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The Role of Sports Vision in Eye Care Today

David G. Kirschen, O.D., Ph.D., and Daniel L. Laby, M.D.

Abstract: Sports vision as an academic discipline is in its infancy. This review traces its history on many different fronts: early work, research, organizations, literature, cultural environment, sports injuries, and a view of the future. This article was presented as the opening remarks to the first-ever academic sports vision meeting held at Fenway Park in Boston, Massachusetts, in January 2010.

Key Words: Sports vision—Eye care.

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Vision is our dominant sense. The eyes provide both spatial and temporal information to the brain, which must then be processed and acted on. For this processing system to work optimally, its input must be optimal. In sports, especially in fastball sports, information must be gathered quickly, processed quickly, and acted on quickly if the athletes are to perform at their best in their sport. A dramatic example of this is illustrated in a graphic depicting the "most difficult act in sports"—hitting a baseball (Fig. 1).

The ball is only 3 in. in diameter, and the bat is only 2.25 in. in diameter, which does not leave much room for error. The batter has only 100 millisec to "look" at the pitch and to extract information about the spin, trajectory, and velocity of the ball all of which must be completed within that short time. The batter then has 75 millisec to "think" about the information just collected and calculate the location of the ball as it approaches and crosses the plate. The batter then has 50 millisec to "decide" whether to swing or not. Therefore, a swing has to be initiated after only 225 millisec from first seeing the pitch or the batter will not be able to get the bat around fast enough to make successful contact with the ball. As a testament to how difficult it is to hit a baseball, it is the only sport in which the player can fail 7 out of 10 times and still be considered a hero and reach financial success.

For the batter to be successful in the above example, several aspects of the visual system, such as visual acuity, contrast sensitivity, and binocular vision must be active and functioning at the highest level.

HISTORY

Historically, the understanding of how vision affects sports performance has evolved over the years. From initially being concerned with simple protection of the eyes, to more recently incorporating the importance of visual function to elite athletic performance. In antiquity, various techniques were used to protect athletes from exposure to the sun.[1] More recently, in the 20th century, specifically in 1921, scientists tried to ascertain what, if anything, was special about Babe Ruth's vision that might have contributed to his outstanding baseball performance. They concluded, after administering several tests, that his eyesight was 12% faster than that of normal individuals.[2] The tests they performed are unknown, and the method of analysis they used to reach their conclusions is not available, but at a minimum, this was the first attempt to relate visual function to sports performance. More recently, several studies have attempted to delineate the specific visual factors necessary for success in sports. In 1942, Winograd[3] studied collegiate baseball players and found that their stereopsis and visual efficiency were better than those of both the general population and students who did not qualify for the team. Rouse et al.[4] reported that dynamic visual acuity (the ability to resolve detail while there is movement between the object and the subject) in a group of collegiate baseball players was better than in normal controls. The relationship between athletic performance and visual factors such as contrast sensitivity and stereoacuity has also been researched. Hoffman et al.[5] reported increased ability to detect small differences in luminance between an object and its background (contrast sensitivity) in baseball players as compared to controls. Solomon et al.[6] described better dynamic depth perception (stereopsis) in major league batters than in pitchers. Baseball players are not the only athletes whose visual systems have been studied over the years. Jafarzadehpur et al.[7] studied female volleyball players for the facility of their eye movements and accommodation and found a significant difference between players and nonplayers and between levels of volleyball players. Young skilled basketball players have also been reported to have superior visual functions as compared with an age- and sex-matched nonathlete population.[8] Participants in many of the sports in the 1997 and 1998 Junior Olympic Games have been shown to have better visual fixations, an increase in foot speed, and a decrease in hand speed with increasing age. They also found that eye care in this population was underused with almost 30% of the participants never having had an eye examination.[9] Not all the reports have found that athletes have had better visual function. Deshaies and Pargman[10] examined college football players and found no

