Elite Skill & Concussion
Comparative Study Between NHL Draft Prospects and Kinesiology Students at York University

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ABSTRACT

It is commonly understood that elite athletes have superior eye-hand coordination and visuomotor skill allowing them to perform at the highest level in their sport when compared to non-elite population. The research study examined data from elite athletes at the 2014 National Hockey League (NHL) Draft Combine and Kinesiology students at York University to examine their visuomotor skill when learning to perform a novel motor learning task. The experiment explored the possibility for lingering visuomotor effects in elite asymptomatic athletes with concussion history. When analyzing the progression in performance, it was found that the elite and non-elite groups without concussion history demonstrated similar improvements in performance, whereas the elite group with concussion history displayed variable and inconsistent performances.

RESEARCH QUESTIONS

1. Will the performance of elite athletes with and without a history of concussion be indistinguishable from each other?
2. Are male Kinesiology students capable of performing the task with the same performance outcomes as elite athletes?

METHODS

Participants: 36 male participants classified into 3 groups.
- Elite CH- NHL draft prospects (n = 12, mean age = 17)
- Elite CH+ NHL draft prospects (n = 12, mean age = 17)
- Non-Elite CH- Kinesiology students (n = 12, mean age = 21.7)
➤ Note: CH- are participants without concussion history, CH+ are participants with at least 1 concussion that was previously medically diagnosed.

Apparatus: Phantom™ 3.0 Haptic 6D robotic arm. The robotic equipment created a virtual environment in 3 planes of motion that provided feedback through the form of resistance on impacts.

Task: Participants were asked to perform 10 consecutive trials. The goal of the task was to navigate a virtual red ball around the course as quickly and smoothly as possible around 6 obstacles from the start to end locations. A time penalty of 500ms was added to the total movement time for every obstacle hit during the trial.

Performance outcomes measured: Movement Time, Self-Control Performance Percentage, Obstacles Hit, Path Length, and Jerk.
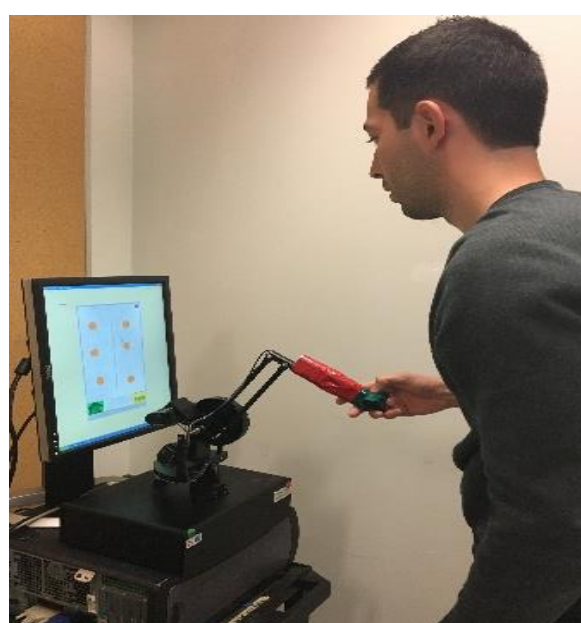
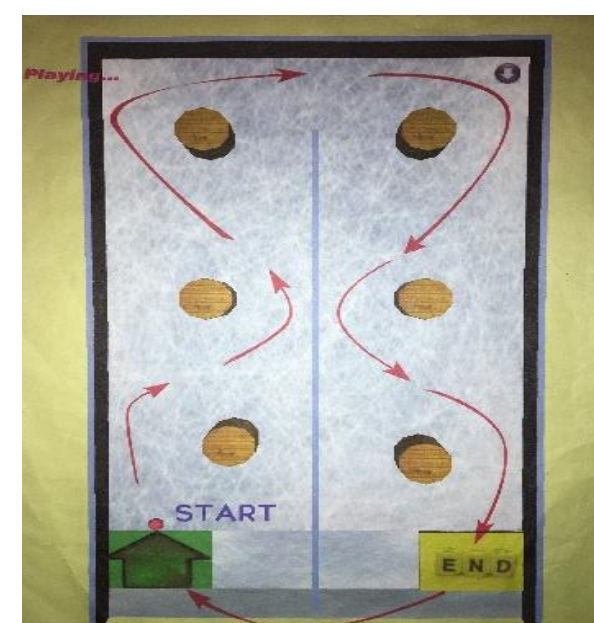Figure 1: Demonstration from the experimenter.

