Driving After Concussion; An Innovative Combination of Virtual Reality and Machine Learning Classifiers

Molly Split, Maryam Daniali, Jillian Tessier, Dario Salvucci, and Maria T. Schultheis

Objective:
Driving abilities are often compromised in individuals after concussion. Virtual Reality Driving Simulation (VRDS) provides clinicians with the ability to examine driving behaviors safely and with an ecologically valid approach. VRDS generates a large volume of driving performance metrics but determining the clinical utility of these metrics can be challenging. Therefore, the present study used hypothesis-driven machine-learning techniques to differentiate driving behaviors in post-concussive individuals.

Participants and Methods:
VRDS performance data from 24 individuals with concussion and 22 healthy controls were analyzed. All individuals completed an experimental drive on VRDS. During the experiment, they were asked to complete two behavioral tasks: a coin-sorting task and verbal task. Data was analyzed using a machine-learning classifier, namely a Support Vector Machine (SVM). Three VRDS metrics – standard deviation of steering angle, lane position, and velocity/speed for subjects driving with or without performing the behavioral tasks – were selected for analyses.

Results:
The SVM classifier used 75% of data for the training phase and 25% for the testing phase by applying a cross-validation technique. Results showed that the verbal task was able to differentiate concussed individuals from healthy individuals at a 66.16% classification rate. For the coin sorting task, results were able to differentiate concussed individuals from healthy individuals at a 63.16% classification rate. By contrast, when subjects were driving without performing a task, the classification rate was around chance level (50%).

Conclusions:
This study revealed that specific driving behaviors can be measured quantitatively and used to differentiate concussed individuals from healthy individuals. Moreover, the study showed that machine learning classifiers, such as SVM, are a useful tool in accurately identifying these specific driving behaviors in concussed individuals (i.e. standard deviation scores for steering angle, lane position, and velocity/speed). In summary, the combination of VRDS and machine-learning classifiers can improve accurate identification of clinically relevant driving behaviors in individuals with a concussion.