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Optimizing Athletic Performance with Sports Vision Training (SVT): A Preliminary Study

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Abstract

A new avenue for elite athletes is “brain-centric” training that aims to train the brain to more efficiently process sensory information and produce superior movements. This could enable athletes to improve their reaction times and game readiness, thus leading to better results. This type of training will be of particular benefit in sports that rely on fast reaction times. It is easy to imagine that faster reaction times will improve performance of athletes in ball games such as ice hockey and baseball. However, in order to develop new, “brain-centric” training protocols it is important to measure effects on reaction times and changes in underlying brain activity.

This preliminary study used saccade latency, brain vital signals and hand-eye coordination measures to provide objective markers to evaluate the effects of a protocol of Sports-Vision Training (SVT)-enhanced ice hockey practice. This study showed that a 12 week SVT- enhanced ice hockey practice improved the brain signals N100, P300 and N400 as measured using the NeuroCatch Platform. These signals are indicative of cognitive processing speed, auditory sensation and basic attention. In addition, the average saccade latency was significantly reduced, while the number of targets hit within 30 seconds was significantly improved.

These improvements seen in this preliminary study warrant further research efforts into the mechanisms underlying these improvements.

Keywords: Cognitive training; saccade latency; perception; hand-eye coordination; neuronal plasticity; electroencephalography

Abbreviations: ERP = event-related potentials; ms = milliseconds; SVT = Sports Vision Training; VR = virtual reality

Introduction

A confluence of cognitive training, sports vision training (SVT) and motor learning has led to a new brain-centric avenue in performance training for elite athletes. Specifically, training the brain to efficiently process incoming sensory and cognitive signals to drive superior movements. These methods aim to improve brain function, visual perception, oculomotor or decision making skills [1].

SVT aims to improve visuomotor skills through exercises that stimulate the neural visual system and promote adaptive structural and functional changes [2]. Visuomotor skills are important in athletic performance as shown in collegiate level baseball players or elite skeet shooters [3–5]. Also, visual-perceptual and visual-cognitive skills are enhanced in elite athletes compared with non-athletes [6].

Portable technologies have made brain–training accessible for elite athletes. These machines provide objective measures of brain performance through brain vital signs or the saccade latency of the visual-oculomotor system. For example, a 6-week stroboscopic training program improved the reaction speed in volleyball players and use of stroboscopic eyewear induced a~18% improvement in on ice performance of professional ice hockey players [7, 8].

The aim of this preliminary study was to evaluate the effect of a 12 week SVT-enhanced training program on visual, hand--eye and cognitive performance markers in Junior-A league ice hockey players.

Materials & Methods

Study Design

The study included 22, male Junior-A league ice hockey players (mean age±SD= 18.6±0.8, range 16 years – 20 years) in a 12 week SVT-enhanced ice hockey training program during the 2023/2024 ice hockey season. Changes in the lineup resulted in some variation in n-numbers per measurement. The study design for all athletes consisted of a baseline measurement of event-related potentials (ERPs), 30 second hand-eye coordination target scores, and saccade latency. A 12 week SVT-enhanced ice hockey training program was carried out and followed by a repeat of those measurements. Athletes provided a general services consent and waiver prior to completing the NeuroCatch EEG scans to allow the use of their data in an anonymized way. These data were used in this retrospective, observational study.

SVT-Enhanced Training Program

Senaptec Sensory Station

The Senaptec Sensory Station (Senaptec Inc, USA) consists of a large touchscreen that displays a series of visual drills and requires a user response either via smartphone or by touching targets on screen. It has been validated for reliability and effectiveness [9, 10].

The Senaptec Sensory Station was used for two to four sessions per week, with each session lasting ☒10 and ☒60 minutes. Core drills included contrast sensitivity, near-far quickness, dynamic vision and Go/No Go drills as described elsewhere [11]. Training sessions were carried out in a group and testing sessions individually. Drills were progressed every week to maximize focus and engagement.

Stroboscopic Glasses

Senaptec Strobes stroboscopic glasses (Senaptec Strobe Elite, Senaptec, US) provided intermittent occlusion using liquid crystal technology. Athletes wore the glasses while performing hand-eye drills or balance drills to train visual tracking, anticipation, timing, and balance. Use of the strobes glasses was integrated into weekly Senaptec sensory training sessions.

