The effect of an Ice Hockey Faceguard on Peripheral Awareness & Reaction Time

■ **Suzanne N. Tran O.D.**[A]
■ **Angel Lopresti O.D.**[B]
■ **John H. Lee O.D.**[C]
■ **Carmen N. Barnhardt O.D., M.S.**[C]

A. Las Vegas, NV. Private Practitioner.
B. Eugene, OR. Private Practitioner.
C. Southern California College of Optometry, Fullerton, CA. Members of faculty.

Abstract

Peripheral awareness and reaction time are two important skills to athletic performance in ice hockey. This study addressed whether or not a faceguard has an effect on these two skills in ice hockey players. Previous studies have shown a decreased sensitivity with peripheral visual field testing while wearing a faceguard. However, no studies have evaluated peripheral awareness and reaction time with ice hockey faceguards. Peripheral visual field tests evaluate retinal sensitivity to peripheral stimuli; peripheral awareness measures the incorporation of stimuli into one's perceptual visual world; reaction time measures how quickly the individual responds to presented stimuli. Twenty-five male and female ice hockey players, 18 to 35 years old, participated in this study. All subjects passed a vision screening prior to testing. The Wayne Peripheral Awareness Tester was used to measure peripheral awareness in eight fields. The response time was slower by 0.2041 seconds when the faceguard was worn (p = 0.034). Slowest reaction time was ob-served in the right and down field positions (0.50 sec, p = 0.005; 0.59 sec, p = 0.001, respectively) while the faceguard was worn. Generally, the athletes reported they did not like wearing a face cage or shield due to visual restrictions and compromised reaction time. We believe that if future faceguards are designed with peripheral awareness in mind, athletes would be more inclined to wear them. Future studies should investigate optimum faceguard designs to maximize the athletes' safety and still provide minimally impaired peripheral awareness and speed of reaction time.

Key Words

eye injuries, ice hockey, peripheral awareness, protective eyewear, reaction time, sports vision, Wayne Peripheral Awareness Trainer

INTRODUCTION

Superior visual skills are important elements for athletic performance. Some examples of these skills include the ability to follow the trajectory of a baseball (pursuits) and judging how far to throw a football to a receiver (depth perception).[1] These skills also include returning a serve with a backhand slice in tennis (eye-hand coordination) and the ability to be aware of where teammates are on the field while maintaining focus on and reacting to an ice puck (pe-ripheral awareness).[1] Ice hockey requires a diverse range of visual skills similar to many sports. We were interested in evaluating the degree to which wearing an ice hockey faceguard affects peripheral awareness and speed of reaction.

Peripheral awareness differs from the peripheral field of vision.[2,3] Peripheral awareness incorporates peripheral stimuli into one's visual world rather than just perceiving whether or not a stimulus is present.[2] It also involves simultaneously perceiving what is central and appreciating what may or may not be off to the side.[3] Speed of reaction represents the time required to process a stimulus by the visual system and to evoke a neuromuscular response.[4] Anything that compromises the ability of an athlete to respond accurately and quickly could have a dramatic effect on his or her performance.

Previous studies have shown restricted visual fields with different ice hockey goalie masks. Seven different ice hockey goalie masks were evaluated on the visual field of an intercollegiate goalie.[5] This study found that all masks produced reduced visual fields, including central scotomas. Others have shown statistically significant restrictions in binocular visual fields while wearing racquetball goggles.[6] Lin and Ortiz addressed peripheral awareness in racquetball players using the Wayne Peripheral Awareness Trainer (PAT).[a] They reported no

statistical significance in reaction time while wearing protective eyewear.[7]

Previous studies have demonstrated that different mask designs can cause visual field restrictions.[5,7] These restrictions did not appear to affect peripheral awareness. The aim of this study was to determine if visual field restrictions from ice hockey faceguards would adversely affect our subjects' peripheral awareness and speed of reaction.

SUBJECTS

Our subjects consisted of 25 competitive and/or recreational ice hockey players. The group was composed of 23 (92%) males and two (8%) females with age range of 18 to 35 years (mean = 26.5).

