

Enhancing Ice Hockey Skills Through Stroboscopic Visual Training

A Pilot Study

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■ ABSTRACT

Recent research has suggested that a new sport training tool may enhance vision, attention, and response timing. The tool, stroboscopic eyewear, includes lenses that alternate between transparent and opaque states to produce stroboscopic visual conditions. Previous research has demonstrated that stroboscopic training can improve visual abilities, but can stroboscopic training affect sport performance directly? The current pilot study explored this question by assessing athletic skill in professional ice hockey players. Participants trained either with stroboscopic eyewear (strobe group) or with no eyewear (control group). The strobe group averaged an 18% improvement in on-ice skill performance from pretraining to posttraining, whereas the control group's performance did not improve. The current results demonstrate improvement in the athletic skill of professional athletes with training that added one new component—wearing stroboscopic eyewear—to their normal routines. [*Athletic Training & Sports Health Care*. 2013;5(x):xxx-xxx.]

Sports often involve dynamic activities that require participants to be at the right place at the right time—a baseball player must accurately judge the

timing and location of a pitched ball, an American football player needs to correctly judge the speed and location of a competitor, and an ice hockey player must be able to precisely time and locate a constantly moving puck. Such tasks are at the core of performing well in a sport, and any improvement could dramatically impact performance.

Recent research has suggested that a new sport training tool, Nike SPARQ Vapor Strobe eyewear (Nike Inc, Beaverton, Oregon), can improve vision, attention, and anticipatory timing.¹⁻³ Those studies found improvement in cognitive abilities after training in suboptimal visual conditions, which is in line with related work on intermittent vision.⁴⁻⁹ Specifically, when participants engaged in physical activities (eg, playing catch) while experiencing only momentary exposures of the visual world, they subsequently demonstrated enhanced perceptual and attentional abilities.

These new findings are intriguing but leave an important question from a sports perspective unanswered—can the observed enhancements to vision, attention, and anticipatory timing translate directly to increased sport performance and injury prevention?

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Dr Mitroff reported serving on the Nike SPARQ Advisory Board and reported receiving a previous grant and travel support from Nike Inc outside of the current work. Mr Friesen reported having received travel support from Nike Inc. The remaining authors have no financial or proprietary interest in the materials presented herein.

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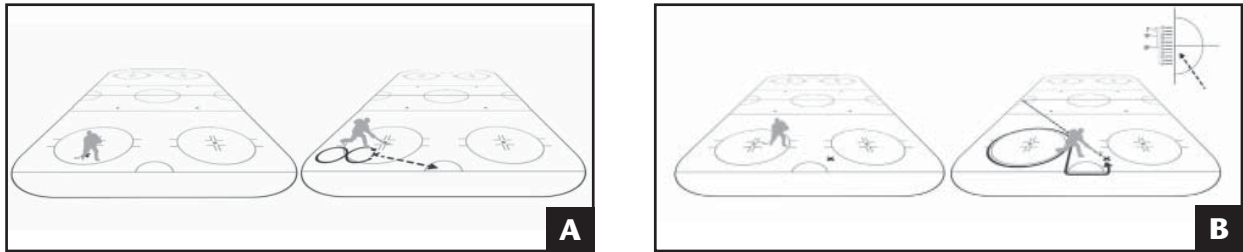


Figure. (A) Forwards' pretraining and posttraining assessment. A puck was placed on an X that was painted on the ice 2 feet from the goal line, between the goal line and the face-off circle. The participants were to take the puck and skate a figure-8 pattern in the direction of the boards of the hockey rink. On returning to the X, the participants took a slapshot to put the puck into the goal. One point was awarded for each successful shot, for a maximum of 20 points. (B) Defensemen's pretraining and posttraining assessment. Participants started with a puck placed on the inside of the face-off circle. The participants skated a full circle behind and around the net to an X painted on the ice 2 feet from the goal line and 6 feet from the near goal post. When the participants reached the X, they were to make a long pass to the opposite side of the ice, where the red line (middle line) meets the boards of the rink. Scoring was determined by a grid painted on the ice where the red line meets the boards, for a maximum of 60 points.

The goal of the current field study was to implement a research training protocol with elite athletes and, with direct assessments of sport-related performance, to extend this previous research into the sports arena. This study represents a pilot research project that added one training component to a professional sports team's established training regimen, thus offering access to a specialized and elite participant pool. Such an approach has limitations (eg, small number of participants, lack of control over the nature of training regimens), but it can offer important pilot data to inspire future work.

METHOD

The current study was conducted with professional ice hockey players from the National Hockey League's (NHL) Carolina Hurricanes. Testing and training were completed at the team's preseason training camp between August 22 and September 14, 2011. All testing was conducted by the team's athletic training staff. Participation was voluntary and no benefits or penalties were offered to encourage participation. The experimental methods were constrained by the field study aspects of the research—the athletes were engaged in their normal activities for preseason camp (ie, some were trying to make the team). The study was approved by Duke University's institutional review board.