Dual Tasking

Dual tasking was introduced to the Senaptec and Strobes training during SVT weeks 7-12. Dual tasking involved simultaneous balance and cognitive challenges, or balance and hand-eye coordination tasks.

Data Collection

Neurophysiological Data via NeuroCatch Platform

Brain vital signs were recorded using the NeuroCatch® Platform (Version 2.0). Athletes wore an EEG sensor cap, in–ear headphones and were seated in a quiet room. Athletes received passive, repeated auditory standard tones (80 dB) and random rare deviant tones (105 dB) ahead of basic spoken word pairs that either matched or were mismatched. Instructions were to decide if a word pair matches or not.

Senaptec Sensory Station

The assessment modules of the Senaptec Sensory Station were used to collect baseline and post–SVT-enhanced training program values. Thirty second hand-eye coordination was the only metric tracked for this study.

NeuroSync VR

The NeuroSync™ Virtual Reality (VR) goggles, were used to test the reaction time in the visual- oculomotor system. Data were recorded while athletes sat in a quiet room wearing the goggles. Following a calibration period, the 30 second test was run and the average saccade latency over the test period was reported.

Analyses

Recorded EEG traces were processed in Python as described elsewhere [12]. The numbers software was used to draw graphs and compute statistical analyses. One-tailed, paired T-tests were performed. P<0.05 was considered statistically significant. Results were presented as mean�s.e.m., unless otherwise specified.

Results

Differences in Cognitive Processing, Auditory Sensation and Basic Attention:

There was an improvement in N100, P300 and N400 metrics that were measured at T0 and T1, see Table 1. The latency in the N100 measure was significantly reduced at T1 compared to T0. There was no significant increase in P300 amplitude, if a threshold of $p<0.05$ was taken.

However, the confidence level for the improvement was 80.61%. Finally, the N400 amplitude was significantly reduced from T0 to T1.

Table 1: The N100 latency (ms) as a marker of sensory processing speed, P300 amplitude, as a metric of reaction time and N400 latency (ms) as a marker of cognitive processing speed and anticipation were measured before (T0) and after (T1) the 12 week SVT-enhanced training protocol.

	N100 latency (ms)		**P300 amplitude**		**N400 latency (ms)**	
	T0	**T1**	**T0**	**T1**	**T0**	**T1**
mean	108.32	94.37	6.11	7.07	466.1	382.1
STDEV	30.78	20.45	3.84	2.77	92.21	65.35
S.E.M.	6.56	4.36	0.82	0.59	19.66	13.93
P-value	0.04 (*)		0.10		0.00001 (****)	
Confidence level	91.68%		80.61%		100%	
n	19		21		20	

ms = milliseconds; n = number; S.E.M. = standard error of the mean; STDEV = standard deviation; T0 = measurements taken before 12 week SVT + ice hockey training; T1 = measurements taken after 12 week SVT-enhanced ice hockey training protocol.

Effect on Saccade Latency and Gross Motor Hand-Eye Coordination Scores

The average saccade latency was significantly reduced from 0.14±0.003 ms at T0 to 0.11±0.004 ms at T1 after 12 weeks of SVT -enhanced ice hockey training, see Figure 1A. Similarly, there was a significant improvement in number of targets hit within 30 seconds from 106.13±2.01 targets at T0 to 111.61±1.84 targets at T1, see Figure 1B.