All subjects met the following qualifications: best corrected distance visual acuity of 20/30 or better monocularly and binocularly using a Snellen acuity chart at 20 feet; no oculo-motor restrictions detected by versions; no strabismus detected by the unilateral cover test at 6 meters and 40 centimeters in primary gaze; no external and internal ocular pathology or injury detected by slit lamp and direct ophthalmoscopy; no apparent visual field defects detected by confrontation fields. All subjects signed an informed consent to be a part of the study after the testing procedures were explained to them. The procedures complied with the tenets put forth in the Declaration of Helsinki and were approved by the Institutional Review Board at the Southern California College of Optometry (SCCO). Subjects were compensated with a complimentary, comprehensive visual exam or sports vision evaluation from SCCO.

MATERIALS

Testing was performed with the Wayne Peripheral Awareness Trainer (PAT)[a],[8] This instrument is compact and contains an Intel micro-computer programmed to measure reaction time to a peripheral stimulus in eight fields of gaze. There are eight peripheral rods (six long and two short at the 12:00 and 6:00 position) inserted into eight holes in the instrument. The rods are displayed radially in eight fields of gaze where a single green light appears at the end of each rod. See Figure 1. The subject maintains central fixation by viewing a centrally positioned red light that turns on and off. The PAT randomly presents a peripheral green target light in one of the rods. The subject is

Figure 1. Wayne Peripheral Awareness Tester.

instructed to move a joystick when he or she perceives the green light, but only while the central red light is on. The PAT displays the subject's reaction time in 1/100 seconds for each randomly displayed light position.

The PAT was attached to an adjustable wall mount or stand on a neutral colored background. Height was adjusted to maintain eye level with the central red fixation light. Each subject was instructed to view the red fixation target at eye level, while holding a joystick. This joystick has a trigger to reset the test and is toggled to randomly presented target lights in eight fields of gaze. A green light in one of the positions turned on every two to four seconds.

We selected the CCM 2001 HK 400 combo helmet.[b] See Figure 2. The manufacturer claims this faceguard is lightweight and delivers superior visibility.[9] Three different sizes (large, medium, and small) were used to ensure proper helmet fitting.

METHOD

Testing was performed with the PAT utilizing a previously described protocol.[10] This protocol had: settings for the PAT, verbal instructions for the subject, test distance, lighting conditions, subject's testing alignment position, recording method. Incident luminance on the PAT measured 40-70 cd/m^2 of illumination with a light meter.[c] Each subject maintained a test distance at one meter from the PAT. The PAT mode was set to "touch, eight fields of gaze" in the "test position." Testing at SCCO was completed in two days by two authors (ST, CB) and one day at the San Diego Ice Arena, Mira Mesa, California, by three authors (ST, AL, JL). We verbally gave

Figure 2. CCM 2001 HK 400 combo helmet.

each subject a scripted explanation of the purpose of the study and demonstrated how to use the joystick.

Each subject performed three practice trials using the PAT with the faceguard. This familiarization helped the athlete move more accurately and negated the learning effect influencing the responses. Testing began immediately after the rehearsals.

Subjects were randomly selected into two groups by drawing a letter A or B from a bag. Each subject performed two testing trials, each of which had two parts. Group A wore the faceguard initially and then removed the faceguard for the second part of the first trial; in the second trial, the order of faceguard wearing was reversed. Group B began without the faceguard and then wore the faceguard for the second part of the first trial, and then reversed the order for the second trial. Reaction times were displayed on the PAT in hundredths of a second, and were recorded on a summary sheet.

After testing, the following information was recorded from the subject: hand dominance, position(s) of play, years of experience, and any participation in a sports organization or sports team. All information and results were recorded on a summary sheet.

RESULTS

The mean number of years our subjects played ice hockey was 11.74 (8.22) with a range of six months to 30 years. Ninety-six percent of subjects were right handed and 88% used the right side of the ice hockey puck to make a slap shot.

