Article ▸ # A Vision Training Program's Impact on Ice Hockey Performance

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ABSTRACT

Background: This study was carried out to determine whether a preseason vision training program would improve visual skills and season success in a Division I men's ice hockey team.

Methods: A six-week vision training program was implemented with the Ferris State University Men's Ice Hockey team during their pre-season workouts. Vision training incorporated binocular and accommodative training along with dynamic visual skills training.

Results: The study showed an improvement in base out vergence ranges, binocular accommodative facility, and Wayne Saccadic Fixator (WSF) scores and was viewed by players to have made a positive impact on their individual performance. The pre- and post-vision training goals, shots on goal, and shooting percentage all significantly improved following training.

Conclusion: The vision training program during preseason workouts had a positive impact on the players' visual skills important for hockey. The players' perception of their vision and how they were using their vision during competitive play also showed a significant change. The majority of the players felt that vision training was an effective use of their practice time allotted by the NCAA.

Keywords: ice hockey, sports vision training, vision therapy, visual skills

Introduction

When watching a professional or collegiate-level athlete in competitive play, it is evident that vision is the dominant sensory system. The game is occurring at such a fast pace that the athlete must quickly and efficiently use their vision to perceive what is happening. The input of visual information is processed by the brain, which then must interpret the information and send a signal to the body to make the appropriate physical response. The visual skills of an athlete go beyond static visual acuity. Athletes must use their vision dynamically. The dynamic visual skills include stereo acuity, visual attention, eye movements, dynamic acuity, reaction time, peripheral awareness, visual direction, and anticipation.[1]

Sports teams devote many training hours and funds to nutritional supplements, strength and conditioning, rehearsal of plays, and other drills to keep their players in peak physical condition. In contrast, for the average team, there is very little to no time devoted to training the visual system. Some organizations, such as the United States Air Force Academy, implement vision training for their varsity athletes, and the IMG Academy's NFL Combine Training Program has a vision training program in its curriculum.[2,3]

The University of Cincinnati baseball team implemented a six-week pre-season vision training program during their 2010-2011 season and determined that a vision training program as part of conditioning and injury prevention can improve batting parameters.[4]

The captivation with vision and sports began with Babe Ruth. Ruth's eyes and brain were evaluated by Columbia University in 1921, where researchers in the psychology department determined that he was 12% faster and 90% more efficient than the average person.[5] As a trend, when compared to the average person, athletes have superior visual skills in areas such as visual acuity, contrast sensitivity, stereoacuity, dynamic acuity, and reaction time.[6–9] When broken down by individual sports, a baseball player may have enhanced vision in different areas compared to a track and field athlete.[10] Visual skills important for hockey players are peripheral vision, visual reaction time, visual acuity, and eye movements. Within hockey, each player's position may also require different visual skills. For example, in a study by Bhanot and Sidhu, defenders in field hockey have faster reaction times than do the midfielders.[11]

Vision therapy has been implemented for binocular conditions often seen in children and adults. Research has shown that ocular conditions such as convergence insufficiency can be managed with a twelve-week in-office vision training program.[12] Other research has shown that dynamic visual attributes of athletes can also be trained. In a study of Little League baseball players, the number of hits in a batting cage improved by 90% after training eye movements with the EYEPORT™.[13] Previous research supports that stroboscopic training improves anticipation and attention.[14,15] Stroboscopic training for the Carolina Hurricanes improved players' performance of an on-ice drill.[16] It has also been demonstrated in baseball players that better scores on a tachistoscope test are correlated to better batting averages.[17]

There has not been significant research dedicated to a vision training program containing both binocular vision training and dynamic visual skills training in athletics. The question of whether those skills can be trained to a higher level and, as a result, improve competitive play is ambiguous and has been challenged by some.[18] This research is seeking to determine whether training binocular vision and dynamic visual skills important in hockey during the off-season will reap benefits during the season for a Division I college men's ice hockey team.

Methods

Participants

In this study, 22 Ferris State University male ice hockey players, freshman through senior year, were recruited before preseason training for the 2013-2014 season.

Procedure

Pre-Training Evaluation:

All athletes completed a comprehensive eye examination at the Michigan College of Optometry University Eye Center to determine the participant's ocular health and refractive status. The comprehensive examination comprised the following parts:

Pre-testing: Sports case history (Appendix A), distance and near monocular and binocular visual acuity with the Snellen chart, cover test distance and near with best correction, extraocular muscle evaluation, confrontation fields, pupils, retinoscopy and subjective refraction, intraocular pressure measured with Goldmann tonometry, and dilated fundus evaluation.