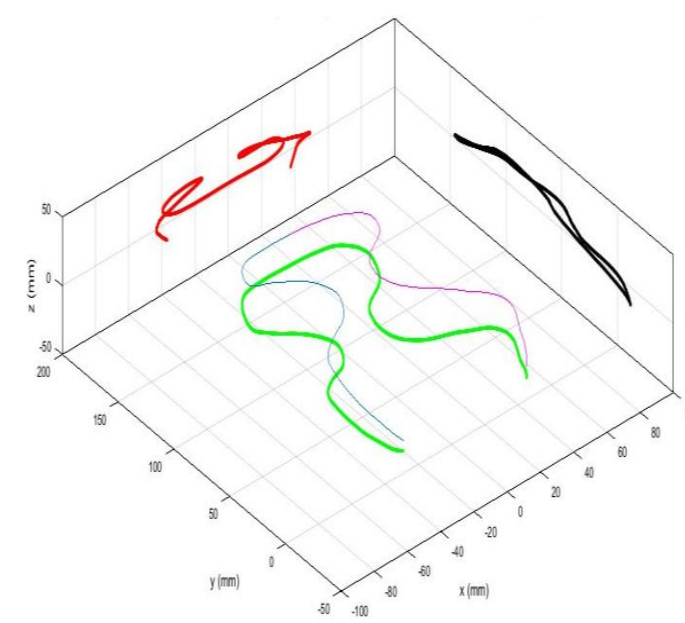Figure 2: Visual display outlining the required movement path.

Figure 3: MATLAB trajectory plot from the experimenter's demonstration.

RESULTS

Movement Trajectory Examples on Haptic Robot for the Motor Learning Task

Trials: Initial — Middle — Final

Elite CH-: Best Initial Performance | Early Learning, Smooth Trajectory | Highly Consistent Throughout

Elite CH+: Poor Initial Performance | Greater Improvement Variability | Inconsistent Final Performance

Non-Elite CH-: Worst Initial Performance | Slower Consistent Improvement | Later Learning

Within Groups Analysis: Trends in Motor Learning

Legend: Elite CH- (blue), Elite CH+ (orange), Non-Elite CH- (green)

Figure 5: Bar graph depicting the mean movement time to complete the task.

Figure 6: Bar graph depicting the mean path length taken to complete the task.

Figure 7: Bar graph depicting the mean number of obstacles hit during the experiment.
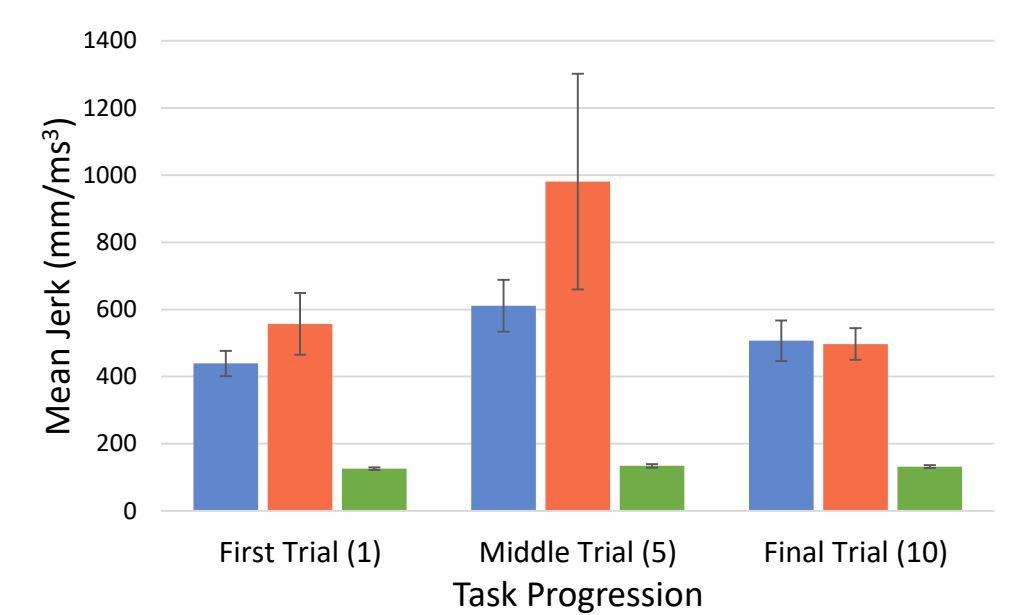
Figure 8: Bar graph depicting the mean jerk during the experiment.