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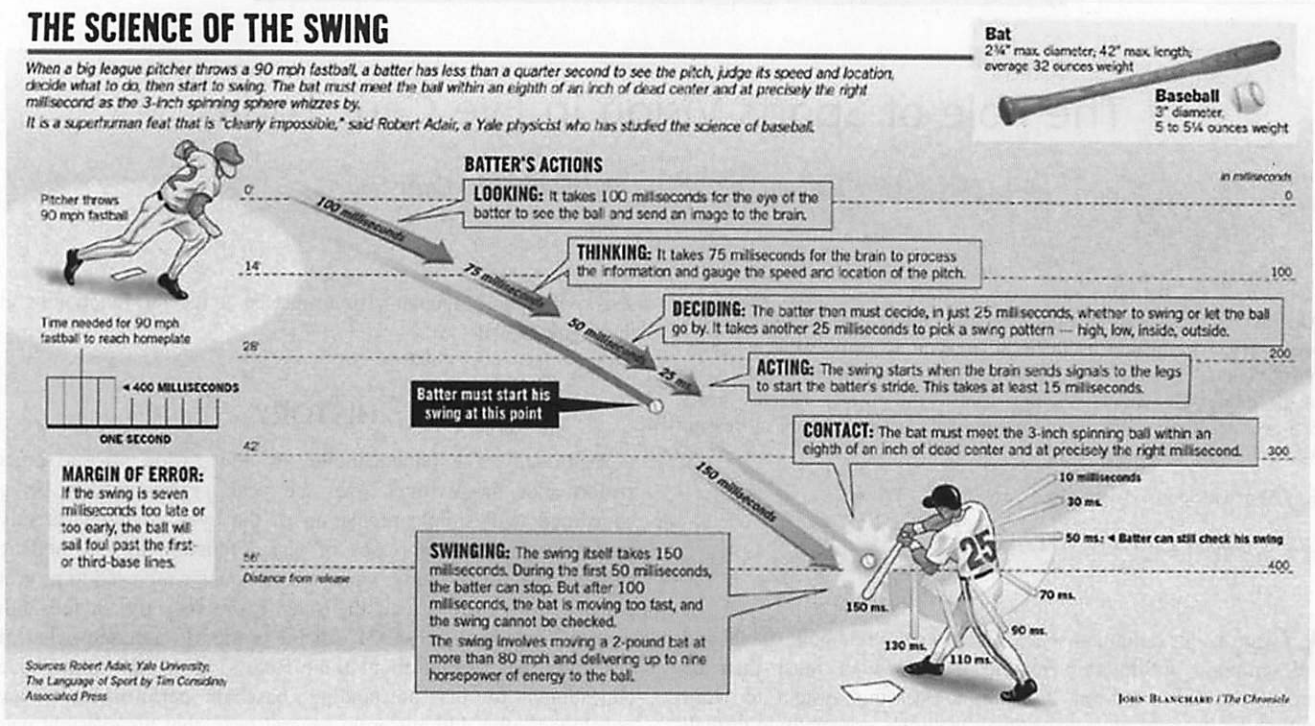

FIG. 1. The science of the swing.

differences in their visual function between varsity and junior varsity players.

THE SPORTS VISION PYRAMID

By the mid-1990s, there was still relatively little published specifically on sports vision, although the number of publications was ever increasing and the topics were widely varied. To help organize many of the research findings and to provide a systematic approach to understanding the various components of sports vision, we developed the concept of the Sports Vision Pyramid (Fig. 2).

Each layer of the pyramid is laid on the one below and contributes to the overall strength and stability of the structure. For objects on or near the top of the pyramid to be stable, they must be placed on a solid foundation. So is the case with the Sports Vision Pyramid. The apex of the pyramid is "Best On-Field Performance." For that to occur, it must rest on several layers of solid visual function.

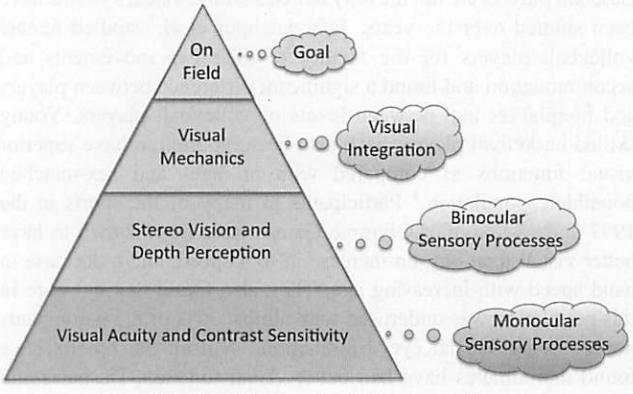

FIG. 2. The sports vision pyramid.

The base of the pyramid is concerned with optimizing monocular visual function. The two main components of this level are visual acuity and contrast sensitivity. Optimizing visual acuity usually entails a careful refraction paying special attention to small cylindrical corrections. It has been our experience that correcting small amounts of astigmatism can have a dramatically positive effect on the visual acuity of elite athletes. Contrast sensitivity, especially at the higher spatial frequencies, is vital for optimum visual performance. Various filters can be used to enhance contrast sensitivity; this includes yellow goggles for skiers on a cloudy day, which allow them to see the changes in the terrain (i.e., moguls) more easily. Other filters can decrease glare on a sunny day or under bright stadium lights.

After fully testing and correcting monocular visual functions, we must turn our attention to how the two eyes work together. The next level of the pyramid is concerned with binocular visual functions, for example, stereopsis. Unlike the arms and legs, which are designed to work independently, the eyes are "wired" to work together. There are several visual conditions that can negatively influence binocularity. Motor problems such as strabismus or fixation disparity or sensory problems such as suppression or amblyopia can compromise binocularity. Visual efficiency problems such as accommodative or vergence infacilities can also negatively influence binocularity.

Only after the first two levels of the pyramid have been optimized, can our attention be turned to the third level, which comprises visual mechanics. This level of the pyramid highlights how the brain uses the visual information it has been provided to instruct the arms, the legs, and the rest of the body to successfully compete. Attempting to train the visual mechanics

level of the pyramid before the first two levels have been optimized will not yield optimum results and in fact can be counterproductive.