Visual Analysis: Ocular dominance testing, monocular estimation method near point retinoscopy, near Maddox rod with Saladin card in 5 positions of gaze, near point of convergence, stereo acuity with the Randot Stereo Test, binocular accommodative facility with +/-2.00 flippers and Borish card for suppression check, and distance and near base in and base out prism bar vergence ranges.

M&S Technologies Eye Check Sports Vision Screening: Each athlete completed the M&S Technologies Sports Vision Screening, comprising visual acuity, contour stereo, random dot stereo, contrast sensitivity, and contrast sensitivity with glare. The players' performances were compared to the database of professional baseball players within the software.

Player Survey: Survey administered to measure each athlete's perceived ability (Appendix B). The survey was administered three times. The first administration was before training began, the second was after the six weeks of training, and the final administration was at the conclusion of the season.

Demonstration on Sports Vision Training. *Photo Credit: ©2013, Bill Bitzinger, University Photographer, Michigan College of Optometry, Ferris State University, Big Rapids, Michigan*

Sports Vision Training:

Following the determination of the best corrected refractive error and normal ocular health, players began the sports vision training program. Players with significant refractive error wore their best correction in contact lenses during the training. Vision training was done within the hockey team's training complex. Players were scheduled to rotate through vision training along with strength and conditioning training for their preseason workouts. Vision training was done 2-3 times per week for twenty-minute sessions during the 6 weeks, resulting in thirteen sessions.

There were 6-10 players in the vision training room at a time. Players were paired up as they went through each of the training activities for the day. Two optometrists were present at each session to conduct the training.

Training began with lower-level visual skills and progressed as players began improving with each activity until they reached the endpoints. Training activities included the following:

Basic binocular vision skills: Brock string, vectograms, eccentric circles, accommodative facility, Hart charts, and rotators.

Dynamic hockey visual skills: Wayne Saccadic Fixator, Nike SPARQ Vapor Strobe glasses (stroboscopic training), card catch, bean bag toss visualization, and tachistoscope activities.

Each player was given an activity sheet where they documented their performance daily. On the activity sheets, players could see each activity's endpoint and the daily performance goal to achieve the endpoint. At the conclusion of the 6 weeks of preseason vision training, the Visual Analysis, M&S Technologies Eye Check Sports Vision Screening, and Player Survey were conducted again.

Throughout the season, vision training was performed four times during bye weeks or weeks that the team's schedule allowed. At the end of the season, the players completed the Player Survey again with the addition of two open-ended questions: "Did this program benefit your hockey skills? If so, how?" and "Would you recommend this program continue?"

Results

Dropouts

Of the twenty-two players enrolled in the study, not all participated in each of the thirteen training sessions due to injuries, class schedules, or other appointments (Figure 1). Re-evaluations were completed by all participants, and all three survey administrations were

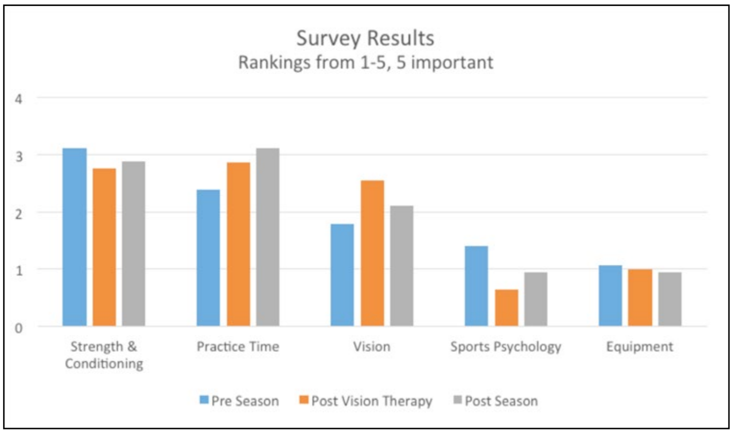

Figure 1: *Survey Results*

completed by all participants, except the final survey, which was completed by nineteen of the twenty-two players.