➤ Note: Error bars in the graphs are plotted using SEM values.
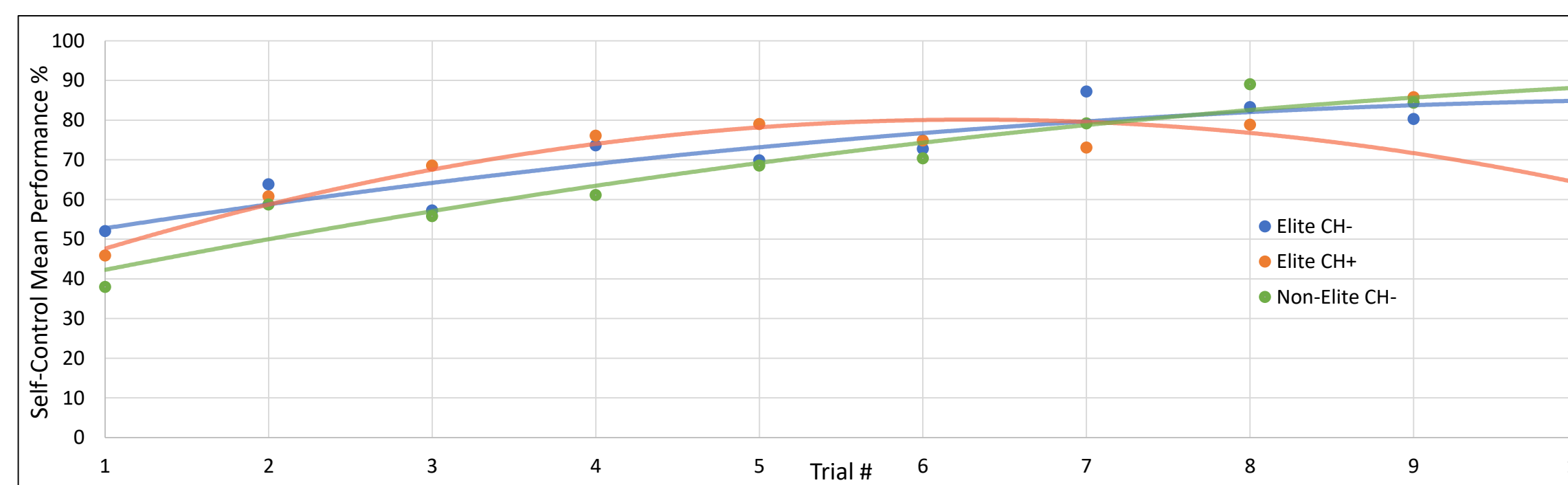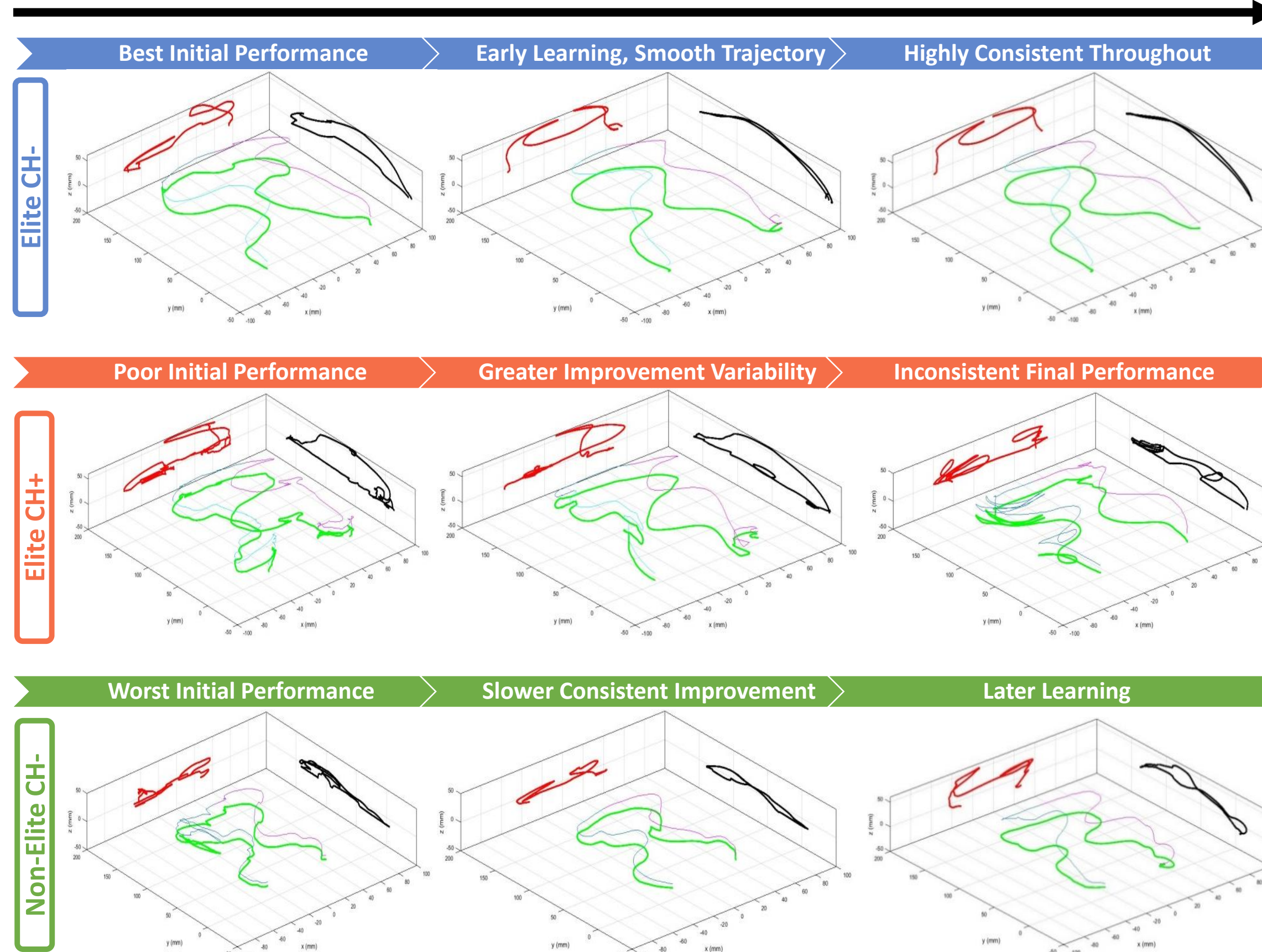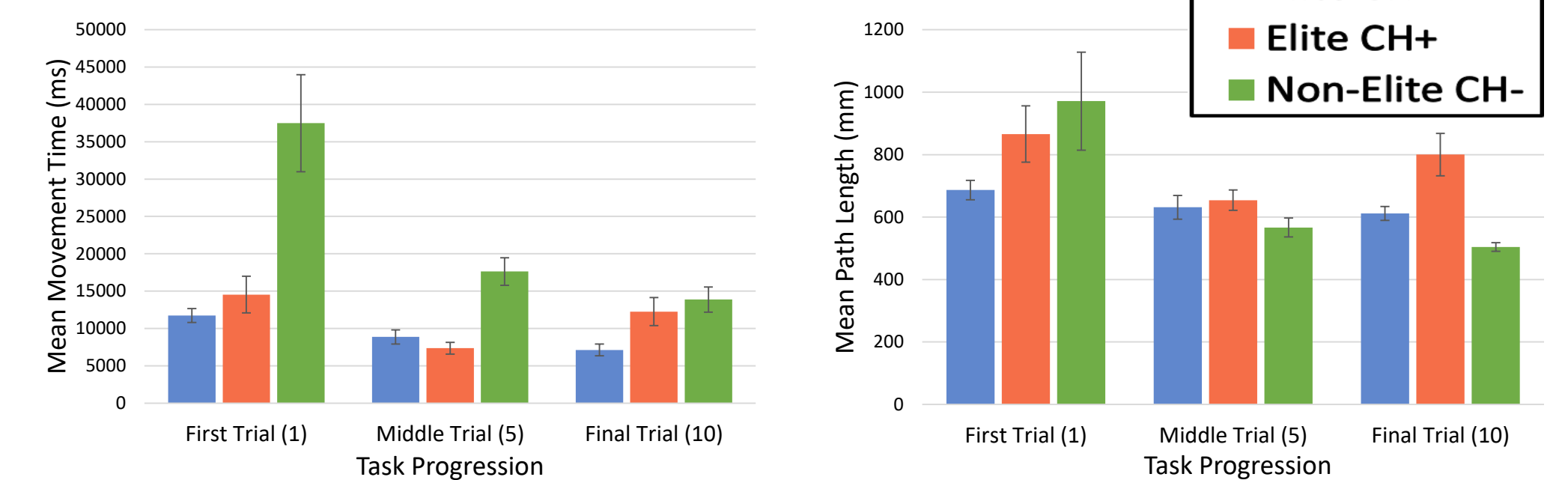