality* variable through four significant models (Model-1 r^2=0.368, p=0.018; Model-2 r^2=0.359, Model-3 p=0.008; r^2= 0.303, Model-4 p=0.008; r^2=0.245, p=0.005).

Perceptual-Cognitive Tasks

Looking at the three perceptual-cognitive tasks, both groups reached floor results (17ms) for *Processing speed* and *Divided attention*. Non-athletes scored 24ms faster than soccer players in the measures of *Selective attention* task (63.2±6.2 vs. 87.2±10.7), but the difference was not significant (p=0.76). Appendix 2 presents the results of the physiological response.

DISCUSSION

Driving task

Based on the driving variables measured in this study, it is possible to identify two categories of driving-related components: behaviour and skill. As expected, the varsity soccer players displayed more risky behaviours while driving in the simulator than the non-athlete students' group, as reflected by driving variables related to behaviours, where varsity soccer players perform more unsafe and illegal maneuvers and spent more time over the speed limit and had more driving errors than non-athletes. These results are in accordance with the literature (Asif et al. 2013; Nattiv et al. 1997) that showed that athletes were more involved in risky driving behaviours. Furthermore, this study was the first paper that measured and observed risky behaviours at the wheel among athlete drivers rather than to report them with an epidemiological approach.

Considering the studies of Hancock et al. (2002), Wayne and Miller (2018) and Matos et al. (2009), it was anticipated that the current cohort of athletes would present greater skill while they drove. However, this was not the case. Some methodological considerations can help explain the differences between the current study and previous literature. Specifically, for the three studies highlighted, one looked at driving maneuvers in athletes using a driving simulator, the second with an on-road setting, and the third paper performed cognitive tasks during a closed-circuit driving task. Hancock et al. (2002) observed that athletes outperformed non-athletes for an imposed task within the driving simulation and they also found no significant difference between gender. This task required participants to maintain a safe and constant distance from a lead vehicle, and their reaction time to stop when the lead vehicle braked. The results from Hancock et al. are difficult to compare to our own because of differences in driving context (i.e. close vs. open scenario, imposed tasks vs. urban route). Wayne et al.'s study observed that, among a cohort of young and novice drivers, those with an athlete-background demonstrated better driving skills. Wayne et al.'s study used a cohort of non-licensed drivers without driving experience, and their driving skills were assessed using a subjective approach, where vehicle control and maneuvers in traffic were rated on a single scale of one to four by a driving instructor. Wayne et al.'s participants were younger (18±2.6 vs. 21.5±1.6 years old) and less experienced (less than five hours of actual driving vs. 5.1±1.5 years of driving experience) compared to our study. Also, their driving conditions during evaluations were not reproducible (e.g. traffic density, events) and the evaluation criteria were too wide and not specific enough (e.g. which driving components were satisfactory or not). In short, our participants were more experienced drivers and we used a driving simulator offering reproducible conditions as well as specific driving variables. The third study assessed perceptual-cognitive tasks while driving on a closed-circuit. Matos and Godinho (2009) observed that team-sport players outperformed non-athletes in the detection of peripheral stimuli, but found no significant difference on peripheral reaction times during a driving task. The present study does share some similarities with Matos et al., particularly with regards to age (20±1.3 years old), driving experience (maximum of 1.5 years), and the reproducible nature of their assessment. Nonetheless, the driving task was completed on a closed circuit which eliminates a lot of the complexity associated with driving when interacting with other road users. In the present study, the driving and perceptual-cognitive tasks were done separately.

Cognitive-perceptual tasks

Similar to McManus et al. (2015), all participants obtained the same result for *Processing speed* and *Divided attention* which represents a floor performance (best response achievable) for both tasks. This study confirmed that the two first subtests of UFOV are easily achieved in a young and healthy driver population. Additionally, a non-significant difference was observed for the *Selective attention* task (third subtest of UFOV), where non-athletes outperformed athletes. This result contrasts with the literature, where it was documented that athletes possess the better useful field of vision (Matos and Godinho 2009), processing speed and attention than non-athletes (Voss et al. 2010). Upon a closer look at the literature, regarding perceptual-cognitive skills for athletes and non-athletes, only a meta-analysis published by Voss et al. (2010) reported that athletes performed better on *Processing speed* tasks and *Varied attention* tasks, but no difference was found for *Attentional cuing* tasks. However, although the tasks from Voss et al. do share similarities with UFOV, there are differences. For example, UFOV is based on the speed needed to process visual information as opposed to a reaction time measurement).

The current study was the first study to compare the three perceptual-cognitive tasks of UFOV between varsity soccer players and undergraduate non-athlete students. Despite non-significant results obtained between both groups, it appears that the *Selective attention* task was sensitive enough to predict the *Legality* variable for the driving task among all young adults of this cohort. Considering that varsity soccer players demonstrated lower *Legality* score than undergraduate non-athlete students, it remains surprising there was no significant group effect in the regression models. In addition, at the first look, the relationship between *Legality* and *Selective attention* seems difficult to understand. Nevertheless, focussing on the meaning of the *Legality* variable, we must refer to the components of the driving variable (which include respect of road signs and lights). It could be speculated that individuals with limited attentional resources, or difficulty focusing on specific information (e.g. road signs) and recalling it in a dynamic environment (like driving), would not detect or process the peripherical information available adequately while driving (White and Caird 2010). The driver may have looked but not seen the road sign and executed an inappropriate (perhaps illegal) maneuver. This is in line with the results of studies investigating "*looked but failed to see*" situations (White and Caird 2010). Overall, the current study has shown the usefulness of this tool, however more research is needed to provide better knowledge related to driving components and the young population. Appendix 2 discussed the results of the physiological response. Limitations, practical implications and future research orientations are addressed in the Appendix 3.