Case History Data

On average, each player had been playing ice hockey for 16 years. Of the players, 78% were right handed, 95% were right footed, and 61% were right eye dominant. Ten of the players had never had a comprehensive eye examination. One player had previously participated in a vision training program. There were six players who wore soft contact lenses and one who was corrected with LASIK. Just over 50% of the players reported at least one previous head injury. Of those 12 players, the average number of head injuries was two.

Visual Analysis Data

Visual acuity, accommodative posture (MEM), binocular accommodative facility, bar vergence ranges, and stereoacuity were analyzed. The mean entering logMAR acuity was -0.05 (SD=0.07) in the right eye and -0.034 (SD=0.11) in the left eye. MEM showed an average entering lag of +0.35 D (SD=0.31) in the right eye and +0.30 D (SD=0.30) in the left eye. There was no statistically significant difference between pre and post measurements for MEM and visual acuities.

The mean pre binocular accommodative facility was 9.4 cpm, and the mean post binocular accommodative facility was 12.98 cpm; this is statistically significant ($t(22)=-4.2$, $p= 0.000$). The mean difference of 7.74 prism diopters found between the pre and post distance base out break was found to be statistically significant ($t(22)=-5.867$, $p=0.000$). There was a statistically significant difference between the pre and post mean distance base out recovery ($t(22)=-6.136$, $p=0.000$). The pre and post mean near base out break and recovery were also statistically significant. A difference of 4.39 prism diopters was found between the mean near pre and post base out break ($t(22)= -2.152$, $p=0.043$). The mean near pre base out recovery, 17 prism diopters, and mean near post base out recovery, 21.52 prism diopters, showed a significant difference ($t(22)=-2.821$, $p=0.010$). There was no statistically significant difference between the pre and post mean distance base in break ($t(22)=-1.785$, $p=0.088$) and recovery ($t(22)=-0.581$, $p=0.567$). The difference between the mean pre and post near base in break and recovery were also not statistically significant: break ($t(22)=-1.019$, $p=0.319$) and recovery ($t(22)=-0.331$, $p=0.744$) (Table 1).

There was no significant difference between the mean pre and post local stereoacuity ($t(22)=1.761$, $p=0.092$). The average post local stereoacuity was 25.8 arc sec (SD=9.1). All players had global stereopsis pre and post.

Information from vision training

The scores from the Wayne Saccadic Fixator (WSF) were analyzed. The mean of the first three binocular scores were averaged, and the mean of the last three binocular scores were averaged. These scores were then compared, and the results show a statistically significant difference. The initial average score was 90.87, and the ending average score was 110.70 ($t(20)=-14.087$, $p<.000$).

Information from player survey

The only question with a significant difference between survey administration 1 (before training) and survey administration 2 (after training) was how the players ranked

Table 1: Number of Sessions Completed

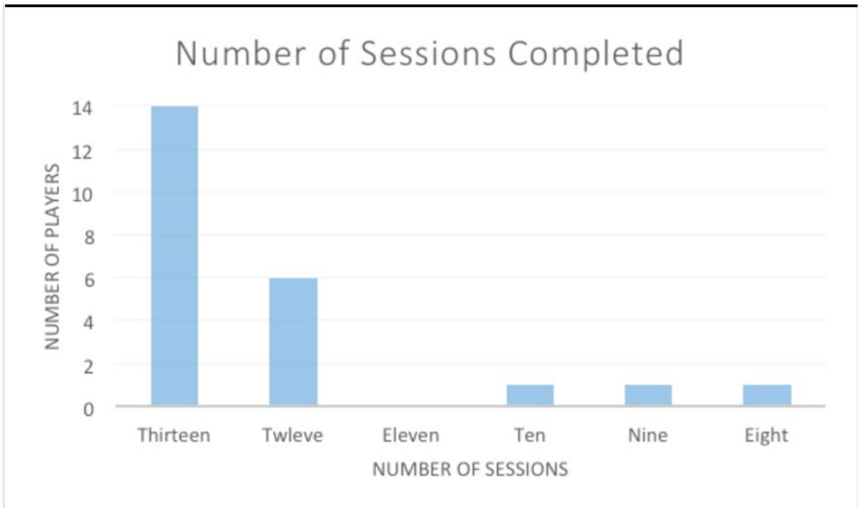

Table 2: Summary of Statically Significant and Non-Significant Visual Skills

Statistically significant findings					
	Pre, prism diopter		Post, prism diopter		Significance
	Mean	SD	Mean	SD	p
BO distance break	9.9	4.6	17.6	4.9	0.000
BO distance recovery	7.2	4.9	13	4.9	0.000
BO near break	22	11.09	26.4	11.09	0.019
BO near recovery	17	9.9	21.5	9.9	0.001
	Pre, cpm		Pre, cpm		
Binocular Accommodative Facility	9.4	3.64	12.98	2.88	0.000