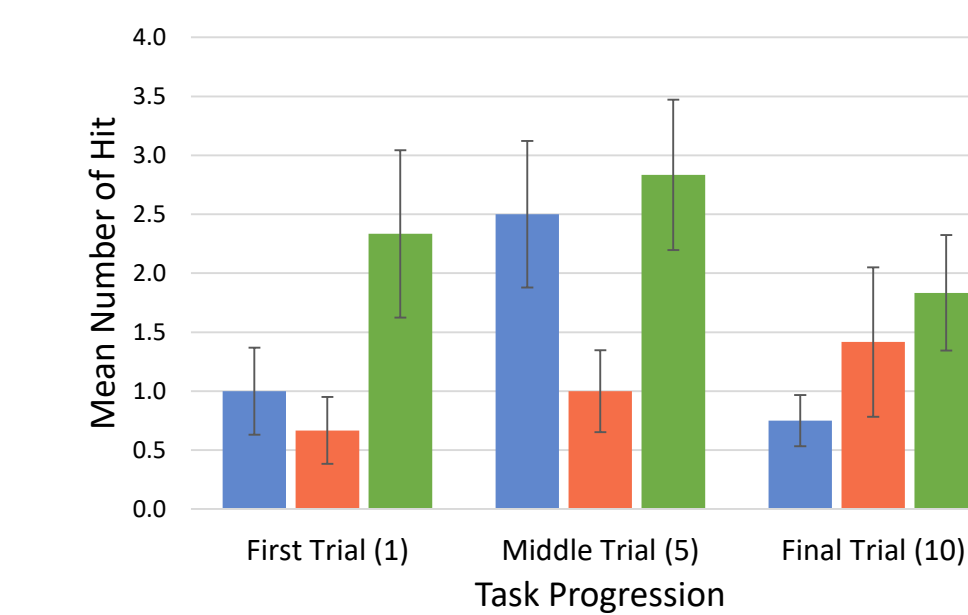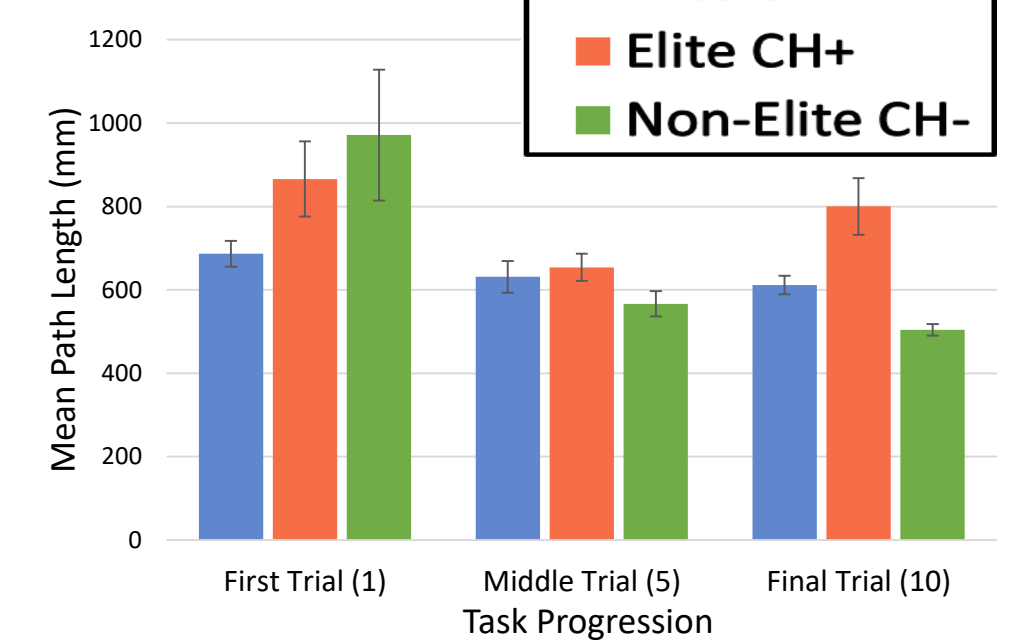
Figure 4: Scatter plot illustrating the mean performance percentages. The fastest time for each participant was used as a self-control value. A trendline is plotted to assist in the visualization of learning trends over the course of the experiment.