For best results, each level of the pyramid should be considered in ascending order, starting from the bottom, and only then moving up to a higher level. The best On-field Performance can only be achieved when each level of the visual pyramid has been optimized. Or at least if performance is less than desired, we are in a position to say "Its not the eyes!"

SPORTS VISION ORGANIZATIONS

Various organizations have been formed over the years to provide a forum for the presentation and discussion of sports vision research. The Sport Vision Section of the American Optometric Association is the oldest, founded in 1978. Members of this Section have played a significant role in providing eye care to participants in the Junior Olympics. Sports vision associations are not limited to the United States; there are several worldwide, for example, the Sports Vision Section of Canadian Association of Optometrists, the European Academy of Sports Vision, The Sports Vision Section of Optometrists Association Australia, and the Sports Vision Association in United Kingdom. For years, The International Academy of Sports Vision provided a forum for those interested in sports vision to present various clinical techniques they had developed to other like-minded sports vision practitioners. None of these organizations, however, was or is specifically dedicated to sports vision research and publishing in scientific, peer-reviewed journals.

Although these organizations serve a valuable function of bringing together various disciplines to discuss the topic of sport vision, there are still significant gaps in the establishment of sports vision as an accepted academic discipline. There are no organized and accepted training programs in sports vision. There are sport vision clubs at several schools of optometry and some intern programs in private offices that provide sports vision education, but none of this is organized or unified with a consistent curriculum and national (or international) certification.

SPORTS VISION LITERATURE

The sports vision literature is scattered among numerous specialties and is unknown to most sport vision practitioners. Many of the reports are only anecdotal, and few have any scientific basis. Some of the best research relating to sports vision occurs in other allied disciplines such as psychology or rehabilitative medicine and rarely reaches the eyes of the sports vision practitioner. There is no forum for discussion and interaction among sports vision specialists worldwide. There is a poor understanding by the public and even by coaches, trainers, and athletic directors as to what a sport vision specialist really does.

The discipline is young and is still finding its legs. Starting in the 1990s, there have been more research articles in sports vision that have been published in peered-reviewed professional journals. Joan Vickers is a good example of someone who has rigorously studied the role of eye movements in sports. She has published several scientific articles and a book "The Quiet Eye."[11–13] We also now have a textbook authored by Dr. Graham Erickson solely devoted to sports vision.[14] An e-mail list serve has been started to foster the open e-mail discussion of all topics related to sports vision. Most recently, in January 2010, we had our first academic-based sports vision conference at Fenway Park in Boston. It is hoped that this event will become a biennial event.

GENERAL SPORTS ECONOMIC ENVIRONMENT

The economics surrounding sports vision is encouraging. The number of people involved in sporting activities is increasing every year.[15] The amount of money being spent on sports in the United States is also ever increasing. As of 2000, sporting goods equipment sales amounted to over "$18 billion." Add to this sports apparel at over "$20 billion" and athletic footwear at almost "$10 billion"—not included in these numbers are the dollars spent each year on gym memberships and on professional trainers. Most recent estimates suggest that parents are spending a significant number of dollars on their children in support of their sporting activities. The numbers range from $2,000 to $10,000 per year, per child.[16]

Parents should be educated on the fact that vision is a prerequisite to their child's success in sports and that the appropriate vision correction should be a standard part of their child's "sports" equipment.

SPORTS-RELATED INJURIES

Unfortunately, along with the increase in the number of people being involved in sports each year, the number of sports-related injuries is also increasing. For 2006, there were in excess of 2 million sports-related injuries as reported by Forbes.com. It is interesting to see in which sports the most injuries occur.

Basketball: 529,000;
Bicycling: 490,000;
Football: 460,000;
All Terrain Vehicles: 275,000;
Baseball/softball: 274,000.

Not surprising is the fact that sports in which the most head injuries occur are cycling, football, use of powered recreational vehicles, basketball, baseball, and softball.[17] Dr. Paul Vinger[18] has been a leader in illuminating the potential dangers of eye injuries while playing sports. He has also championed the development of several protective devices to protect the athletes from injury. Recently, he has been using computer modeling to understand the physics behind sports injuries to develop even more effective protective eye devices.[19] There is a great need for vision-related services, prevention education, trauma treatment, and vision enhancement within the sports community.

FUTURE OF SPORTS VISION

Expansion of the discipline of sports vision could serve as a platform for a closer interprofessional relationship between ophthalmology and optometry. Offering vision care to athletes is one area in which there is a chance for greater synergy, mutual respect, and the sharing of knowledge between the two professions. It provides a great learning experience for all. Interaction with other allied health disciplines is also possible and can lead to important discoveries. The practice of sports vision brings together physicians, optometrists, neuroscientists, psychologists, coaches,

and athletic trainers in an environment of mutual respect and openness for all ideas. The mutual goal is the appropriate diagnosis and treatment of the athlete's vision.

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