Statistically significant findings					
	Pre, prism diopters		Post, prism diopters		Significance
	Mean	SD	Mean	SD	p
BO distance break	5.3	1.7	6.0	2.4	0.088
BO distance recovery	3.4	4.9	13	4.9	0.000
BO near break	12.4	4.3	13.22	4.9	0.319
BO near recovery	9.8	4.1	10	4.1	0.744
	Pre, seconds of arc		Post, seconds of arc		
Stereoacuity	33.7	27.56	25.87	9.12	0.092

Table 3: Summary of comments from open-ended questions

	NEGATIVE/NEUTRAL 2 TOTAL COMMENTS	**SAMPLE OF POSITIVE 17 TOTAL COMMENTS**
DID THIS PROGRAM BENEFIT YOUR HOCKEY SKILLS?	Not really	Yes, better vision on the ice to find players
		Yes, helps me keep track of the puck on the ice better
	I didn't notice a difference, but there may have been one	Yes, can use my peripheral vision better/reaction time
		Yes, personally I think it helped not only my vision, but my hand-eye coordination as well. Everyone thinks they have good vision, I know I did before we started vision training. The program quickly showed that we had gains to make and I feel I made a good amount of gain from it
WOULD YOU RECOMMEND THIS PROGRAM CONTINUE?	Yes/No, my vision was great to start with, maybe for some that need help would want this to continue	Good use of time and helped a lot
	Undecided	Very beneficial
		We should always be looking to other ways to out-train our opponents.

vision on the scale of importance. Players were asked to rank from 1 to 5 the importance of Equipment, Strength and Conditioning, Sports Psychology, Vision, and Practice Time, with 5 being the highest importance. The average rank for vision preseason was 1.78, and following training, vision was ranked 2.55 (t(20)=-14.08, p=.000).

The survey was repeated a third time at the completion of the season, and the results were again compared to the entering survey results. The two areas that showed a statistically significant difference were Practice Time and Sports Psychology. Practice time was ranked more important at the end of the season: average ranking entering 2.39, average ranking post season 3.11 (t(17)=2.50, p<0.023). Sports Psychology was ranked less important at the end of the season: average ranking entering 1.39, average ranking post season 0.94 (t(17)=-2.204, p<0.042)(Figure 2).

The two open-ended questions were asked at the end of the season: “Did this program benefit your hockey skills? If so, how?” and “Would you recommend this program continue?” Two of the responses were neutral, and 17 were positive (Table 2).

The team had a successful year in which they played 43 games during the 2013-2014 season. They had 138 goals and 222 assists. The team averaged 3.21 goals/game and 29.9 shots/game.

A paired-samples t-test was conducted to compare pre-vision training and post-vision training shots on goal, goals, and shooting percentage (goals/shots on goal). This data was collected and analyzed from the 2012-2013 and 2013-2014 season statistics for players who participated in the study. The players who were freshmen during the vision training were not included in this analysis because they had no previous season statistics. There was a statistically significant difference in the mean pre-vision training shots on goal (m=39.250, SD=25.288) and post-vision training shots on goal (m=61.000, SD=34.333; t(11)=-3.262, p=0.008). There was a statistically significant difference in the mean pre-vision training goals (m=3.000, SD=3.411) and post-vision training goals (m=7.000, SD=5.205, t(11)=-3.778, p=0.003). There was a statistically significant difference in the mean pre-vision training shooting percentage (m=6.3%, SD=6.2%) and post- vision training shooting percentage (m=11.0%, SD=4.5% t(11)=-2.598, p=0.025). These results suggest that players’ performances improved post-vision training with there being an increase in the number of shots on goal, the number of goals, and the shooting percentage.

The team finished first in the Western Collegiate Hockey Association and was ranked 5th by the NCAA going into the championship games. To end their season, FSU lost in double overtime during the second round of championship play.