Using a driving simulator, varsity male soccer players and undergraduate non-athlete students were assessed for multiple areas of driving proficiency. Varsity soccer players displayed riskier behaviours at the wheel when compared to their non-athletic peers, spending more time over the speed limit while producing more driving errors. Young men are one of the most at-risk groups of being involved and killed in traffic collisions. Based on survey studies, including driving behaviours, athletes display more risky behaviours than non-athletic young men. In addition, traffic collisions are the number one cause of death in undergraduate athletes. However, no formal open-simulation driving studies have assessed driving behaviours in athletes and non-athletes. This group may be overrepresented in traffic collisions, since athletic status is not taken into consideration when looking at traffic statistics. In addition, varsity athletes may benefit from exposure to driving-related information sessions. Preventive interventions deserve more study to determine better strategies for risk reduction in this group.

REFERENCES

Asif IM, Harmon KG, Klossner D. Motor vehicle accidents: the leading cause of death in collegiate athletes. *Clin. J. Sport Med. Off. J. Can. Acad. Sport Med.* 2013;23(6):439–443.

Becker DE. Fundamentals of Electrocardiography Interpretation. *Anesth. Prog.* 2006;53(2):53–64.

Colcombe S, Kramer AF. Fitness Effects on the Cognitive Function of Older Adults: A Meta-Analytic Study. *Psychol. Sci.* 2003;14(2):125–130.

Edwards JD, Vance DE, Wadley VG, Cissell GM, Roenker DL, Ball KK. Reliability and Validity of Useful Field of View Test Scores as Administered by Personal Computer. *J. Clin. Exp. Neuropsychol.* 2005;27(5):529–543.

Faubert J. Professional athletes have extraordinary skills for rapidly learning complex and neutral dynamic visual scenes. *Sci. Rep.* 2013;3:1154.

Hancock PA, Kane MJ, Scallen S, Albinson CB. Effects of gender and athletic participation on driving capability. *Int. J. Occup. Saf. Ergon. JOSE*. 2002;8(2):281–292.

Heron M. *Deaths: Leading Causes for 2011*. USA: U.S. Department of Health and Human Services; 2015. Available at: http://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_07.pdf.

Hillman CH, Erickson KI, Kramer AF. Be smart, exercise your heart: exercise effects on brain and cognition. *Nat. Rev. Neurosci.* 2008;9(1):58–65.

Lambert-Bélanger A, Dubois S, Weaver B, Mullen N, Bédard M. Aggressive driving behaviour in young drivers (aged 16 through 25) involved in fatal crashes. *J. Safety Res.* 2012;43(5–6):333–338.

Mann DTY, Williams AM, Ward P, Janelle CM. Perceptual-cognitive expertise in sport: a meta-analysis. *J. Sport Exerc. Psychol.* 2007;29(4):457–478.

Matos R, Godinho M. Useful Field of Vision and Peripheral Reaction Time in novice drivers – Transfer to a real driving situation after a Perceptual-Motor Training Program. *Adv. Transp. Stud. Int. J.* 2009;Section B(19):77–84.

McManus B, Cox MK, Vance DE, Stavrinos D. Predicting Motor Vehicle Collisions in a Driving Simulator in Young Adults Using the Useful Field of View Assessment. *Traffic Inj. Prev.* 2015:1–6.

Nattiv A, Puffer JC, Green GA. Lifestyles and health risks of collegiate athletes: a multi-center study. *Clin. J. Sport Med. Off. J. Can. Acad. Sport Med.* 1997;7(4):262–272.

Public Health Agency of Canada (PHAC). *Injury in review, 2012 edition: spotlight on road and transport safety*. Canada; 2012. Available at: http://publications.gc.ca/site/eng/420120/publication.html.

Statistics Canada. *Motor vehicle accidents causing death*.; 2014. Available at: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/health112d-eng.htm.

Transport Canada. *Canadian Motor Vehicle Traffic; Collision Statistics 2012*. Available at: https://www.tc.gc.ca/media/documents/roadsafety/cmvtcs2012_eng.pdf.

Vestberg T, Reinebo G, Maurex L, Ingvar M, Petrovic P. Core executive functions are associated with success in young elite soccer players. *PloS One*. 2017;12(2):e0170845.

Voss MW, Kramer AF, Basak C, Prakash RS, Roberts B. Are expert athletes ‘expert’ in the cognitive laboratory? A meta-analytic review of cognition and sport expertise. *Appl. Cogn. Psychol.* 2010;24(6):812–826.

Wayne NL, Miller GA. Impact of gender, organized athletics, and video gaming on driving skills in novice drivers. *PloS One*. 2018;13(1):e0190885.

White CB, Caird JK. The blind date: The effects of change blindness, passenger conversation and gender on looked-but-failed-to-see (LBFTS) errors. *Accid. Anal. Prev.* 2010;42(6):1822–1830.