Average reaction times in hundredths of a second are shown in Table 1. The range was 0.58 to 2.39 seconds with and

without the faceguard. Mean differences were calculated in Trial 1 and Trial 2 (Figure 3). In Trial 1, five of eight field positions showed slower times with the faceguard. In Trial 2, six of eight field positions showed slower times with the faceguard. The overall average reaction time difference with and without a faceguard was 0.2041 sec slower (p = 0.034) using the Wilcoxon Signed Rank Test.
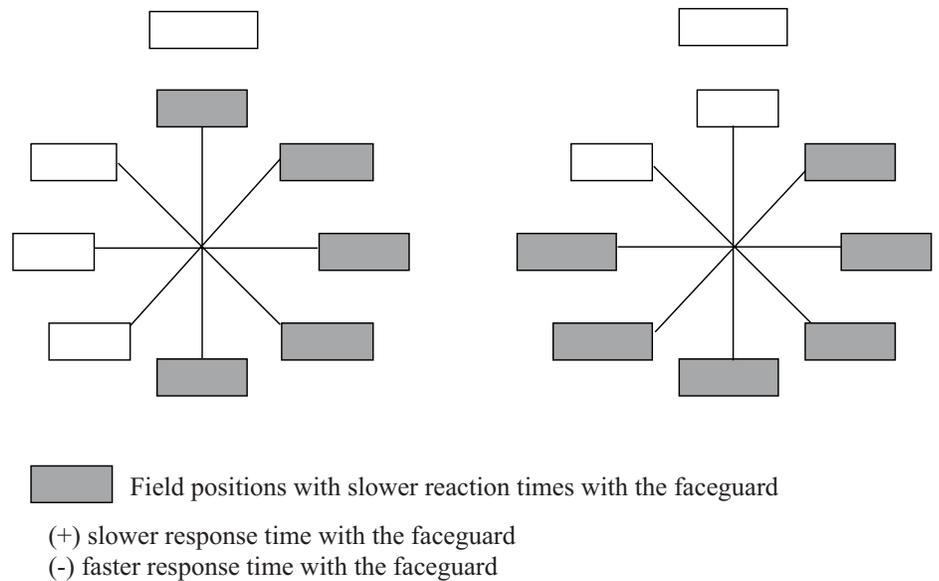
Statistical analysis of individual fields was calculated, using the Wilcoxon paired sample test (Table 2). The mean difference between response times across both trials was compared. Response time was slower with the faceguard when the subject was viewing in the following fields: up (+0.23 sec), upper right (+0.05 sec), right (+0.50 sec), and down (+0.59 sec). But, only two fields showed statistical significance: right (+0.50 sec, p = 0.005) and down (+0.59 sec, p = 0.001). The up position was very close to significance (+0.23 sec, p = 0.051).

DISCUSSION

Our data showed that overall reaction time was slower by 0.2041 seconds with the CCM 2001 HK 400 combo helmet worn. Response times across both trials showed statistical significance in two field positions, down and right. The slowed reaction time in the right field position may be influenced by two factors; subjects' hand dominance and side of their slap shot may play a role in their predominant field. Because the dominant field was on the right side, most subjects would likely notice the hindrance from the faceguard in that field of action. We also suggest the construction of this faceguard may affect the subjects' response times. Based on the results, it would be interesting to alter the inferior region of the faceguard. A change in this region may be beneficial because the inferior field is extremely important to any hockey player.[5]

Visual reaction time has been measured in previous studies using the Wayne Saccadic Fixator. These studies were performed on a diverse age and athletic population ranging from school aged children,[11] to high school & college athletes[12], to amateur and professional athletes.[13] Additionally, measures in different fields of gaze were not reported. Interestingly, Sherman's study[13] found that ice hockey players had the highest visual reaction time, which was defined as

Figure 3. Mean difference between response times in Trial 1 and Trial 2 with and without the faceguard.

Field positions with slower reaction times with the faceguard

(+) slower response time with the faceguard
(-) faster response time with the faceguard

Table 1. Average reaction time in seconds.

Field position	With faceguard Trial 1	Without faceguard Trial 1	With faceguard Trial 2	Without faceguard Trial 2
Up	1.94	1.42	1.21	1.23
Upper right	1.43	1.20	1.11	1.04
Right	1.99	1.51	1.91	1.22
Down right	1.22	1.09	1.35	1.07
Down	1.37	0.78	1.92	0.88
Down left	0.99	1.56	1.10	0.58
Left	1.87	2.39	1.98	1.68
Upper left	1.38	1.95	1.30	1.30

Table 2. Mean difference between response time with a faceguard and without a faceguard using the Wilcoxon paired sample test.