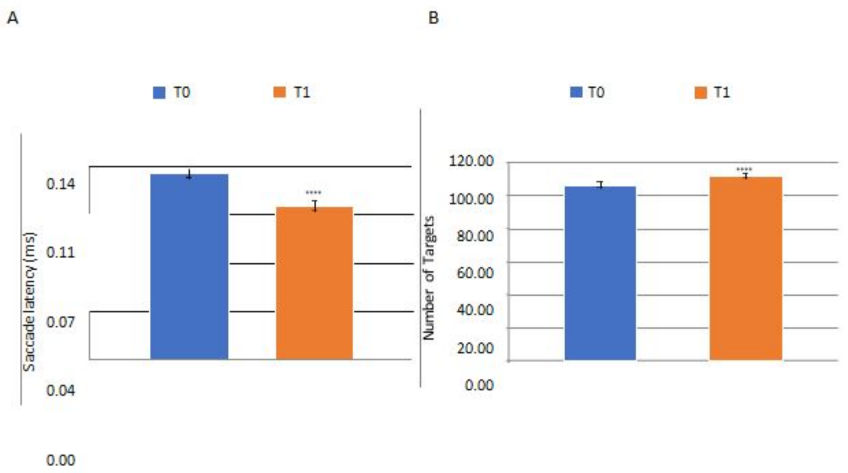

Figure 1: There was a significant improvement in saccade latency (A) and gross motor hand-eye coordination scores (B) between baseline values and post 12 week SVT-enhanced training values, n=20

ms = milliseconds; n = number; T0 = baseline; T1 = results after 12 weeks of SVT-enhanced ice hockey training

Discussion

In this preliminary study an improvement in cognitive function markers and athletic skills was demonstrated in Junior A team ice hockey players after a 12 week SVT-enhanced ice hockey training program. It was shown using objective and quantifiable neurophysiological measurements, oculomotor speed measurements and hand-eye coordination measurements.

The NeuroCatch platform was used to obtain auditory sensation (N100), basic attention (P300) and cognitive processing (N400) measurements [12, 13]. The N100 response has been localized to the primary auditory cortex and is associated with early cortical auditory sensory processing and selective attention. P300 responses are associated with engagement of cortical attention networks [12]. After 12 weeks of SVT-enhanced ice hockey training there were significant improvements in the N100 and N400 latency. The N100 latency was significantly reduced, meaning players were faster to react to auditory stimuli. With a confidence level of 80.61% there was an increase in P300 amplitude, see Table 1. Finally, the N400 latency was significantly reduced, again indicating a greater cognitive readiness of players.

Fickling and colleagues also used the NeuroCatch platform to compare pre-season with post- season N100, P300 and N400 signals in Junior A ice hockey players [13]. The N100 latency in Junior A players was significantly increased, indicating a slower reaction time and the amplitude of the signal was significantly reduced. This detrimental effect was correlated with the number of head impacts sustained during the season. There was no significant effect on P300 amplitude or N400 latency [14]. Similar patterns were observed in young American football players (13) and mixed martial arts athletes [15], who likely sustain head impacts.

It is tempting to speculate that the SVT element of the enhanced ice hockey training had a protective effect on brain vital signals. This could be through improved awareness during matches that allowed athletes to avoid head impacts or through a direct protective effect on brain vital signals. However, a larger follow up study with a control group would be needed to determine this. One limitation of this study is the lack of a control group. The number of athletes was restricted to a single Junior-A team. With this limited number of players, coaches needed to provide the same training opportunities to every player and ensure the entire team was optimally trained.

In the current study, the authors showed significant reductions in the saccade latency and significant improvements in the number of targets hit in 30 seconds (Figure 1). This is consistent with literature on the positive effects of vision-based training in other disciplines like baseball (3) or soccer [16]. An improvement in hand-eye coordination and reaction speed was shown in soccer goal keepers after a 7 week SVT regime [16]. Improved saccade latency and hand-eye coordination are likely closely related to changes seen in N100 and N400 brain signals. N100 signals are indicative of pre-processing of sensory information, while improvements in N400 signals likely indicate an increased readiness to make decisions. Both factors are essential skills in ice hockey and it is likely that SVT positively affected the objective measurements taken in this study.

Conclusions

This study demonstrated an improvement in visual, hand-eye and cognitive performance markers in Junior-A league ice hockey players after a 12 week SVT-enhanced ice hockey training program. The results support further research into brain-based training programs to optimize game readiness and possibly provide some neuroprotective benefits.

Practical Implications

- SVT-enhanced ice hockey training leads to improved saccade latency and hand-eye coordination.
- SVT-enhanced ice hockey training leads to measurably improved brain vital signals.
- Follow up, controlled studies are needed to determine if these measurable improvements are due to SVT.

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