Participants

Eleven players participated in the study (7 forwards and 4 defensemen). The 11 volunteers were divided by position (forwards vs. defensemen), and then their names were randomly drawn for assignment to either the strobe group, composed of 6 participants (4 forwards, 2 defensemen), or the control group, composed

of 5 participants (3 forwards, 2 defensemen). No significant differences were noted between the strobe and control groups in the following demographics (all P values were $> .36$): average age, strobe group = 23.67 ± 3.08 years, control group = 25.20 ± 1.92 years; years since drafted into the NHL, strobe group = 4.67 ± 2.66 , control group = 5.80 ± 3.03 ; average draft round (the draft is composed of 7 rounds; lower numbers represent being selected sooner), strobe group = 2.34 ± 1.03 , control group = 3.40 ± 2.51 ; and years of NHL experience, strobe group = 2.00 ± 1.79 , control group = 3.20 ± 2.77 . Seven participants began the subsequent hockey season with the NHL franchise (4 from the strobe group) and 4 began the season with the team's minor league affiliate of the American Hockey League (2 from the strobe group).

Study Design

The experiment consisted of 3 phases: pretraining assessment, training, and posttraining assessment. The pre- and posttraining assessments, designed by the team's athletic trainers to be challenging, were identical and included drills not typically conducted by the participants (nor were they done during the training phase). The pretraining assessment was performed before the participants were assigned to groups, and the posttraining assessment was done 24 hours after the final training session.

In the pre- and posttraining assessment of the forwards (Figure, A), the player used his hockey stick to take a puck placed on an X marked on the ice 2 feet from the goal line and then skated a figure-8 pattern while moving the puck with his stick. When he returned back to the X mark, he took a slapshot to put

TABLE

Raw Scores and Percent Change for Each Participant by Group

GROUP/POSITION	PRETRAINING SCORE ^a	POSTTRAINING SCORE ^a	IMPROVEMENT (%)
Strobe group			
Forward	12/20	14/20	17
Forward	7/20	9/20	29
Forward	10/20	12/20	20
Forward	9/20	10/20	11
Defenseman	37/60	43/60	16
Defenseman	31/60	36/60	16
Average (SD)			18 (6)
Control group			
Forward	12/20	11/20	-8
Forward	12/20	13/20	8
Forward	12/20	10/20	-17
Defenseman	31/60	35/60	13
Defenseman	35/60	32/60	-9
Average (SD)			-2 (13)

^a Forwards could achieve a maximum score of 20; defensemen could achieve a maximum score of 60.

the puck into the goal. After 2 practice trials, 10 shots from each of the left and right sides of the net were completed (1 point was awarded for each successful shot, for a possible total of 20 points). For the defensemen's assessments (Figure, B), the player used his stick to take a puck from the inside part of the face-off circle and then skated a full circle behind and around the net. When he reached an X marked on the ice 2 feet from the goal line and 6 feet from the goal post, he made a long pass to the opposite side of the ice where the red line meets the boards of the hockey rink. Five points were assigned if the participant accurately placed the puck on the red line, and then 4, 3, 2, and 1 points were earned for each 2-foot increment from the red line (in both right and left directions). After 2 practice trials, 6 shots from each side of the net were completed (60 total points could be earned).

For the training phase, all study participants engaged in normal training camp activities, except those who were in the strobe group wore Nike SPARQ Vapor Strobe stroboscopic eyewear (model #AC1937) one time each day for a minimum of 10 minutes per day for 16 days. The eyewear uses liquid crystal lenses that can alternate between clear and opaque states to create a stroboscopic visual experience. The flicker rate can vary through 8 levels, where the clear

state is held constant at 100 ms, and the opaque state ranges from 67 to 900 ms. The stroboscopic training involved a range of natural activities in which professional hockey players engage, such as on-ice skills (eg, skating, passing) and off-ice skills (eg, balance and conditioning drills). Given the pilot nature of this study, and the implementation of the training into the players' existing training regimens, the exact drills and timing of the stroboscopic experiences were not regulated or recorded.

RESULTS

The Table shows each participant's pre- and posttraining scores and their percent of change. An analysis of covariance (ANCOVA) with pretraining performance as the covariate and posttraining performance as the dependent variable produced a significant effect of group ($F_{1,10} = 7.20, P = .028$; data were collapsed over forwards and defensemen). Follow-up, 1-tailed, t tests revealed that the strobe group significantly improved from pretraining to posttraining ($t_5 = 3.67, P = .007$) but the control group did not ($t_4 = 0.16, P = .440$). The strobe and control groups showed dramatically different patterns; all of the strobe participants improved (mean = 18.12%), but only 2 of the 5 control participants improved (mean = -2.47%; $t_9 = 3.61, P = .006$).