Field position	Time (seconds)	P-value
Up	+0.23	0.051
Upper right	+0.05	0.638
Right	+0.50	0.005
Down right	-0.01	0.904
Down	+0.59	0.001
Down left	-0.002	0.979
Left	-0.003	0.872
Upper left	-0.02	0.936

the correct number of hits in 30 seconds. However, he did not indicate whether the athletes were wearing a faceguard.

There were limitations to the present study. We did not have a large sample size. We attempted to achieve consistent lighting conditions with a light meter as indicated by Beckerman and Zost.[10] They recommended a lighting level of 1 foot-candle to maximize the contrast and decrease testing variability when using the PAT. Their lighting recommendations

would be too dim to match the player's ice rink environment. We chose to use between 40-70 cd/m^2 of illumination as recommended by the PAT manufacturer.[a] Also, ice hockey is not played on a vertical plane (as the PAT was mounted on the wall or stand). Further research should have the PAT placed in a horizontal horizontal position on the floor to simulate actual playing conditions.

Although the present study strongly indicates that reaction time is slowed with

the use of a faceguard, safety should not be sacrificed. The reason for this is clear since the ice puck acts as a projectile, traveling faster than 150 mph. Proper eye protection includes polycarbonate lenses, certified face cages, and mesh protectors through which neither the stick nor the puck can penetrate.[14,15] The CCM 2001 HK 400 combo helmet was chosen because of the manufacturer's claims of delivering superior visibility, and being lightweight. We thought that the horizontal and vertical grid bars on this faceguard may compromise visibility, yet provide excellent safety for the ice hockey athlete. These cage-type masks are becoming increasingly popular due to safety factors.[5]

The preferred style of face shields, if worn at all, is the polycarbonate half shield in the National Hockey League.[16] Visual issues associated with face shields or polycarbonate visors include fogging, ice shaving condensation, scratches, and glare.[5,16] Central scotomas are not an issue when the face shield is new and free from scratches, but can be a factor in shield cages.[5] However, significant ocular and facial injuries can still occur with visors.[16]

Peer pressure and bravado, rather than visual limitations, are leading factors in choosing not to wear protective eyewear.[16] Our subjects generally reported that they did not wear protective face cages or shields. They believed a faceguard was visually constricting and would compromise their response time. Our study found two-tenths of a second difference in reaction time. More research is needed to determine if the decrease in reaction time found in our results was directly attributed to the faceguard design or other extraneous factors such as lighting, background neutrality, performance fatigue, or hand dominance.

Most importantly, we want to again emphasize that, above all, safety should be the most important factor when ice hockey players are choosing a helmet and faceguard design. Indeed, Ciuffreda and Wang have listed preventative eye injury measures as an important optometric role in the field of sports vision.[17] Pashby reports that 90% of sports injuries can be prevented by enforcing game rules, setting standards and wearing certified eye protection.[18,19] Therefore, our hope in doing this study was to begin a series of studies to best design a faceguard which offers superior visibility and protection.

Ultimately, eye care practitioners have a duty to prevent sports-related injuries by encouraging certified protective eyewear such as a faceguard especially in ice hockey. It would be interesting to further investigate different faceguard designs which maximize an athletes' visual field to help improve reaction time and peripheral awareness.

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DISCLOSURES

None of the authors have a financial or other interests in the products used in this study.

SOURCE

a. Wayne Engineering Laboratories, 1825 Willow Road, Northfield, IL 60093, (708) 441-6940
b. Light meter – calibrated in foot-candles. Spectra Lumicon Series II. Photo Research, Burbank, CA.
c. World Wide Sports, 199 Constitution Avenue, Building 2 Unit C, Portsmouth, NH 03801, (800) 997-7678.

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Corresponding author:
Suzanne N. Tran, O.D., FAAO
Vision Source!
8937 W. Sahara Ave., Suite A
Las Vegas, NV 89117
sntranod@aol.com
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