Discussion

The six-week vision training program focused on improving two areas: binocular vision skills and dynamic visual skills important in hockey. Binocular visual skills are classified as vergence and accommodation. Dynamic skills are reaction time, eye movements, visual memory, and peripheral awareness. The binocular vision skills were trained with vectograms, lenses, distance and near letter charts, and eccentric circles. The dynamic vision skills were trained with the WSF, tachistoscope, McDonald Form Field, rotating pegboard, and Nike SPARQ Vapor Strobe glasses.

The primary outcome for binocular vision skills was base in and out vergence ranges and binocular accommodative facility. The outcome for dynamic vision skills was measured with the WSF scores. The base out vergence ranges, binocular accommodative facility, and WSF scores were positively impacted by the vision training regimen.

The ability to improve these skills is significant for the hockey athletes because improving those visual skills through training may positively impact their competitive performance. Vergence, accommodation, and reaction time are important for tracking and reacting to the puck, making split second decisions, and perceiving what other players are doing around them. This was demonstrated in analysis of the goals, shots on goal, and shooting percentages, which all improved during the season in which vision training was implemented.

The results of the surveys show that following vision training, the players ranked vision as more important to success in their sport immediately following the training program. The open-ended questions at the completion of the season revealed that the players saw value in spending training time working on visual skills. It may be inferred from the change in binocular vision status, improvement on the WSF, and positive survey results that the vision training positively impacted the players' performances and perception of how they were using their vision before and after the training program.

Other interesting data revealed that this group of athletes was underutilizing eye care; 10/22 or 45% of players had never had an eye exam. Similar results were concluded from a study of the athletes participating in the 1997 and 1998 AAU Junior Olympics.[19]

A study done at Duke University with an NHL men's ice hockey team showed that the players' performance of an on-ice skating and shooting task improved following a stroboscopic vision training program.[16] In similar fashion, an improvement for future design in following up this study would be to include and on-ice/field training task. This type of study design helps to dispel the popular theory that vision training does not transfer to athletic play.

Conclusion

This study concluded that a six-week vision training program during preseason workouts had a positive impact on visual skills that are important in hockey including basic binocular vision skills and visual reaction time. You would expect these results because this training combined vergence and accommodation training along with training dynamic visual skills. The ability to improve these skills is important for the hockey player because these visual skills are used while playing the sport.

The players' perception of their vision and how they were using their vision during competitive play was also positively impacted. The vast majority of the players felt that vision training was an effective use of their practice time allotted by the National Collegiate Athletic Association.

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Appendix A

Athlete Case History

1. How many years have you played hockey?

2. How many years have you been on the FSU Hockey team?

3. What position do you play?

4. Are you right or left handed?

5. Are you right or left footed?

6. Have you ever had a complete visual exam by an eye care provider? Yes / No
   If yes: When was your first exam? When was your most recent exam?

7. Have you ever been involved in a vision training program? Yes / No
   If yes: When and for what reason?

8. Do you wear glasses? Yes / No
   If yes: How old are they? Are they satisfactory?
   When are they used? (Near, Distance, Both, during sports)

9. Do you wear contact lenses? Yes / No If yes: What type? (Soft, Hard)
   Do you presently wear them during your sport?
   Do you wear them all day?
   When did you have your lenses last checked by your doctor?

10. Do you ever see blur? Yes / No

11. Do you ever see double? Yes / No

12. Do you ever notice variations in your performance during a game? Yes / No

13. Do you experience loss of concentration during sports performance? Yes / No

14. Have you suffered a head injury? Yes / No How many?

Appendix B

Player's Survey

1. Do you feel vision is important to hockey? Yes / No
2. Do you use visualizations/imagery techniques? Yes / No
3. Do you feel you use your visual system to its max potential? Yes / No

Rate the following items:

	Very Poor	Poor	Neutral	Good	Very Good
How well do you feel you currently use your visual system during games?					
How well do you use your peripheral vision?					
How well do you keep track of the puck during games?					
How well are your vision care needs met?					
	Never	**Seldom**	**Occasionally**	**Frequently**	**Always**
How often do you lose focus during a game?					
Do you feel your eyes ever hinder your ability to play hockey?					
How often do you lose track of the puck during a game?					
How often do you know where every player is on the ice?					

Rate the following in order of importance for improving your ability to play hockey?
[5 being the most important and the highest]

_______Equipment

_______Strength and Conditioning

_______Practice time

_______Vision

_______Sports Psychology