Follow-up repeated measures analysis of variance was performed with a within-subject factor of assessment phase (pre- versus posttraining assessment) and a between-subject factor of training condition (strobe versus control). This additional analysis was performed because it can assess main effects and interactions and because a repeated measures test is unaffected by different scoring scales across participants (ie, it does not matter that the forwards' scores were a possible maximum total of 20 and the defensemen's scores were a possible maximum total of 60). No significant main effect of assessment phase ($F_{1,9} = 3.79$, $P = .083$, partial eta squared = 0.296) or training condition ($F_{1,9} = 0.02$, $P = .889$, partial eta squared = 0.002) was noted. In support of the ANCOVA, there was a marginally significant interaction between the assessment phases and the training condition ($F_{1,9} = 4.95$, $P = .053$, partial eta squared = 0.355).

DISCUSSION

In agreement with previous research,¹⁻⁴ the current study results indicate that stroboscopic training could enhance performance. In addition, this study of professional athletes demonstrates such benefits by directly assessing sport performance. In short, professional ice hockey players performed better at relevant skills in their sport (goal scorers [forwards] became better at scoring goals and defensemen became better at making long passes) after wearing stroboscopic eyewear during their normal practice activities. Previous research suggests that stroboscopic training enhances visual and attentional abilities^{1,2} and anticipatory timing,³ and we found that changes to these underlying attentional and visual mechanisms can manifest in measurable benefits in sport performance.

The current data represent a first-step, pilot study with elite performers; however, more work will be needed to address a number of limitations. First, there were only 11 total participants, which limits the ability to conduct nuanced evaluations. Second, training studies with multiple conditions are open to concerns about participant motivation; however, previous results¹ suggest that motivational and placebo effect concerns may not be warranted. Finally, there was considerable variability in the nature of the training. Participants were free to use the stroboscopic eyewear as they wished, as long as they wore the eyewear for at least 10 minutes each day. This reflects the

field study nature of this project—the athletes were engaged in their own activities; we simply added the eyewear to the training. This variability is not different from previous studies with the eyewear,^{1,2} and any effects that were found suggests that the training may be a general form of learning that is not linked to specific learning conditions or timing.¹ Future work can use a more regimented training procedure, as this initial pilot study has suggested that stroboscopic training might produce benefits for increased sport performance.

IMPLICATIONS FOR CLINICAL PRACTICE

The current experiment provides an initial case study that suggests sports performance can be enhanced through stroboscopic training. Variants of this basic concept (eg, a classic American football practice drill is to have players catch passes while a pad is moved in and out of their line of sight) have been used, but, to our knowledge, this is the first examination of the effect, which was performed in a way to quantify the participant's enhancement. These results suggest that coaches and athletic trainers interested in using stroboscopic vision to improve performance could incorporate stroboscopic training into their existing drills. Moreover, we believe these results are especially compelling, given that we observed an 18% improvement in professional athletes 24 hours after their last training exposure. The clinical implications of this type of training on injury prevention are both exciting and unexplored, and this pilot study may lead to additional investigation. ■

REFERENCES

1. Appelbaum LG, Schroeder JE, Cain MS, Mitroff SR. Improved visual cognition through stroboscopic training. *Front Psychol*. 2011;2:276. doi:10.3389/fpsyg.2011.00276
2. Appelbaum LG, Cain MS, Schroeder JE, Darling EF, Mitroff SR. Stroboscopic visual training improves information encoding in short-term memory. *Attent Percept Psychophys*. 2012;74(8):1681-1691. doi:10.3758/s13414-012-0344-6
3. Smith TQ, Mitroff SR. Stroboscopic training enhances anticipatory timing. *Int J Exerc Sci*. 2012;5(4):344-353.
4. Bennett S, Ashford D, Rioja N, Elliott D. Intermittent vision and one-handed catching: the effect of general and specific task experience. *J Mot Behav*. 2004;36(4): 442-449.
5. Lyons J, Fontaine R, Elliott D. I lost it in the lights: the effects of predictable and variable intermittent vision on unimanual catching. *J Mot Behav*. 1997;29(2):113-118.
6. Reschke MF, Krnavek JM, Somers JT, et al. Stroboscopic vision as a treatment for retinal slip induced motion sickness. In: Proceedings from the First International Symposium on Visually Induced

- Motion Sickness, Fatigue, and Photosensitive Epileptic Seizures (VIMS2007); December 10-12, 2007; Hong Kong.
7. Reschke MF, Somers JT, Ford G. Stroboscopic vision as a treatment for motion sickness: strobe lighting vs. shutter glasses. *Aviat Space Environ Med.* 2006;77(1): 2-7.
 8. Senders JW, Kristofferson AB, Levison WH, Dietrich CW, Ward JL. The attentional demand of automobile driving. *Highway Research Record.* 1967;195:15-33.
 9. Tsimhoni O, Yoo H, Green P. *Effects of Visual Demand and In-Vehicle Task Complexity on Driving and Task Performance as Assessed by Visual Occlusion.* Ann Arbor, MI: The University of Michigan Transportation Research Institute; 1999. UMTRI Technical Report 99-37.