Between Groups Analysis: Performance Measures

Table 1: Groups performance outcomes recorded during the motor learning experiment.

	Groups		
	Elite CH-	Elite CH+	Non-Elite CH-
Mean Fastest Time (ms)	5759	5500	11778 **
Mean Slowest Time (ms)	14118	18718	38506 **
Mean Number of Obstacles hit over 10 trials	13	10	20 *
Mean Path Length (mm)	668	729	617
Mean Jerk (mm/ms³)	724	916	130 **

* Significant difference (p<0.05) between the Elite CH+ and Non-Elite CH- groups.

* * Significant difference (p<0.01) between the Elite CH- and Non-Elite CH-, and the Elite CH+ and Non-Elite CH- groups.

CONCLUSIONS

Between Groups: Analysis of Performance Measures
- The differences between the Elite CH+ and Elite CH- groups were not significant in key performance measures outlined in the goal of the task.
- The Non-Elite CH- group performed the task with a lower degree of visuomotor skill than the elite groups.

Within Groups: Analysis of Trends in Motor Learning
- The trends in motor skill learning during the progression of the 10 trials were similar between the Elite CH- and Non-Elite CH- groups.
- The Elite CH+ displayed variable and inconsistent learning trends over the course of the experiment.

Limitations: Further research sampling male CH+ Kinesiology students to investigate the visuomotor effect of concussion in non-elite population.

REFERENCES

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- Hurtubise, J., Gorbet, D., Hamandi, Y., Macpherson, A., & Sergio, L. (2016). The effect of concussion history on cognitive-motor integration in elite hockey players. *Concussion (London, England)*, 1(3), CNC17. doi:10.2217/cnc-2016-0006
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- Crawford, J. D., Medendorp, W. P., & Marotta, J. J. (2004). Spatial transformations for eye–hand coordination. *Journal of neurophysiology*, 92(1), 10-19.